

# Proceedings of

# ACN

# INTERNATIONAL CONFERENCE



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**ACN**  
**INTERNATIONAL CONFERENCE**  
**THIRUVANANTHAPURAM, INDIA**

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## **EDITORIAL**

It is my proud privilege to welcome you all to the ACN International Conference at Thiruvananthapuram, India. I am happy to see the papers from all part of the world and some of the best paper published in this proceedings. This proceeding brings out the various Research papers from diverse areas of Science, Engineering, Technology and Management. This platform is intended to provide a platform for researchers, educators and professionals to present their discoveries and innovative practice and to explore future trends and applications in the field Science and Engineering. However, this conference will also provide a forum for dissemination of knowledge on both theoretical and applied research on the above said area with an ultimate aim to bridge the gap between these coherent disciplines of knowledge. Thus the forum accelerates the trend of development of technology for next generation. Our goal is to make the Conference proceedings useful and interesting to audiences involved in research in these areas, as well as to those involved in design, implementation and operation, to achieve the goal.

I once again give thanks to the Institute of Research and Journals, ACN & The IIER for organizing this event in Thiruvananthapuram, India. I am sure the contributions by the authors shall add value to the research community. I also thank all the International Advisory members and Reviewers for making this event a Successful one.

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# ANALOGY OF POINT FEATURE EXTRACTION TECHNIQUES

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**Abstract** - Image processing is a significant section of robotic and machine learning. The field of image processing is significant in terms of usage in the advanced world ranging from security, facial recognition to remote autonomous terrain mapping. The salient problem in image processing is how to detect, identify and recognize the feature points in an image. However, there are numerous feature point extraction techniques. In this paper, we are comparing the different available point feature extraction techniques currently in existence based on the scale changes, noise, rotation etc. The evaluation is based on the number of feature points from the reference image as well as matched points in the wild frame and elapsed time. The data and information from the study open up new research in the field of image processing based on point feature extraction.

**Keywords** - Descriptors, Feature Extraction, Interest Point.

## I. INTRODUCTION

The human brain is capable of extracting, processing and manipulating data efficiently as information based on the neural pathways residing over our nervous system with the influence of neurons. However, compared to the machine point of view this concept of identification is relatively harder as they are trained to perform over an algorithm for fast computation. For example, computers can perform large amounts of calculation in milliseconds which would be a lifetime process for human brains. In contrast to that, humans can identify, differentiate, categorise the world around them which is harder from the machine's perspective. The artificial intelligence concept where the computers think like humans is the near future, but for the computer vision to attain the capability to identify, differentiate, categorise the world, it has to be trained under supervised or unsupervised learning. Image processing with feature extraction is an inevitable part of the machine training process and it is essential to find the most efficient feature extraction algorithm for every possible scenario. The concept of feature extraction works significantly in hand with image processing.

## II. FEATURE DESCRIPTORS

### 1. BINARY ROBUST INVARIANT SCALABLE KEYPOINTS

The Binary Robust Invariant Scalable Keypoints algorithm is also known as BRISK is a feature point detection and description algorithm that is orthogonal in terms of scales and rotations. Brisk builds the binary feature descriptor of a given image by crossmatching the grayscale relation of different pair points in the image. An ideal interest point descriptor recognises the most prominent information content contained within the uncovered salient region and can

recognise the same information content when encountered.

The BRISK algorithm can be grouped into three main processes, namely Scale-Space Keypoint Detection, Keypoint Description and Descriptor Matching[1]. In the Scale-Space Keypoint Detection, the saliency of the image is considered a continuous quantity throughout the scaling dimension and a sub-pixel and continuous scale refinement is performed for each of the detected maximum contrast points. In a keypoint description, the characteristic direction of each interest point is identified to achieve rotation invariance[2]. The brightness comparisons to aid the descriptiveness also helps in achieving robustness. The third process is Descriptor matching which can be expressed as a bitwise XOR followed by a bit count which can be achieved with great ease in today's computer architecture.

### 2. FEATURES FROM ACCELERATED SEGMENT TEST

Features from accelerated segment tests commonly known as FAST is a common corner point detection based feature extraction algorithm that gained momentum due to its computational efficiency. FAST corner detector was developed by Edward Rosten and Tom Drummond in 2006. Moreover, the FAST method produced superior performance in terms of computational time and resources when machine learning methods were applied, contributing to the ascension of this method. The FAST corner point detectors are also found to be efficient for real-time video processing implementations due to their rapid performance.

The interest point detection in FAST can be explained as:

1. Selection of a pixel from the given image, considering the pixel has intensity I the pixel has to test if its an interesting point or not.
2. An approximate threshold value is selected for the image and a circle containing 16 pixels is considered around the selected pixel.

3. Now the selected pixel is an interesting point if the circle contains at least 12 continuous pixels that have intensity within a range of threshold from the intensity of the pixel to be tested.
4. To increase the efficiency of the method 4 pixels at a distance of 3 pixels from each other are compared first. If any 3 of these 4 pixels does not fall in the range of required intensity the given point is not a point of interest.
5. The above process is repeated on every pixel in the image[3].

One of the limitations of this method is the difficulty in finding adjacent maximum points and it is solved using non-maximal suppression(a method involving the assignment of score value to each of the detected interest points). Since the detected interest point must have a ring of darker or lighter pixel values around the centre FAST does not work well with crisp images and computer-generated images.

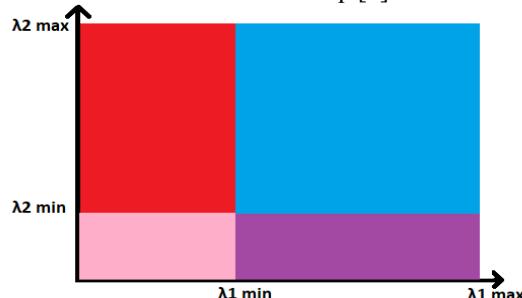
### 3. MINEIGEN

This method is a modified version of the Harris Corner Detector and was proposed by Shi and Thomas. Instead of using the score function as used in Harris Detector, MinEigen uses the Eigenvalues, which is used to calculate the score, to decide the corners[4].

The corner is calculated in MinEigen using the equation:

$$R = \min(\lambda_1, \lambda_2)$$

----- eqn[1]



*Figure 1. Min Eigen*

Here, the blue region has both the eigenvalues greater than a certain value and is considered to be region accepted as corners.

The red and violet regions have either of the eigenvalue less than the minimum required and is considered an edge.

The pink area has both eigenvalues less than the minimum and is a flat area.

### 4. MAXIMALLY STABLE EXTREMAL REGION

MSER is used in the detection of blobs in images. This algorithm extracts several covariant regions called MSER(Maximally Stable Extremal Region). Its basic idea is to target regions that stay almost constant for a wide range of threshold values.

For a particular threshold value, the pixels with a value lower than the threshold are taken as white and

pixels that have a value equal to or greater than the threshold are taken as black.

The following steps are involved in the extraction of MSER:

- The threshold intensity of the image is done by going back and forth from black to white which is called luminous thresholding.
- The related components are extricated, i.e. the extremal areas.
- Detect a threshold for which the extremal areas is Stable Maximally. A region is maximal even if the region above/below might be concurrent with the actual area.
- These MSER regions are then approximated within an ellipse.
- These region's descriptors are kept as features[5].

There are chances that a maximally stable extremal region is still rejected under the following conditions:

- The region is too big (according to the MaxArea parameter).
- The region is too small (according to MinArea).
- The region is too unstable (according to MaxVariation).
- The region is too similar to the parent MSER[6]

### 5. ORIENTED FAST AND ROTATED BRIEF

Oriented fast and Rotated Brief is a local feature descriptor having attracted major recognition from the existing SLAM scheme[7] with increased processing efficiency and having solid concurrent performance. It is a combined descriptor having a FAST keypoint detector and an enhanced variant of visual descriptor BRIEF(Binary Robust Independent Elementary Features). ORB was first presented by Ethan Rublee in 2011.

The ORB algorithm consists mainly of three major steps mainly feature point extraction, generating feature point descriptors and feature point matching. In the first step of the ORB image detection algorithm sequence the image feature point detection, feature point screening, image scale pyramid construction and sampling, feature point direction determination. The next step involves descriptor calculation from the ORB feature extracted points extracted from the previous step. Descriptor calculation[7] is the scale and rotation information regarding the image feature points. In the last step, the retrieved descriptors for feature extracted points need to be compared between two different time images to check if both of them matches.

### 6. SPEEDED UP ROBUST FEATURES

The normal steps of image cross-matching which are followed by the Speeded Up Robust Features(SURF) method are feature extraction, descriptor analysis and image cross-matching.

SURF extraction method uses a distribution-based descriptor and measure based on the Hessian matrix[8] for the detector. Irrespective of orientation the detector autonomously extracts features that must be extracted using a hessian based blob detector to

seek out interest points. The detector is used to subtract the pyramid layers obtained using subsampling and Gaussian kernels smoothing[9].

Haar wavelet responses along with integral images are used efficiently with the descriptor. The area around the focal point is reoriented before the descriptor calculation.

### 7. HARRIS CORNER FEATURE EXTRACTION

Harris detector is a corner detection algorithm that is remarkably utilized in computer image processing algorithms to extricate the corners points and to extract the features of an image. The algorithm was improvised over the existing Moravec's corner detector. Compared to the previous algorithms, the Harris corner detector considers the differential of the corner score with relevance to direction directly, rather than mistreatment of shifting patches for each 45-degree angle. As the method is observed to be efficient in distinguishing between edges and corners, it has been improved and adopted in many algorithms to preprocess images for successive applications. This method considers a small window around each pixel in the given image and identifies all distinctive pixel windows[10]. Soleness is calculated by moving windows by a minute value in a particular direction and comparing the change that is detected in each of the pixel values. The sum squared difference(SSD)[11] is the sum of the squared difference of the values of each pixel score before and after the shift in all 8 directions. A change function for each image is defined as an aggregate of every sum squared differences(SSD).

Harris algorithm can be explicated in the following steps:

1. Transformation of the given image to a grayscale image
2. Application of a Gaussian filter to remove any noise or distortions.
3. Application of Sobel operator to obtain the x and y gradient values for each pixel in the grayscale image.
4. A  $3 \times 3$  window is considered around every pixel in the grayscale image and the corner strength function is computed. This value is called the Harris value of the image.
5. all pixels that exceed a certain threshold are detected and is the local maxima within the window
6. For every pixel that meets the criteria of the threshold, a feature descriptor is computed[12].

### 8. KAZE

The KAZE method utilizes the non-linear scale-space through non-sequential diffusion filtering for feature point extraction and was put forward by P. F. Alcantarilla et al in 2012. KAZE method is built on scale normalized determinant of Hessian Matrix that is calculated at multiple scale levels[13]. The highest point of detector output is recorded as an interesting point by a mobile window. In the Feature description, the feature of orientation equability is introduced by

detecting prominent orientation in the vicinity of a given radius around each of the recorded feature. Although this method requires high computational resources KAZE features are equable to rotation, scale, limited affine and are more distinctive at various scales. The equation representing the standard nonlinear diffusion can be expressed as.

$$\frac{\partial L}{\partial t} = \text{div}(c(x, y, t) \cdot \nabla L) \quad \text{----eqn[2]}$$

Where  $c$  = conductivity function

$\text{div}$  = divergence,

$\nabla$  = gradient operator

$L$  = luminance of the image.

## III. EXPERIMENTS

This paper focuses on various feature detection algorithms. The implementation was done on Intel® core(TM) i7 10th gen processor with 16GB RAM and speed of 2.6-5GHz. The code was written in MATLAB R2020b on Windows 10 64 bits. The experiment consists of various tests by introducing effects like rotation, scale change and noise. The sample picture considered for all the tests is shown below having a size of 2.2Mb.

The experiment is divided into two sections.

The first section tabulates the time required for feature extraction of each point feature extraction methods namely BRISK, FAST, HARRIS, KAZE, MINEIGEN, MSER, ORB, SURF.

ALGORITHM	TIME OF FEATURE EXTRACTION
BRISK	<b>0.313587</b>
FAST	<b>0.074147</b>
HARRIS	<b>0.0853465</b>
KAZE	<b>4.763558</b>
MINEIGEN	<b>0.91857</b>
MSER	<b>1.010411</b>
ORB	<b>0.148321</b>
SURF	<b>0.334866</b>

Table 1. Time of feature extraction for each algorithm

TIME OF FEATURE EXTRACTION vs. ALGORITHM

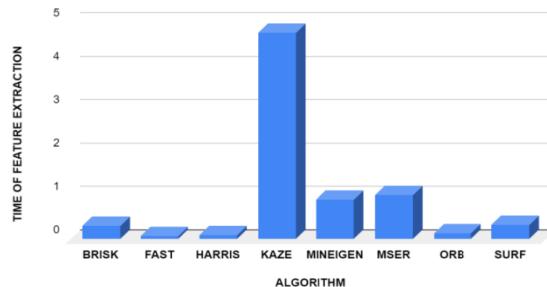


Figure 2. Graph for Feature Extraction time vs Algorithm

The graphs are plotted between different types of feature extraction algorithms and the time taken by these algorithms to extract the feature points from a given reference image. It is evident from the graph that the highest time for feature extraction was for KAZE and the lowest time was recorded for the FAST feature extraction method. Although KAZE required a higher computation time, the number of matched points was comparatively higher for KAZE, emphasising the linear relation between computation time and the number of matched points. From the above visualisation, it can be observed that the SURF feature extraction method requires comparatively less computation time in all variants of inputs and provides a relatively higher number of match points in most cases. Thus it can be concluded that SURF is befitting in a situation where the raw inputs are provided.

The second section is sub categorised into three parts. The first part determines the time for evaluation of matching points and the number of matched points for images having angular distortion. For the experiment distortion angles of 0, 45, 90 degrees have been considered.

TILT - FEATURE EXTRACTION METHOD VS TIME			
ALGORITHM/TILT ANGLE	45° TILT	90° TILT	0° TILT
BRISK	0.057429	0.046397	0.048213
FAST	0.064922	0.060837	0.067189
HARRIS	0.057784	0.055006	0.063457
KAZE	0.02712	0.027696	0.026556
MINEIGEN	0.053279	0.050198	0.05072
MSER	0.029002	0.031249	0.029311
ORB	0.06573	0.064043	0.05838
SURF	0.039339	0.03423	0.044163

Table 2. TILT - Feature Extraction Method and time taken

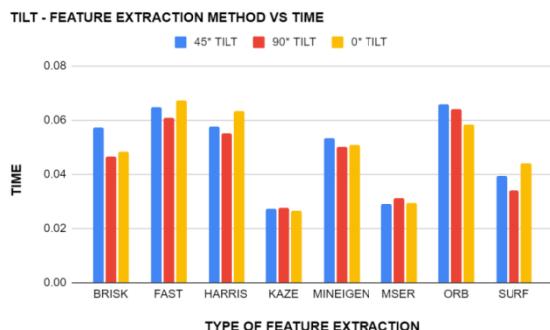


Figure 3. TILT - Feature Extraction Method VS Time

The above graph is plotted between the different feature extraction algorithms and the time taken by these algorithms to cross-match the interesting point in the reference image to the points in the variants of the reference image with different tilts of 0°, 45°, 90°. As visible from the graph, the KAZE algorithm was able to cross-match all three cases of tilt with the reference image within a time range of 0.026 to 0.027 seconds. It can also be observed that the time taken by KAZE to cross-match is almost consistent for all the three types of tilt image inputs whereas methods like ORB show large variation time taken for different tilts. Moreover, the highest time of computation for the cross-matching process was observed in ORB and Fast methods making these methods less suitable for scenarios that require high computational efficiency and quick outputs.

TILT - FEATURE EXTRACTION METHOD VS MATCHED POINT			
Algorithm	45° Tilt	90° Tilt	0° Tilt
BRISK	35	47	496
FAST	25	118	483
HARRIS	3	31	498
KAZE	44	41	500
MinEigen	3	46	500
MSER	140	193	463
ORB	41	41	500
SURF	142	327	500

Table 3. TILT - Feature Extraction Method and number of matched points

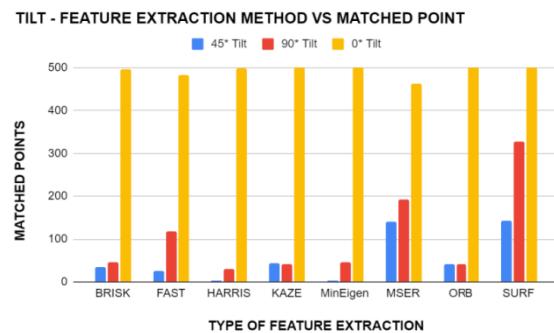


Figure 4. TILT - Feature Extraction Method vs Matched Points

The above graph is plotted between the different feature extraction algorithms and the number of matched points. As evident from the graph, the number of match points is maximum at 0° tilt for all the different types of feature extraction. Comparing the above two graphs of tilt input scenario it can be

concluded that ORB requires higher computational infrastructure compared to methods like KAZE and MSER as the latter method was able to extract approximately the same number of interest points within one by the third fraction of time consumed by ORB and FAST methods. Also, contrary to the prior traits SURF has cross-matched the maximum number of points in all three type of tilt inputs.

The second part determines the time for evaluation of matching points and the number of matched points for images having noises. For the experiment, common noises like median, Gaussian and Dust and scratches are considered.

NOISE - FEATURE EXTRACTION METHOD VS TIME			
ALGORITHM	MEDIAN NOISE	Gauss Noise	Dust and scratch
BRISK	<b>0.048426</b>	<b>0.044872</b>	<b>0.041388</b>
FAST	<b>0.047351</b>	<b>0.041478</b>	<b>0.04614</b>
HARRIS	<b>0.054686</b>	<b>0.05249</b>	<b>0.05528</b>
KAZE	<b>0.025917</b>	<b>0.026505</b>	<b>0.027484</b>
MINEIGEN	<b>0.054124</b>	<b>0.051961</b>	<b>0.050279</b>
MSER	<b>0.030573</b>	<b>0.035674</b>	<b>0.037759</b>
ORB	<b>0.060046</b>	<b>0.065243</b>	<b>0.066454</b>
SURF	<b>0.037223</b>	<b>0.033108</b>	<b>0.038761</b>

Table 4. NOISE - Feature Extraction Method and time taken

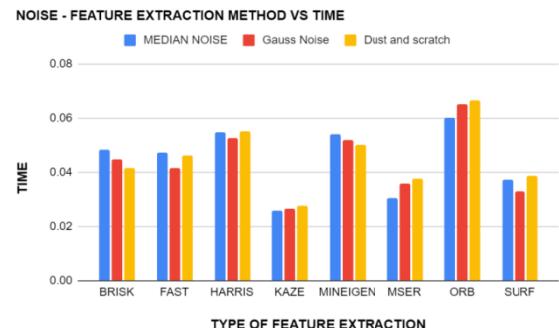


Figure 5. NOISE - Feature Extraction Method VS Time

The graph has been plotted for noise-feature extraction of three different types of noise against the time taken for these extractions by each method. From the graph, we can observe that KAZE took the least time, between 0.0259sec (for median noise) and 0.0274sec (for Dust and Scratch) for feature extraction for all three types of noise, followed by MSER and SURF. The time taken by KAZE is also consistent when compared to the other methods where the time taken differs from each other by a greater value. We can also observe that ORB is the method that took the longest for extracting the

features for all three types of noises and thus making it the least suitable among the bunch if the images to be cross-matched have a significant amount of noise.

#### NOISE - FEATURE EXTRACTION METHOD VS MATCHED POINT

Algorithm	Median Noise	Gauss Noise	Dust and scratch
BRISK	<b>15</b>	<b>103</b>	<b>13</b>
FAST	<b>0</b>	<b>20</b>	<b>1</b>
HARRIS	<b>4</b>	<b>9</b>	<b>2</b>
KAZE	<b>28</b>	<b>162</b>	<b>49</b>
MinEigen	<b>2</b>	<b>3</b>	<b>3</b>
MSER	<b>18</b>	<b>12</b>	<b>14</b>
ORB	<b>34</b>	<b>8</b>	<b>34</b>
SURF	<b>94</b>	<b>259</b>	<b>94</b>

Table 5. NOISE - Feature Extraction Method and number of matched points

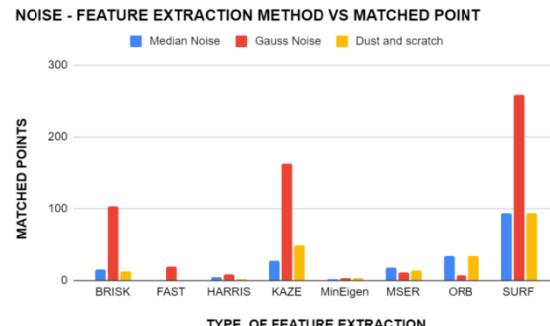


Figure 6. NOISE - Feature Extraction Method vs matched points

The graph has been plotted for noise-feature extraction of three different types of noise against the number of matched points they were able to come up with for the different method. It can be inferred from the graph that SURF has the highest number of cross-matched points with Gaussian noise having the highest number among the different noises. KAZE and BRISK are the methods that have some comparable stats and all the other methods falling behind them by a large margin. So when it comes to extracting the feature points from the images with noise, SURF is the best. If we are to combine time taken and the number of points they were able to come up with in that period, SURF is the best available choice for cases where noise is there.

The third part determines the time for evaluation of matching points and the number of matched points for images having scaled distortion. For the experiment distortion angles of 120, 150, 170, 190 percentages of the reference image has been considered.

SCALED - FEATURE EXTRACTION METHOD VS TIME				
ALGORITHM/SCALE D FACTOR	120% SCALE	150% scale	170% scale	190% scale
BRISK	0.0439	0.04487	0.04931 7	0.04229 9
FAST	0.04634 7	0.04366 5	0.04719 4	0.04701 5
HARRIS	0.05978 6	0.05282 6	0.05323 8	0.05311 7
KAZE	0.02676 1	0.02854 7	0.02632 7	0.02556 2
MinEigen	0.05112 4	0.04995 8	0.05288 5	0.05135 5
MSER	0.04223 4	0.04188 2	0.03079 9	0.03008 6
ORB	0.06239 9	0.06315 5	0.07005 3	0.06449 8
SURF	0.03727 9	0.03431 4	0.03872 8	0.03515 3

Table 6. SCALE - Feature Extraction Method and time taken

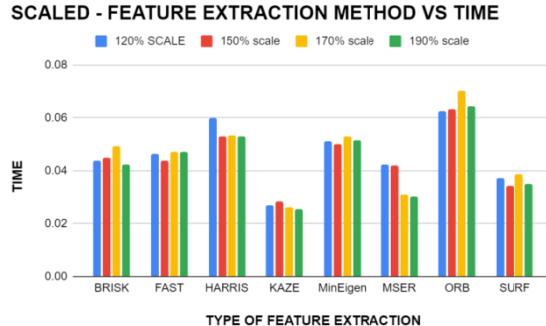


Figure 7.SCALE - Feature Extraction Method and time taken

The above graph is plotted between different feature extraction algorithms and the time taken by these algorithms for feature extraction. The scaled variants of the Preference image was provided as the input for plotting the graphs. It is evident from the graph that the KAZE method has the least computation time ranging from 0.026 to 0.028 whereas the ORB method requires the maximum computation time ranging from 0.062 to 0.070. It is also noteworthy that the SURF method maintained its trait by requiring a computation time slightly above the method with the least computation time.

SCALED - FEATURE EXTRACTION METHOD VS MATCHED POINT				
Algorithm	120% scale	150% scale	170% scale	190% scale
BRISK	35	23	19	7
FAST	45	50	14	6
HARRIS	25	8	2	0

KAZE	76	23	7	13
MinEigen	28	5	4	4
MSER	67	29	41	28
ORB	61	42	71	25
SURF	200	228	177	172

Table 7.SCALE - feature extraction method vs matched point

SCALED - FEATURE EXTRACTION METHOD VS MATCHED POINT

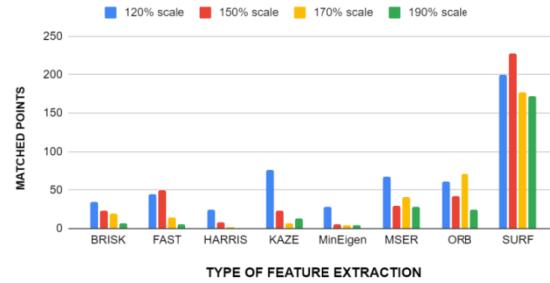


Figure 8.SCALE - feature extraction method vs matched point

The above figure shows the graph between different feature extraction algorithms and the maximum number of matched points of these algorithms. Scaled image variants of the reference image were provided as the input in the above graph and the results were as expected with SURF uncovering the maximum number of match points. Although the KAZE method required the least amount of computation time (0.026-0.028 ) it was only able to locate relatively very few matchpoints.

As evident from the above two graphs, SURF was able to locate the maximum number of match points, within a comparatively lesser amount of time. Thus it can be concluded that for scaled input variants SURF has the maximum computational efficiency.



Figure 9.KAZE, ORB, SURF reference image with feature extraction implemented

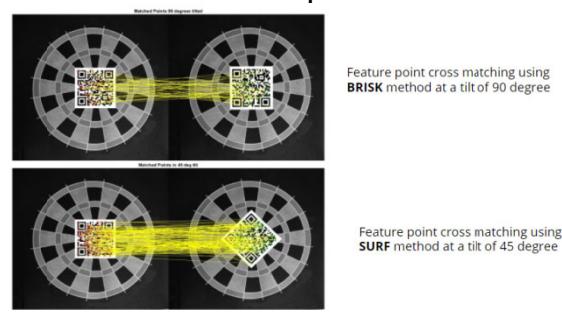
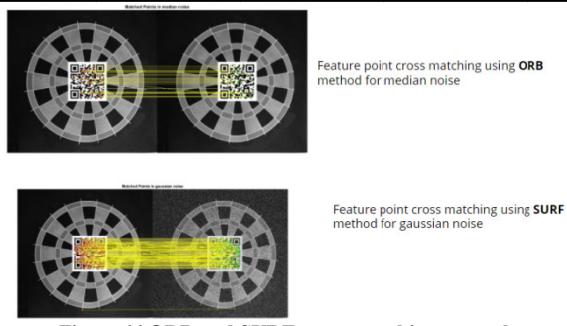


Figure 10.BRISK, SURF cross matching examples

**Figure 11.ORB and SURF cross matching examples**

#### IV. CONCLUSION

In summary, the SURF algorithm performs the best in cases of noise, rotation and scaling with maximum feature points extracted in a relatively minimal time. Brisk is the method that performed moderately well in all of the test scenarios. FAST has the least time for feature extraction and KAZE has the most time among them. ORB performs well in scaled case but at the cost of time.

In the case of noise and scaled condition, SURF outperforms every other method with the highest number of feature points matched with the best time to points matched ratio. Even though KAZE has the least time taken, the number of points matched is way less.

In the case rotation, SURF and MSER performs the best among them with a maximum number of extracted points matched in a relatively less time frame. All the features matched all the points when presented with ZERO degrees tilt.

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# USING UNDERUTILIZED SPACES TO INCREASE URBAN VIBRANCY IN NEHRU PLACE

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**Abstract** - Vibrancy refers to the liveliness of a place, vibrancy is an important component for making sustainable cities. High vibrancy helps build connections between the residents and their environment. Vibrant areas usually found in a diverse and dense setting areas that are self supporting. Increased diversity and density are positively related to urban vibrancy. Underutilized spaces refer to those spaces that are not being used to the full potential, these spaces are all around us but are often neglected. These spaces can be used to inject new programs to create a mixed land use. The paper revolves around measures to improve vibrancy by programming the existing underutilized spaces. This approach helps densify the city center and slows urban sprawl.

**Keywords** - Built environment, Mixed use, Nehru place, Underutilized spaces, Urban vibrancy

## I. INTRODUCTION

### 1.1 Urban vibrancy

The concept of urban vibrancy was first brought into the discussion by (Row & Jacobs, 1962) when she appealed that the cities should be lively because at that time modernist architects were building highly functional and monotonous buildings. The subjective feeling in a built environment was not being considered. Recently, (Gehl, 2010) has explored the effects of safer and vibrant streets. According to (C. Wu et al., 2018) as cited in (Barreca et al., 2020), urban vibrancy refers to liveliness of a place which is defined by attractiveness, diversity and accessibility. According to (Yue et al., 2017) urban vibrancy is defined by the intensity of the activities taking place. Vibrancy deals with the emotions of the residents; vibrancy can build connections and increase interactions in a community. Vibrancy is a subjective topic but it has real effects; in city centre urban vibrancy is linked with house prices, increased urban vibrancy results in a higher multiplier on the price of the land or the house (Barreca et al., 2020). Earlier, the concept of vibrancy was judged in a qualitative way but with technological progress vibrancy can be quantified. (Yue et al., 2017) used big data to measure neighbourhood vibrancy to find the effects of mixed land use on vibrancy. Huge sets of data are available from GIS, websites and phone data which provides a holistic view rather than field interviews which are time consuming and cover a small group of people (Tu et al., 2020).

### 1.2 Urban sprawl

Urban sprawl is defined as spatial growth of the cities to primarily provide people with housing which leads to loss of cultivable land and other problems (Brueckner, 2000). In this spatial growth of cities, high cultivatable land or forest are turned into urban areas which in turn lead to loss of habitat and biodiversity. These cities have separate zoning areas, for example malls are built on huge plot of land and

because the residents have to drive to a place, parking lots take up a huge amount of space which is unused most of the time. The high number of cars lead to traffic congestion and air pollution (Brueckner, 2000). A sprawled city promotes people to buy land outside the city which can cause the residents of the city to move out in search of better and bigger house; this is the cause of urban decay where the buildings in the city center become dilapidated and this overtime reduces the price in that area.

### 1.3 Dense cities

Dense cities are the opposite of urban sprawl, dense cities are designed for a mixed land use which makes a more walkable city because all the necessities are located in close vicinity which promotes social interaction (Neuman, 2005). Basically, our environment should be devoid of monotony in terms of both architecture and culture. A mixed and heterogeneous environment consisting of people from different backgrounds combined with a mixture of different densities of development results in a dynamic city (Petković-Grozdanović et al., 2016).

A mixed land use that combines residential, commercial, and other land uses is beneficial for neighbourhood vibrancy (Montgomery, 1998). Mixed land use is aimed at increasing the intensity, diversity of the land while reducing segregation (Grant, 2002). Mixing different functions can reduce the travel distances which promotes walking and cycling, this increases the intensity of activities taking place in an urban setting. This assumption has been reinforced by (Yue et al., 2017) that heterogeneity is necessary to create a lively environment for the residents.

### 1.4 Factors influencing urban vibrancy

1.4.1 Relationship of vibrancy and built environment (Tu et al., 2020) cited various researches that suggested at a relationship between built environment and vibrancy. Our cities are like an ecosystem and all elements are interconnected to each other; numerous researches have pointed out that elements of the built environment like roads, metros and buildings

influence urban vibrancy(De Nadai et al., 2016; Huang et al., 2020). For example, (Gehl, 2010) suggested that people are more likely to walk in a small block with multiple shops that have a rich façade. (Barreca et al., 2020) points out five important components of built environment that are shops, cultural buildings, transport services, green areas and healthcare. The consequences of a change in built environment results in a change in the density which affects the liveliness. A research conducted by (Huang et al., 2020) found out that increasing building footprint positively correlated with vibrancy.

#### 1.4.2 Relationship of density and vibrancy

According to (Lu et al., 2019) as cited in (Barreca et al., 2020), an increase in density correlated with increased neighborhood vibrancy. Density in sprawled cities is low which makes them more susceptible to creation of low vibrancy areas because people are less likely to encounter other people. High-density setting will increase vibrancy because presence of a diverse set of functions creates more opportunities for interaction(J. Wu et al., 2018). Fictional densities are also detrimental to the city and a balance needs to be maintained while considering density.

#### 1.4.3 Relation of mixed use and vibrancy

Plenty of contradicting literature have been found about the relationship of mixed use and vibrancy.(Jacobs-Crisioni et al., 2014) found a positive correlation between mixed land use and vibrancy whereas (Tu et al., 2020) deduced the opposite. The reason is that (Tu et al., 2020) used Shannon Entropy which is the most common approach to quantify mixed land use. Shannon Entropy is uncomprehensive and misleading, Hill numbers is a multifaceted approach to depict the diversity by adding up Richness, Simpson, Entropy (Yue et al., 2017). Point of Interest (POI) refers to the primary data which is collected from the navigation databases that helps to quantify the land use. Richness (POI), Simpson (POI), Entropy (POI) measures the richness, concentration and orderliness of the POI, Hill numbers showed a positive correlation between mixed land use and vibrancy(Yue et al., 2017).

### 1.5 Underutilized spaces

Underutilized spaces largely refers to the lack or absence of activity, usually these are vacant lots, parking lots, wedges which have the capability to accommodate more functions(Ukil, 2017). When cities sprawl quickly, it leads to creation of underutilized spaces.(Jonas & Rahmann, 2015) links underutilized spaces with ephemerality which means that the full potential of the space is yet to be achieved. The main reason is that these spaces are overlooked and are considered worthless. Underutilized spaces are residual spaces that are not being used to the full potential. Utilizing these spaces can increase diversity of a neighbourhood. Land is an

indispensable commodity that should be used more efficiently(Villagomez, 2010).

It is beneficial to use underutilized spaces to provide housing and other facilities because people prefer to live near the city center. Firstly, this approach would be cheaper as compared to building a new settlement because the city center has an existing infrastructure network. Secondly, the areas with more vacant plots of land experience a higher crime rate and using the underutilized spaces can increase the density (Humphrey et al., 2020).

#### 1.5.1 Types of Underutilized spaces

The spaces can be differentiated on the basis of location, size and shape, the scale of these spaces differs widely. There are eight different types of underutilized spaces, they are void spaces, spaces below, spaces around, spaces between buildings, rooftops, wedges, oversized infrastructure and redundant infrastructure(Villagomez, 2010).

- i. Spaces between buildings refers to residual spaces in between two buildings which have proliferated because of obsolete functionality such as service entries.
- ii. Wedges refers to the irregular shaped that are created when grids form an acute angle. These spaces are neglected by developers because acute angle creates negative spaces.
- iii. Spaces below are theneglected spacesbelow highways and elevated metro, rail lines are not used to the full potential and are usually used for parking.
- iv. Oversized infrastructure refersto the oversized residual spaces which exist because of overestimation of traffic, this leads to abundant amount of space which is occasionally used by cars.
- v. Rooftops are the most abundant residual space. Rooftops are present in both high density and low density. They are often overlooked but, in a time, when physical spaces are such an expensive commodity it is important to utilize all spaces.
- vi. Redundant Infrastructure refers to spaces that have fallen out of use because of a change in functionality. These usually exist in the part of the cities that have undergone radical transformation.
- vii. Void spaces are created because of the dependence over automobiles in a sprawled setting, for example huge parking lots. These spaces are used for certain time period during the day.
- viii. Spaces around buildings are often left unused because of a change in policies or poor policies to begin with. These spaces proliferate when planning is not done with holistic view and important factors are ignored.

#### 1.6 About the site

Nehru place is located in the south of Delhi and the total area of the site is 0.52km<sup>2</sup>. Nehru place is a

business center which consists of offices and retail shops and attracts 130,000 visitors daily(Gadepalli & Vaid, 2016). The area witnesses a sharp change in density according to the time of the day, during the day time it is a bustling commercial center; by the evening the plaza becomes empty and attracts illegal and criminal activities(UTTIPEC, 2018). Nehru Place is unsafe at night and especially unwelcoming to women(Delhi Development Authority, 2014). Nehru Place is well connected to the city because New Delhi has robust transport services. The site can be accessed easily by using bus services, subway or with private vehicles.

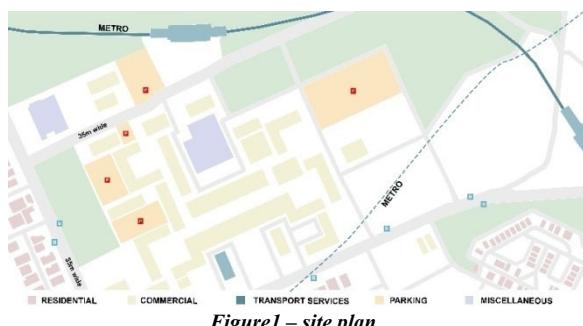


Figure 1 – site plan

## II. DISCUSSION

City center is more apt for the intervention than the outskirts because of the presence of existing infrastructure and economic opportunities. Land is too valuable not to be used to the full extent. By injecting different functions in underutilized spaces, a more vibrant mixed use area can be developed. Neighborhoods should be self-sustaining with a diverse set of functions and an appropriate density. Researches about vibrancy points out that increasing population density and building density can help increase vibrancy in sprawled cities. Using underutilized spaces is subjective because it depends upon factors like density, demographic, urban context etc.

### 2.1 Urban vibrancy analysis

There are a number of variables that can affect the vibrancy of an area, these variables were taken from earlier research done by (Kim, 2020).

The tare area indicates the share of space that is unused or unavailable for people's activities in the block. Tare area amounts to 24% of the site, it is calculated by dividing tare area with total area(Kim, 2020). Tare area is a negative variable which means a higher value of tare decreases vibrancy.

Street network density is defined by the length of roads in a given area. (length of interior networks + length of exterior networks/2/Total area). The value of network density is 4.36. The mesh refers to the average distance between roads in a block, $2/4.36=0.45$ (2/Street Network Density). The size of the block of Manhattan is 80m x 274m, elongated blocks hinder the walkability of a city; the average value of mesh is 450m which is higher than

most of the standards(Kim, 2020). The gamma index measures the maximum number of links that can happen between nodes(Rodrigue et al., 2019). A value of 1 refers to a well-connected place, the gamma index of the site came out to be 0.46{number of links/3(number of nodes-2)} which means that the area is not well connected, this reinforces the hypothesis that more connections are needed at the Nehru Place(Rodrigue et al., 2019). The number of subway station entrances were counted and divided by the total area to express the density of subway station entrances which came out to be 13.4;(number of subway station entrances/total area). This represents the level of accessibility for the residents, better accessibility increases the travel distance and the ability to participate in activities. Balance index is the ratio of the ground coverage of a particular function to the total ground coverage. A healthy balance between functions is needed to create a vibrant environment.

Variable	Description	Unit	Value
<b>Dependent variable</b>			
Service population	Population of a given area	Number	14341
<b>Urban variables</b>			
Tare area	Unused areas	km <sup>2</sup> / km <sup>2</sup>	0.24
Street network density	Density of street	km/ km <sup>2</sup>	4.36
Mesh	Distance between roads	km/ km <sup>2</sup>	0.45
Gamma Index	Connectivity between nodes	Number	0.46
Subway entrance density	The number of subway entrances in a given area	Number/km <sup>2</sup>	13.4
<b>Building Form</b>			
Balance index	Ratio of commercial to total ground coverage	index	0.58
Balance index	Ratio of residential to total ground coverage	index	0.16

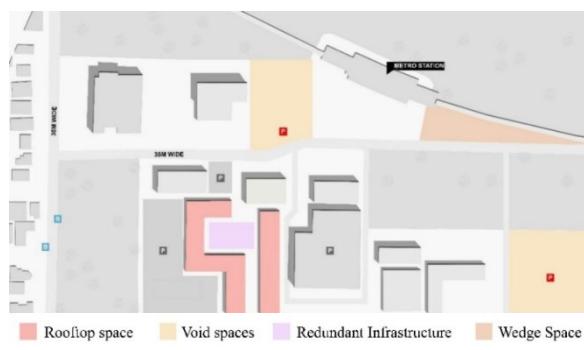
Table 1-Statistics of variables

Nehru place has poor connectivity, unwalkable environment, contradicting balance indexes and high tare area; most of the variables are negative. Vibrancy is low when most of the buildings are of the same use, commercial buildings account for 58% of the buildings whereas residential buildings are only 16%. High concentration of commercial buildings and

low concentration of residential buildings leadsto significant changes in population during the day.

## 2.2 Proposal

CBDs are known to be unsafe at night which makes them less vibrant because of the singular zoning due to which the density decreases at night(Ratnayake, 2013). Introducing residential buildings and other supporting facilities will increase the density of the residents and will even out the balance index. The site has a few underutilized spaces which can be used to increase the diversity of the urban functions. Employment density of the site is high because of the abundance of commercial and retail functions.



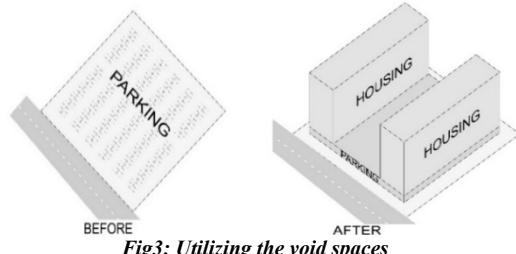
*Fig2: Underutilized spacesin Nehru place*

Both the void spacesare currently being used as surface parking for the business center. The space above the parking can be used to provide social housing and the existing function can be accommodated on the ground floor or the basement in Figure-3. Housing will also increase the diversity of the area. Our environment feels safer when we are surrounded by people and density promotes vibrancy by encouraging interaction among people(Huang et al., 2020). Underprivileged people tend to prioritize location over the quality of the housing because they prefer to live closer to economic opportunities(Celhay& Gil, 2020). Currently, affordable housing is being provided on the outskirts which ends up segregating the society. Providing social housing near Nehru Place will result in an equitable distribution of housing in the city. Both of these sites can provide 150 lower income dwelling units.

The wedge space currently serves no purpose. This space is an opportunity to enrich the public life by providing a formal space for hawkers and building an enjoyable public space. According to (DelhiDevelopmentAuthority, 2014) there are 600 hawkers in Nehru place. A lack of commerce can reduce vibrancy(Barreca et al., 2020). Commercial activity is needed to attract people to the public realm, shops encourage people to leave their homes for non-work related activities.

Rooftops are useful because they are flexible and can be used for a plethora of purposes. The buildings functions as an IT hub and hosts a variety of shops. Community spaces are necessary to create a

familiarity between the residents. A community is created when familiar people living in close vicinity. Rooftops are multifunctional spaces, activities like yoga, open air cinema can be held to strengthen the social ties. Leisure areas provide a space for residents to spend their free time(Barreca et al., 2020).



*Fig3: Utilizing the void spaces*

The plaza partially acts asredundant infrastructure. The plaza is occupied only from 9am to 8pm, rest of the time it is desolate and unsafe(DelhiDevelopmentAuthority;, 2014).Shopping for groceries is usually an early morning errand for Indians, this underutilized space can accommodate temporary grocery carts because groceries are sold on carts in India. The supporting facilities for housing are necessary to meet the day to day needs of the residents.

## III. CONCLUSION

Humans are social animals since our existence humans had to hunt in group to stay alive. Humans were meant to stay in packs. For example, people feel unsafe walking on a dark and empty street but feel safe when walking through a crowded area. Our cities have been planned according to the functions but subjective factors have not been incorporated which is why loneliness is increasing among urban residents. Public spaces promote communication but they have not been prioritized.

Our cities have parcels of spaces which have not been efficiently used. These spaces can improve vibrancy. The two ways of improving vibrancy in sprawled cities are by increasing density and creating mixed use neighborhoods.The number of researches on vibrancy is low and contradicting results have been found in various researches. Nevertheless, vibrancy is a key factor in our lives which affects our happiness. Vibrant areas create a community and a better social atmosphere. Injecting new function into the existing urban fabric will lead to an equitable distribution of functions; poor people are pushed outside the city in search of a decent home. Adding new functions will maintain the density throughout the day, neighborhoods lack meeting spaces. In India, streets were the places where social gathering took place now those spaces have been taken over by automobiles which has left the people with no space to engage in conversation.

Our cities are sprawling day by day and land needs to be considered as a finite resource. In order to slow down urban sprawl, land needs to be used more

efficiently. Accommodating more functions in a finite space reduces the demand in the outskirts of the city.

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# ATTITUDES TOWARDS THE USE OF HUMOUR: A CASE STUDY OF MOROCCAN SECONDARY SCHOOL TEACHERS

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**Abstract** - This study investigates the possible benefits of using humour in the classroom for teaching and learning purposes. It is intended to prove whether humour facilitates and creates appropriate conditions for teaching and learning or not. In this manner, it explores teachers' perceptions of and attitudes towards classroom humour and the types of humour devices they involve in their day-to-day teaching and instructional practices. The study used a qualitative method that comprised 31 open-ended questionnaires delivered to teachers of various school subjects. The findings revealed that most of the respondents believe that humour facilitates teaching, does not make it difficult, does not contradict with teachers' appropriate behaviour, is not a waste of time and is not associated only with teachers' who have a sense of humour.

**Keywords** - Attitudes, Benefits, Humour, Learning, Perceptions, Teachers.

## I. THEORETICAL FRAMEWORK

### 1.1. Introduction

Educational psychologists concur that diversifying instructional techniques and teaching styles can improve the quality of successful learning. Classroom humour is one of the advisable techniques that can, among other things, serve this purpose by increasing students' motivation, developing positive attitudes towards the teacher and the subject and creating an anxiety-free learning setting. Teachers can make a good use of humour to develop students' level of attention, retention and comprehension; to encourage their creativity and imagination; to enhance teachers-students relationship; and to promote students' positive attitudes towards the teacher and the course.

The use of humour is also one of the leading factors in teachers' increased effectiveness in the classroom (Bryant, Crane, Comisky & Zillmann, 1980, as cited in Wanzer, 2002). Teachers who employ it for educational purposes, or who have a high sense of humour are likely to receive more positive evaluation from students, and if compared to other teachers, they may be more approachable and likeable. This is why students in such light-hearted classes may feel encouraged to participate, and are usually motivated to perform in a better manner.

### 1.2. Different uses of classroom humour

Humour has numerous applications. The literature contains a large amount of information about the reasons for using humour as a learning aid and a teaching tool. Humour serves language teaching and learning psychologically, socially and at the level of language acquisition / learning.

#### 1.2.1. The educational psychology role of humour

One of the main humour application areas is found in educational psychology. Learning according to educational psychologists is closely attached to positive emotions and affective factors that will be

elaborated on in more details in the section about affective factors. Psychological benefits stand, for instance, for students' increased motivation to participate in classroom activities driven by exposure to humour. In this concern, research exhibits a direct relationship between humour and motivation. For example, Wanzer et al.'s Instructional Humour Processing Theory (2010) "offered an explanation for why some types of instructor-generated humour lead to increased student learning" (p. 10). This explanation involves an increase in students' motivation as a result of the humour generated by the teacher's instructional techniques and their humour-related behaviour in front of the students.

Besides, Stephen Krashen's ubiquitous Input Hypothesis (1982) represents another important reason for using humour. Following Krashen, if there is a feeling of anxiety among students, it will create an affective filter or a mental obstacle, which will in turn hinder the comprehensible language input. In this manner, learners are likely to find themselves unable to upgrade their level of proficiency since they cannot make use of the input they receive for language acquisition. So, humour is highly likely to lower the affective filter by making learning an enjoyable experience.

#### 1.2.2. The social role of humour

Humour expresses spontaneity and pleasure. It has a social role in everyday life that allows people to appreciate an event, a thought, an emotion, and it is this particular element that makes it so necessary. It enables speakers "to establish, maintain, reinforce, renegotiate, or even break social relationships via targeting unacceptable behaviours and views" (Dynel, 2013, p. 31). As a means of communication, humour accounts for a paramount contribution to the teacher-student relationship. Teachers' classroom humour strengthens their social bond with students and usually makes the former more approachable. This is why a socially appropriate understanding is a prerequisite for a positive learning environment. Also,

humour clears tension and misunderstanding, and assists learners in expressing their mind whilst avoiding the teacher's possible untimely reaction. Therefore, the better the connection they build with students, the easier it is for teachers to transmit plenty of valuable knowledge.

### 1.2.3. Instructional role of humour

As illuminated in the educational psychology section, most students enjoy their teachers' humorous discourse, for it reduces anxiety and motivates them for learning. From an instructional perspective, humorous activities and materials delivered in class result in increased students' attention (as confirmed by Phillips, 1991), which is essential in language learning. And with a growing level of attention and noticing, students are likely to receive more comprehensible input.

Similarly, humour provides opportunities for a better and longer memorization of content. Therefore, tacit and practical uses of educational humour involves, as proclaimed by a number of researchers (Bryant et al., 1980; Garner, 2006; Wanzer et al., 2010), direct effects on remembering information and language learning in general. In addition, if used appropriately, humour can facilitate class management through holding students' concentration and attention for longer periods of time. It also assists in establishing or dissolving boundaries between the teacher and students, in encouraging creativity and in managing conflicts (Wanzer, 2002).

Besides, humour is quite beneficial in reviewing grammatical structures (Martin, 2007) and revising vocabulary and other linguistic aspects, such as phonology, morphology and semantics (Ross, 1998); however, this remains conditional to the level of students. Using humour to learn phonology, morphology, syntax, or semantics is set for advanced levels, whereas elementary and intermediate students can practise vocabulary retention activities and revise grammar.

### 1.3. Areas to avoid in using humour

It is frequent that some teachers use self-disparaging humour in an attempt to create humour. This may end up breeding negative effects, for if used excessively, teachers may be regarded as incompetent, which may later damage their credibility. Teachers, on the one hand, should refrain from being self-deprecating, and on the other, they need to select the best humour stimuli that suit their teaching behavior. If they think they are not humorous, as Wanzer (2002) said, it will be too challenging to wear a false funny veneer in front of their class.

From another perspective, using humour for teaching and learning purposes may become counter-productive. Teachers should avoid making fun of students because that will probably drive them away from participation and attending classes. Pointing at individual students to tell humorous stories about can

be embarrassing and deprecating. Wanzer (2002) warned that "if students feel picked on or belittled, they may be less likely to participate or attend classes." (p. 122). Students usually complain, following a study conducted by Wanzer and Booth-Butterfield (1995) about the relationship between humour and learning, about being constantly targeted by teachers. Unfortunately, some teachers, in their attempt to generate humour, single out some students to be the subject of jokes, sarcasm or satire. Initially, that will create humour, but is surely improper and unfitting.

Teachers are advised to be careful when applying humour. They need to choose the most convenient talk. They should not overuse humour, and it is advisable to combine spontaneity with experience. However, students may misunderstand teachers' humour-oriented actions and see them as unsuitable. This is a reason why it is recommended to include humour-related content in lesson planning and connect it to the subject matter. Wanzer has clarified this by saying that "humorous examples, jokes, and stories can help the students recall the material later" (Wanzer, 2002, p. 122). Consequently, students can remember the material provided to them through being exposed to the funny side of the lesson.

Another thing to mull over in the application of humour is to avoid racial, discriminatory or sexual humour. Before designing a funny activity, teachers should know their students' gender and cultural background, for it will probably humiliate or depress some of the class members or the whole class if the video or the picture illustrated is sexually, racially or ethnically biased. Being stereotypical is likely to distract and de-motivate learners instead of motivating them. Therefore, it is recommended that teachers learn about appropriate / inappropriate humour (see Wanzer et al., 2010) as well as cultural and universal humour (see Schmitz, 2002) so that they may not put themselves or their students in non-humorous, uncomfortable, or even embarrassing contexts.

## II. METHODOLOGY

### 2.1 Qualitative data collection

#### 2.1.1 Questionnaires

A set of 31 questionnaires were distributed to the teacher sampling population. The surveys were designed to gather qualitative data about teachers' background knowledge in relation to humour and classroom humour in particular, as well as their opinions, perceptions and attitudes towards the use and / or non-use of humour. The qualitative data obtained from the open-ended questionnaires were organized, analysed and coded by the NVIVO version 10 program

#### 2.1.2 Sample of the study

The target participants in the study were Moroccan Secondary School teachers. The number of

teachers who took part in the study was 31 teachers of various school subjects in the research site.

### 2.1.3 Sampling design

The researcher selected the sample to be included in the study through a convenient sampling strategy given the existing convenience and availability of teachers-participants in the researcher's school.

## III. FINDINGS AND DISCUSSION

Most teachers believe that humour (be it in the form of jokes, funny stories, or other forms) attracts students' attention. It is usually a logical incentive to draw or regain their attention, and even to keep it active. It is considered, as one teacher declared, as one of the most appealing teaching techniques that inspire students to listen, to engage and to be interested in the lesson. However, some teachers suggested that for humour to be useful, it has to be performed judiciously and properly, whereas few others agree that it does not draw students' attention at all. Most teachers' opinions seem to tally with the research, as mentioned both earlier and in the review of literature, that supports the correlation between humour and students' attention.

Besides, a lot of teachers reveal that humour helps students in a variety of ways: it helps them concentrate more on their lessons; it motivates them more; it reduces their anxiety; and it triggers them to participate more. These opinions correspond with those of students discussed earlier, and they show a promising agreement between the two sides on this matter. Such a finding is fruitful for non-humorous teachers and for those who are still reluctant to try humour, or even for the ones who believe that they have no sense of humour. This is because the more humorous the teacher is, the more friendly and approachable they become in the eyes of their students, and as Garner (2006) affirmed "a strong sense of humor plays a major role in developing a positive learning environment" (p. 178). Therefore, it is recommended that teachers of all school subjects, not only English, use humour to create a welcoming learning environment and to establish closer relationships with students.

Most teachers have positive attitudes towards humour and the use of humour. First, they generally believe that humour does not contradict with teachers' appropriate behaviour in class since it is a teaching style that many use to improve the quality of education. It is also a personal trait that they may be endowed with, and which they can employ to create a suitable context that is conducive to learning as long as it is appropriate. This unveils that there are humorous behaviours that are deemed appropriate and others that are not, namely disparaging humour (see Gorham and Christophe, 1990; Neuliep, 1991; Wanzer et al., 2006).

Besides, many teachers contend that humour is not a waste of time as long as it serves the

pedagogical purpose of education, and since the teacher is in control of the situation. This attitude suggests that they like to use humour, but not all of them. In this regard, some teachers reject the notion of classroom humour altogether, claiming that it is just a waste of teachers' and students' time. For them, it does not have anything to do with teaching and learning. This is no more than a point of view that is not validated by research. Neither recent research nor earlier studies (such as Bryant et al., 1980 & Ziv, 1988) about educational humour consider it a waste of time.

In addition to this, most teachers agree that humour does not make teaching and learning difficult. On the contrary, it facilitates communication between them and the students through the verbal and non-verbal forms of interaction embedded in it, and that boosts, in a way or in another, the student-teacher connection. In this vein, Pollio and Humphreys (1996) maintained that the existing connection between the teacher and the student "was key to effective teaching" (as cited in Garner, 2006, p. 178). It is also a "communication behavior we recognize from personal experience that can be used competently or incompetently" (Wanzer et al., 2006, p. 179). So, if it is involved properly, it will be used competently, and vice versa. Its proper application involves using prepared, related (to the course content) or spontaneous humour that does not disparage students.

Regarding the question about sense of humour, I found that the majority of teachers possess a sense of humour. This generally denotes that witty teachers are more likely to use humour. However, it does not necessarily have to be the case since humour is not associated only with those who are funny. It should be pointed out that some teachers, who never use humour, are not sure about whether they are witty or not. Having this attribute is not a requisite for a successful use of it. All teachers, humorous or non-humorous, can create fun and laughter in their classrooms by preparing it or by just being spontaneous. There is another category of teachers who are known to be lighthearted, but never use humour with students. They are usually hesitant or more concerned about their self-esteem or image. These teachers should know that here is a paucity of research that shows that involving humour makes them more approachable and effective and help their students learn better.

In responding to the question of whether Moroccan culture considers humour a disruptive behaviour in class, it was detected that Moroccan teachers are divided on this point. While some of them (8 respondents of 31) are bound by the popular cultural beliefs that view education as a strictly serious process, others (13 respondents out of 31) believe that seriousness does not contradict with fun. Here lies the dialectical relationship between culture and education on the one side, and culture and humour on the other. Since there are teachers who are

governed by their own cultural norms, the influence will probably extend to the teaching style they follow, which may be innovative/ conventional, or personalized / impersonalized. Therefore, it is recommended that teachers prioritize students' learning needs over what cultural limitations may dictate vis-a-vis the use of humour. Moreover, as humour is highly cultural, language teachers are advised to involve the types (avoid culturally specific humour found in certain jokes) and examples (use common and international humour; see Lewis, 2006) of humour that students can understand and appreciate easily (see Bennett, 1993) in order to avoid cultural and linguistic confusion and misunderstanding.

It appears that Moroccan teachers do not use a wide variety of humour devices. The most repeated ones, although used only sometimes, are built around gestures, comments and stories, whereas jokes, pictures and body language are rarely used as tools for humour creation. The reason is that culture may be omnipresent here as some teachers fear for their self-esteem and reputation. This is why they exempt from resorting to body language, for instance, to trigger amusement. As for pictures, because of the nature of several school subjects that do not fully rely on pictures (Mathematics and Physics as example), teachers do not employ them as much as they do with others.

#### IV. CONCLUSION

This paper studied and explored teachers' perceptions of and attitudes towards classroom humour, and the types of humour devices they use with their students. The findings revealed that most teachers have positive attitudes towards classroom humour, and even if they consider that it can greatly serve education, they do not use it quite often; only a few of them resort to it, albeit at a very limited frequency.

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# THE COMPETITIVE ADVANTAGES OF TAIWAN'S TRADITIONAL AGRICULTURAL AUCTION SYSTEM TOWARDS E-COMMERCE OPERATIONS

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**Abstract** - The purpose of this research is to use information technology to promote the e-commerce auction and transaction mode of agricultural products in order to strengthen the order of supply and marketing, and ensure the transparency and openness of agricultural product transaction information. So that the agricultural product transportation and marketing system could be improved, and the diversified agricultural product marketing channels could be expanded . At the same time, using SWOT analysis and Five Forces analysis to conduct secondary data collection method and literature review method in qualitative research. According to the research results, the new agricultural e-commerce business models are suggested as follows:

1. Combining and improving the traditional agricultural industry transaction model, and propose an innovative agricultural business model based on e-commerce architecture with the concept of the e-commerce.
2. The introduction of e-commerce market transactions, logistics warehousing and distribution centers in agriculture can improve the overall transaction efficiency in the entire transportation and sales process, and also can shorten the time to achieve good efficiency.

**Keywords** - Agricultural Cooperatives, Agricultural E-commerce, SWOT Analysis, Competitive Five-force Analysis.

## I. INTRODUCTION

### 1.1 Research motivation

Taiwan's agriculture faces severe challenges due to the internationalization of the economic and trade market. Because Taiwan's accession to the World Trade Organization (WTO),facing global economic and trade liberalization, the production cost of domestic agricultural products is generally higher than that of imported agricultural products, international agricultural import competition pressure, and limited by the natural environment and insufficient arable land , Rural population ageing and declining birthrates and other factors have led to high agricultural production costs. Coupled with the continuous changes in the market environment, the agricultural economic system has become an irreversible trend towards trade liberalization and internationalization.

Taiwan's domestic market is like "shallow dish market." With limited market demand, the agricultural products slightly increases or decreases, and the prices immediately fall or rise sharply. The agricultural market often suffers from imbalances in production and sales, causing farmers to lose their money. In addition, the transportation and marketing of agricultural products and the supply chain process are complicated, resulting in a large overlap in the price of agricultural products, and the opaque transaction information has caused illegal trading and bid rigging to occur frequently. How to build a foundation for agricultural e-commerce and strengthen the structure of agricultural production and marketing supply chain through a stable operation of agricultural e-commerce, enhancing the

competitiveness of agricultural products market, and innovative agricultural technology research and development are the top priorities for Taiwan's agriculture.

### 1.2 Research questions and purposes

Agricultural e-commerce provides consumers with fresh agricultural products through the establishment of efficient and orderly production and marketing channels. In addition to accurately grasping the pulse of production and sales, regulating market supply and demand, stabilizing people's livelihood needs, and ensuring farmers' income, it can also promote the sustainable development of Taiwan's agriculture and agricultural competitiveness. The main problem with the traditional agricultural product trading model is that the agricultural product transportation and marketing supply chain process is too long, which leads to the high price difference of agricultural products. Is this traditional operating mechanism to be operated reasonably? Does it meet market demand? These issues deserve our attention. The main purposes of this article are as follows:

1. For the agricultural product trading market, reviewing the evolution of agricultural cooperatives in various periods and discuss the competitive advantages of traditional auction models in the agricultural cooperative structure.
2. How to apply information technology to promote the e-commerce operation model of auction transactions in order to strengthen the order of supply and marketing, improve the agricultural product transportation and marketing system, and

innovate agriculture and sustainable development.

## II. LITERATURE REVIEW

### 2.1 The origin and operation mode of cooperatives

The model structure of cooperatives originated from the United Kingdom, France, and Germany in Europe. The International Cooperative Alliance (ICA) defines a cooperative as an autonomous organization which is united by human beings voluntarily, through property sharing and democratic management to satisfy their common economy, social, cultural needs, and vision (Ortmann & King, 2007). Karlyle (2005) also advocated that the cooperative economy is a stable agricultural economic model that can avoid the extremes of capitalism and communism.

The beginning of the cooperative movement can be traced back to the United Kingdom in the first half of the 19th century. Robert Owen's demonstration factories and towns based on the principles of cooperation in New Lanark, England can be profitable. Although Owen's operating model was well known and appreciated, it was not supported by the British government or adopted by other companies, so it had little impact on the economic development of the UK at that time (Karlyle, 2005).

Karlyle (2005) distinguishes six types of cooperatives into agricultural cooperatives, credit cooperatives, residential cooperatives, national cooperative business associations, community cooperatives, and international cooperative alliances according to their operation patterns. The operation patterns and types of examples are as follows:

1. Agricultural cooperatives: Cooperatives manage 99% of the dairy products in Sweden, 99% of fish production and 95% of rice in Japan, 75% of grains and oilseeds in Western Canada, and 60% of wine in Italy.
2. Credit cooperatives: Some major commercial banks in Europe are owned or organized by cooperatives, such as DG Bank in Germany, Rabobank in the Netherlands and Credit Agricole Bank in France.
3. Residential cooperatives: There are 10,614,000 residential cooperatives in Europe, 15% of houses in Norway and 2% of houses in the United Kingdom are residential cooperatives, and the Czech Republic has 10,000 residential cooperatives. 25% of residential development in Turkey is carried out through the cooperative system.
4. National Cooperative Business Association: In the United States, the National Cooperative Business Association includes 47,000 member cooperatives, serving as many as 100 million people, accounting for 37% of the population.
5. Community cooperatives: Maleny, which is in Australia, a small town with more than 4,000 people, has established 17 community-based

cooperatives. The Maleny Credit Union was established in 1984 and now has more than 6,000 members and assets of more than 15 million US dollars.

6. International Cooperative Union: There are 760 million members in this cooperative union around the world. This union is member of the world's largest non-governmental organization International Cooperation Alliance. The alliance represents more than 250 countries and international organizations.

### 2.2 The value and development of cooperatives

The International Cooperative Union (1995) defines six organizational values of agricultural cooperatives, including self-help, self-responsibility, democracy, equality, equity, solidarity, and 4 ethical values, honesty, openness, social responsibility, and caring for others. Both organizational values and ethical values originated in 1844. The first successful cooperative – Rochdale Society of Equitable Pioneers (Yuemen Yu, 2020). In addition, the International Union of Cooperatives (1995) promulgated 7 operating principles, called cooperative principles. They are Voluntary and Open Membership, Democratic Member Control, Member Economic Participation, Autonomy and Independence, Education, Training, and Information, Cooperation among Cooperatives, Concern for Community to implement organizational values and ethical values.

Since the definition of cooperatives, cooperative values, and cooperative principles promulgated by the International Cooperative Union, its business philosophy and operating mechanism are all derived from the guidelines of the Rochdale Equitable Pioneer's Society in the United Kingdom. Therefore, Nilsson (1999) is also called the traditional cooperative which conform to the norms for real cooperatives. In other words, any agricultural cooperative that conforms to the specifications of the International Cooperative Union can be regarded as a traditional agricultural cooperative. For traditional agricultural cooperatives, in essence, Barton (1989) believes that agricultural cooperatives are farmers' organizations owned by users, controlled by users, and distributed by users. Broadly classified, King & Ortmann (2007) believes that agricultural cooperatives can be divided into three types: marketing cooperatives, farm supply cooperatives, and service cooperatives.

Every types of agricultural cooperatives can establish different types of agricultural cooperatives according to their exclusive business. Nilsson (1999) found that agricultural cooperatives in Europe and the United States were transforming. From the operation mechanism of traditional agricultural cooperatives to enterprise cooperatives, and divided enterprise cooperatives into four types, namely participation shares cooperatives, cooperatives with subsidiary, new generation cooperatives (NGCs), and PLC

cooperatives. Cook (1995) found that there was a phenomenon in European and American agricultural cooperatives in 1988, the reconstruction and strengthening of traditional agricultural cooperatives. Enterprise cooperatives came into being under this requirement. The types of cooperative operating mechanisms are as follows:

1. Participation Shares Cooperatives: it allows non-trading members to buy agricultural cooperative stocks, such as B shares. Purchasers have the right to vote in the member assembly or council, but the majority of voting rights are still in the hands of the majority of members.
2. Cooperatives with subsidiary: In order to reduce operating costs, the agricultural cooperatives will establish separate sub-institutions. The sub-organizations can be companies, which operate the main subsidy business of agricultural cooperatives under joint ventures with foreigners. Sub-organizations and agricultural cooperatives distribute profits in proportion to their shareholding, and have seats in the assembly of agricultural cooperatives or councils.
3. New Generation Cooperatives: In order to solve the problem that agricultural processing cooperatives require large amounts of funds. Before the annual transaction, each member predicts the trading volume of the cooperative for the next year, and after adding up the transaction volume of all members, each member should subscribe for the shares.
4. PLC cooperative: A type between the two organizations of cooperatives and companies. The basis of judgment is the proportion of shares held by members and investors. When the shareholding ratio of members is greater than the shareholding ratio of investors, the organization is regarded as a cooperative; conversely, when the shareholding ratio of members is less than the shareholding ratio of investors, the organization becomes a company.

Agricultural cooperatives originated in Europe and the United States. Their effect is not only to improve the lives of members, but also to reform society and an ideal organization. They operate under an agricultural cooperative-type operating mechanism, and agricultural development will not be limited by this operating mechanism framework. The main reason is that the structure of agricultural cooperative organizations must reflect the changes in the national conditions and business environment of each country in time, and make adjustments for locality, timeliness, and adaptability. Therefore, the operation mechanism of agricultural cooperatives has been constantly reconstructed in the deep structure of power, responsibility, and benefit in accordance with the needs of dynamic adjustment in the past century, thereby strengthening the organizational and operational efficiency of agricultural cooperatives.

### **2.3 Development and Evolution of Agricultural E-commerce**

The business model is the operating method which a company depends on, and the company creates profits through its position in the value chain. Porter advocates that the competitive advantage of enterprises comes from low cost and differentiation. Information technology can not only create competitive advantages by reducing costs and increasing differentiation. This shows the importance of information technology on the competitive advantage of enterprises (Zhang Beiqi, 2003).

Adrian Slywotzky (2016) advocated the concept of "value network" in the book "Profit Zone" (ProfitZone). He believes that Internet technology and thinking have reconstructed the traditional value chain, and the value chain transformed by the Internet has changed the business model and profit model of the company. Kalakota&Whinston (1997) believe that e-commerce in a broad sense is a modern enterprise business model. Enterprises can use computer network technology to collect information that supports decision-making, so that enterprises can pursue improvements in product and service quality and speeding up service delivery. It also can save costs. E-commerce is the product of the interaction between the economy and the development of information technology. The e-commerce business model is a way for companies to carry out e-commerce. It has undergone an evolving process. In this way, companies continue to operate and obtain profits (Gao Yiqiang, 2017).

Agricultural e-commerce refers to the use of the Internet to provide a process for the production and operation entities engaged in agriculture-related fields to complete the sales, purchase, and electronic payment of products or services online. The development of Taiwan's agricultural e-commerce must clearly analyze the configuration of various agricultural value chains, so that we can clearly formulate strategies to intervene in the value chain activities to create higher value and more unique competitive advantages, so as to form uniqueness in the global agricultural product market competitive position. Due to the simplification of the production and marketing structure driven by e-commerce, the production profits of farmers have been relatively increased. It has become an inevitable trend to deliver agricultural products directly to the consumer through the Internet. Agricultural e-commerce has become the focus of attention and affects the entire agricultural production and sales chain (Liu Wanjun, 2016). Therefore, from the perspective of global agricultural development trends, the Internet and agriculture have begun to accelerate integration, and the Internet is undergoing a comprehensive transformation of the agricultural industry chain to improve planting efficiency and product quality, and to achieve high-quality agricultural products at competitive prices.

### III. RESEARCH METHODS

This research adopts secondary data collection method and literature review method, through the analysis of Taiwan's agricultural environment, the SWOT analysis of Taiwan's agricultural products, and the analysis of the five competitive forces, and then further analyzes the development process of Taiwan's agricultural informatization and the development of Taiwan's agricultural e-commerce and the current situation and prospects, and provide the recommendations and management implications of this research in the end.

#### 3.1 Secondary Data Collection Method

The secondary data collection method is the usage of data collected by others to obtain research findings. Compared with the original data (or primary data). In the original research, the researchers must be responsible for research design and data collection by themselves. However, the secondary data users only need to collect the secondary data that suits their own research purposes, instead of personally collecting the original data. Relatively speaking, after the original data are collected, they will become secondary data for other researchers soon.

#### 3.2 Literature Review Method

The historical literature review method is to collect systematically and evaluate the past facts objectively. It can test the cause and effectiveness or trend of related events, so as to understand the present and the past and predict the future. Therefore, it is the same as other research methods. It must explore past facts through rigorous analysis. In essence, the method of exploring historical documents can be regarded as a scientific study of human past activities. On the one hand, the evolution of human society can be learned from the success or failure experience of the predecessors, and the future can be created by the gains and losses of the predecessors.

### IV. RESEARCH FINDINGS

#### 4.1 SWOT Analysis of E-commerce of Taiwan's Agricultural Product Transportation and Marketing

This study uses the SWOT method which developed by Ken Andrew to analyze the advantages and disadvantages of Taiwan's agricultural transportation and marketing electronics, and the opportunities and threats of the external environment, in order to observe the development direction of Taiwan's agricultural resources and external environment:

##### 1. Strength

- Shortening the production and marketing supply chain of agricultural production and operation, and provide direct internal power for the upgrading of the agriculture.

- Reducing information asymmetry and incompleteness caused by separation of production and sales, and improve the transaction efficiency.

- Promoting the development of related industries such as processing and packaging, and drive local agricultural population employment.

##### 2. Weakness

- The auction trading system is not a trading method under perfect competition.

- The current agricultural product transportation and marketing supply chain process is complicated, and the traditional transaction method is not easy to change

- Rural residents generally have low academic qualifications and lack e-commerce professional knowledge and talents.

##### 3. Opportunities

- Due to quality demands, the middle-class consumers and consumer protection groups have greatly increased their demand for high-quality agricultural products.

- The development of auction trading methods promotes the circulation of agricultural products and accelerates the shift from the farmer's market to the wholesale market.

- Agricultural products are not resistant to storage. Auctions can reduce the separation of production and sales and improve transaction efficiency.

##### 4. Threats

- Buyers are familiar with each other and their interests are symbiotic. The new trading system is still prone to "soft bid rigging".

- The price difference between producers and consumers in the old system has been damaged.

- It needs to be invested a huge amount of capital to build a specialized auction trading market and system.

#### 4.2 The Five Competitive Forces analysis of Taiwan's Agricultural Product Transportation and E-commerce

In addition, the three key areas of industrial structure analysis, competitor analysis, and industrial evolution analysis integrated by Michael Porter, and a system of five forces working together are used to deepen and construct the five forces analysis model of industrial competition of Taiwan's agricultural transportation and marketing electronics.

##### 1. Competition among existing competitors

- In order to stabilize the production and marketing of agricultural products and the prices for agricultural products, the general measures adopted mainly include government purchases, incentives to reduce farming, and price support. The factors between buyers are prone to market price fluctuations.

- Bidding among other agricultural cooperatives in the non-agricultural cooperative system, such as the FVC.Cooperaive, and the farmers produce and sell themselves.

## 2. Supplier

- The price elasticity of supply and demand of agricultural products is low, and the price is volatile.
- Importers of agricultural products control market prices by stockpiling.
- Fluctuations in the supply prices of different types in agricultural, fishery and animal husbandry products, such as the impact on vegetable prices when the price of meat falls.

## 3. Threats of substitutes

- Production responds to prices late. The output and price change in a reverse cycle which is prone to threats of substitute products or marketing transactions.

## 4. Buyer's bargaining power

- Collective bargaining by environmental consumer associations, such as the Homemakers Union Consumers Co-op.
- Collective bargaining by large chain channels, such as PX-Mart.
- Institutional Food Service Group negotiate prices collectively, such as, lunch for elementary and secondary schools of the Ministry of Education, and non-staple food for the army.

## 5. Threats of new entrants

- New agricultural promotion policies.
- Adopting new methods of cooperation, joining specific production and sales alliances, and share production and sales.
- The farmers in new generation use technology to make agriculture more refined.

### 4.3 Analysis of the current situation and problems of Taiwan's agricultural development

With an estimated population of 7.5-100.5 billion in the world in 2050, food demand will be under pressure to double. In addition to the challenges of global warming, population growth and globalization, agriculture is also affected by factors such as an aging population, a decline in the agricultural population, limited arable land, and higher food prices (Xu Renquan, 2010). Taiwan is also facing similar problems, limited by the natural environment, insufficient arable land, aging rural population and declining birthrates, etc. The main problems of Taiwan's agricultural development are analyzed as follows:

- The topography, climate, location, and market influences have led to changes in the prices of agricultural products, causing heavy losses for farmers, and causing market prices of agricultural products to continue to rise.
- There is a huge gap between supply and demand of agricultural products, such as over or underproduction, and it is impossible to achieve a balanced market.
- The traditional agricultural auction market and the transportation and sales supply chain process are complicated, resulting in uneven prices of agricultural products, the supply chain process is

too long and the price difference is too high, and the transaction information is opaque and easy to be interfered with.

- The cost of agricultural production is high, and the product channel between producers and consumers is long, and the profits of producers are exploited by middlemen.
- The competitive trend of global economic and trade liberalization and continuous changes in the market environment have had a huge impact on Taiwan's agricultural economic market and industry.

## V. CONCLUSIONS

### 5-1 Research recommendations

In response to the impacts and trends which are faced by the agricultural industry, combining and improving the auction transaction model of the traditional agriculture to establish an agricultural economic system with efficient production. Therefore, this study provides a flexible, expandable, interoperable, and highly stable architecture of e-commerce auction transaction system.

- Combining and improving the traditional agricultural industry transaction mode, and we propose an innovative agricultural operation model based on e-commerce architecture.
- The introduction of e-commerce market transactions, logistics warehousing and distribution centers in agriculture can improve the overall transaction efficiency in the entire transportation and sales process. At the same time it can shorten the time to achieve great efficiency.

### 5-2 Management Implications

E-commerce affects the entire agricultural production and marketing chain. Through this high-efficiency channel, the relationship between rural areas, agricultural producers and consumers is shortened, which indirectly promotes rural development and also increases farmers' income. In addition, using information technology to promote the e-commerce model of agricultural transactions can strengthen the order of supply and marketing to ensure the transparency and openness of agricultural product transaction information, enhance the competitiveness of farmers, and promote the sustainable development of Taiwan's agriculture.

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# DEVELOPMENT AND STRATEGY OF TAIWAN'S SMART ENVIRONMENTAL INFORMATION PLATFORM

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**Abstract** - Advanced countries have implemented data opening policies to improve the popularization of environmental information and the efficiency of environmental governance. Since environmental information is closely related to each other, how to effectively grasp environmental information is particularly important. my country's smart environmental information platform is based on the application of public Internet of Things data for people's livelihoods and uses data-driven concepts to enhance the sustainability of environmental governance and services. How to effectively grasp the interaction between environmental information and the organizational boundary ecosystem during the development process is turning to an open service innovation strategy with customer experience as its core value is an important subject of environmental governance and sustainable development. This article first explains the motivation, purpose, and problems of this research. The second part reviews the practical concepts of public issues such as data openness, huge amounts of data, data trends, and one-stop services, as well as the development process of the smart environment information platform; the third part , Commenting on the theoretical concepts of open service innovation and service value network; the fourth part, through case studies, explore the open service innovation strategy of Taiwan's smart environment information platform; finally, explain the conclusions and suggestions of this article.

**Keywords** - Data-driven Concept, Intelligent Environmental Information Platform, Open Service Innovation, Service Value Network.

## I. INTRODUCTION

Smart cities are composed of different networking elements. Data-driven digital innovation can improve the sustainability of governance and services. With the development of networking technologies such as sensing terminals, radio frequency identification (RFID), and mobile devices, through open data, Huge amounts of data and dynamic information can improve the management efficiency of the city's environment, energy, transportation, construction, etc., save costs and increase benefits, and enhance the analysis and research functions to improve the quality of urban governance.

The main purpose of this article is to discuss: how to transform the smart environment information platform into an open service innovation strategy with customer experience as its core value, hoping that while network technology continues to develop rapidly, open service innovation can also advance with the times The sustainable development of my country's smart environment information platform.

## II. DATA TRENDING CONCEPT

More and more governments around the world are defining and implementing open data strategies. The accepted premise of these policies is to publish government data in a reusable format to enhance citizen participation and generate new innovative businesses to improve data transparency, citizen participation, and government governance efficiency (Huijboom and Broek, 2011). In 2009, US President Obama signed the "Memorandum on Transparency

and Open Government" (Memorandum on Transparency and Open Government) on the first day when he took office. The government's policy of opening up information is based on the three aspects of democratic participation, government governance, and innovative services (Huijboom and Broek, 2011). In 2011, the World Economic Forum (WEF) announced the "Future of Government" report (The Future of Government), with efficient government (FAST) as the main axis of future government reforms in the 21st century, and suggested that governments should make good use of information technology and business wisdom , And implement platform collaboration and network operation methods to accelerate the innovation and transformation of government governance; in the mapping survey of government data opening motives, except the United States and the United Kingdom, the policies of other EU countries are more inclined to promote products and innovative services.

The world's population living in cities is increasing dramatically. Due to limited resources, only smart cities can move towards the goal of sustainable development. From smart government to open government, data openness and huge amounts of data play a very important role. In addition to promoting cross-domain collaboration between regulatory agencies, it can also create instant solutions to respond to different governance fields such as environmental protection, agriculture, transportation, and administration. Challenges, which in turn promotes greater openness in the public sector and opens up new models for policy making and decision-making (Bertot, Gorham, Jaeger, Sarin, and Choi, 2014). Therefore, the prospects and potential of

data openness and massive data changes are increasingly important for e-government services, openness and transparency, and the interaction between the government and the public.

In the concept of data driven, My Data is the core of data driven, and its interaction with open data and huge amounts of data is very important. The goal of My Data is to enhance the application value of personal data in different aspects such as politics, economy, and society. At the same time, it provides a mechanism that guarantees privacy, security, transparency, standardization, readability and data exchange or interoperability to ensure Individual users, including people, communities, governments, public utilities, companies and non-profit organizations, have individual data autonomy and trusted personal account management (Poikola, Kuikkaniemi and Honko, 2015); especially different across governments In the context of integration between the field of industry management and departmental organizations, or between cross-government organizations and civil organizations, these cross-domain applications are also important benefits expected from open data and huge amounts of data, and they are also information for governments in urban governance and planning implementation. The most frequently discussed key success factors when driving ideas.

The government's open data is based on the open raw data (Raw data), and different users use different methods of data reuse and mashup, resulting in more creativity and changes. The process of data value-added utilization can be divided into four stages: 1) Production and production of information content, 2) Collection and storage of information content, 3) Information packaging and value-added process, 4) Marketing and provision of services to end users; Summarizing these open government data that can be reused can be further divided into eight categories, including: "Laws and regulations information, economic and commercial information, environmental information, agricultural and fishery information, social information, scientific information, cultural information, legal system information, etc. "The value-added use process of government open data and the value creation foundation formed by the interaction and integration of various links converge to form a "government open data value chain model", in which environmental information is closely related to human survival.

The United Nations (2019) "Global Environment Outlook" (The Global Environment Outlook, GEO) report pointed out that up to 25% of premature deaths and diseases in the world are caused by environmental pollution and environmental damage, which have a serious impact on human life and ecosystems. Advanced countries are actively deploying smart environmental monitoring platforms, hoping to solve problems related to environmental pollution and environmental damage through the use

of open environmental data and the application of large amounts of environmental data. The Chinese government approved "Environment Cloud" as one of the 10 government cloud services in 2012. The main task is to combine the National Development Council's fourth-phase e-government promotion strategy, through environmental data collection, exchange mechanism, data opening, public participation and The construction of platform basic service models such as networking technology will increase the capacity of my country's environmental data services and create new opportunities for environmental resource information. In 2013, the Chinese government launched the environmental cloud DaaS (Data as a Service) service model, integrating environmental quality, ecology, atmosphere, water conservancy, water and soil conservation, geology, geology and mining, pollution prevention and other information, through the "Raw Data Shared Warehouse (RDSW) "Use cloud and mobile technology to actively promote various services to implement the transparent circulation, sharing and sharing of environmental information, and to deepen the quality of information services. As there is no clear definition of this type of intelligent environmental information application platform in the academic research community, this article defines it as a "smart environmental information platform".

In order to meet the needs of user ecosystems, smart environmental information platforms in advanced countries have adopted one-stop shops, allowing users to enjoy a variety of public services under one service platform. OECD (2020) proposes ten best practice principles for one-stop services based on a series of case studies to assist governments in various countries to improve one-stop services, as shown in Figure 2-3. These principles not only cover a wide range of management tools and system designs, but also cover many different areas of public governance. Therefore, through the expansion of the value of the dynamic data-driven concept, My Data links personal data management (collection, processing, utilization) with open data, and huge data applications, and together form a data value cycle, and then form a suitable government agency The common one-stop data management mechanism makes the dynamic data-driven concept more rooted in the development of open innovation.

### III. OPEN SERVICE INNOVATION

Organizations must have innovative capabilities that are difficult to imitate in order to create a competitive advantage. Nowadays, with rapid technological development and drastic changes in the times, innovation has become an extremely important source of competitiveness. Only organizations that can innovate can maintain a leading position in response to the ever-changing era; therefore, open service innovation has become academic research,

business management, and An extremely important concept in fields such as public policy.

### 3.1 Open innovation

Chesbrough (2003) believes that open innovation is the process of fusing internal and external thinking with internal and external markets to jointly develop innovative methods in the process of pursuing innovation and change. First of all, we should break through the closed boundaries of the past, integrate internal and external thinking models into platforms, systems, and systems, and at the same time introduce more abundant innovative knowledge and elements from the outside, and then define their needs through business models. , And use the principle of leverage to transfer internal R&D resources to the outside in order to obtain more benefits. Chesbrough (2006) pointed out that the process of these open business model innovations is to integrate internal and external thinking into the platform system and structure. Even large organizations cannot create all the elements of innovation on their own, and they need to borrow the advantages of external knowledge. Create the core value of the platform.

Open innovation has gradually become a model of organizational innovation. Since innovation itself is a complex process of social development, if theory and practice can be combined, it will generate tremendous value. Chesbrough and Bogers (2014) define open innovation as: "An innovation process that crosses organizational boundaries and is based on decentralized and purposeful knowledge management." It provides information on how to master the inflow and outflow of knowledge within the organization. In order to increase the probability of its innovation success, it has become a popular and widely cited theoretical concept in innovation research. In addition, open innovation research has also expanded to a wider field (Chesbrough, Vanhaverbeke, and West, 2014), such as: SMEs, newly established analytical departments, different high-tech industries or traditional industries, non-profit organizations, and public Policy department, etc.

### 3.2 Service Value Network

Although open innovation has been changing the mindset of companies developing products, it is more applicable to services. Destructive economic forces are creating a phenomenon called the commodity trap (Chesbrough, 2011). As computers and the Internet are shifting product design and production to various parts of the world, the product world is facing cost factors and non-value factors. With tremendous pressure, companies must break through the limitations of product-centric innovation, and rethink how to innovate in order to operate sustainably. In the book "Cometitive Advantage", Porter (1985) described the role of service in the traditional value

chain as occurring in the final stage of the linear process, that is, before the product is delivered to the customer. Chesbrough (2011) breaks away from the traditional value chain concept and believes that in terms of service innovation, it must be a Services Value Web (Services Value Web) focusing on improving customer experience.

The service value network takes the customer experience as the core, and there is no simple linear process to transform the product from input to output, and then to the customer; instead, there is an iterative process of customer participation in the experience, co-created by services (Service Co-creation), Elicit Tacit Knowledge (Elicit Tacit Knowledge), Design Experience Point (Design Experience Point), Service Offering (Service Offering), Customer Engagement (Customer Engagement) form the value cycle; of The Firm) and the surrounding environment intertwined with customers, including: Partners, Complementors, Investors or Third Parties.

When we provide customers with products, services can integrate products and values and differentiate competitors; if we can better understand customer needs and problems, we will gain new knowledge that our competitors do not have, and we can further improve processes and provide new products. service. Therefore, service innovation is an important way for organizations to obtain benefits. It is also an important business model to increase transaction profits and improve customer satisfaction.

## IV. CASE STUDY OF TAIWAN'S SMART ENVIRONMENT INFORMATION PLATFORM

Facing the rapid growth of Internet technology, how to make good use of the one-stop environmental information platform to effectively enhance the application value of environmental resource open data is the direction of the government's environmental governance and innovation strategy. The following is the "smart environmental information platform" in my country. Case study and analysis.

### 4.1 Smart environment information platform application service architecture

Under the guidance of network effects, user needs, OECD practical principles and the driving force of the Chinese government to promote policies, the environmental cloud is composed of "Environmental Resources Database", "Environmental Resources Data Exchange Platform", "Environmental Resources Data Open Platform", and "Environmental Resources A cross-domain one-stop environmental information service platform is combined with different application platforms such as the "Environmental Resources Data Analysis and Sharing Platform" and "Environmental Cloud Integration Platform", which are mainly divided into

"data production layer", "data management layer" and "data application layer" "Three levels.

#### **4.2 Open service model of smart environment information platform**

Taiwan's smart environment information is mainly built on the "environmental cloud data service display platform" infrastructure, which collects and manages multiple environmental data services, builds an information disclosure network, and publishes the overall development of the environment to facilitate the opening of data to the external application environment. Take the 2019 environmental resource database integration plan as an example, including the functions of the environmental cloud integration platform and the environmental cloud data service display platform; among them, in the application of environmental resource database data, as of April 12, 2020, integration and opening 23 It provides 222 data collections for public inquiry and download. There are 48 topics, a total of about 987.27 million, a total of about 800,000 downloads and citations, and 45 citations of academic papers.

The environmental resource data exchange platform supports other digital government data exchange service platforms, such as: chemical cloud, disaster prevention cloud, image resource cloud, etc., to improve the efficiency of cross-domain, cross-cloud, and cross-project data collection for government agencies, and establish data quality inspections mechanism. As of April 12, 2020, a total of 96 units have participated in the sharing of environmental data, 362 users, 2,494 have joined the number of platform data, and a total of 3,373 environmental data sets have been subscribed, with a total of more than 30.4 million transactions.

#### **4.3 Environmental data open platform centered on user experience**

The environmental cloud platform is oriented to the diverse needs of different users and provides the following five innovative services: 1) Introduce technologies similar to Yahoo and Google's query interface to provide differentiated query services; 2) Establish "Management of pollution information integration and data openness" "Service, expand the scale of data openness; 3) From the people's perspective and demand, develop a localized environment instant messaging app; 4) Use a hybrid web design concept to develop an environment-friendly information network; 5) Use neural networks Road and other related technologies to optimize internal governance and enhance environmental governance energy.

Through the interface with the government data open platform (Publish API), the Environmental Instant Messenger App has successively completed the revision of the website, providing advanced functions such as data set recommendation, important information statistics, community sharing and citation

statistics, data set sorting, multi-file downloading, etc. ; Industry, academia, research, and civilian development of more than 120 web services, APPs, and academic applications from all walks of life. There are activation cases and value-added convenience services in all walks of life, application of environmental open information, and evaluation of environmental data. As of April 12, 2020, Open Data has released 1,329 environmental data, a total of 44 cooperative units, and 17 application services. It is provided to all walks of life through the M2M (Machine to Machine) mechanism to download value-added applications, with 41.84 million citations and downloads at the same time. It also provides 907 Open APIs; in addition, it also provides inquiries on the types of data sets such as atmosphere, water, land, forest, ecology, living environment and other, pollution prevention and other open data, and provides services through the Google cloud platform.

#### **4.4 Promote the sustainable development of the organization's boundary ecosystem through co-creation and collaboration**

Public institutions around the world have begun to implement digital transformation projects, and gain the benefits of the organization through co-creation of space and cross-domain collaboration. The marathon-style programming innovation platform "Civic hackathons" (Civic hackathons) originated in Canada and is a global innovation model. In 1999, a cryptography development event organized by OpenBSD in Calgary, Canada, used the term Hackathons for the first time; as more and more governments share open data, business regulators use software developers to generate new data using native data. The essence of the content of the software, as well as the services that may be useful to citizens (Johnson and Robinson, 2014; Robinson and Johnson, 2016), the essence of which is that a group of programmers cooperate closely on the purpose of software development in a short period of time, which not only stimulates experimentation and the benefits created also encourage various organizations to use digital technology to innovate in various fields.

In order to cooperate with the development of the country and society, and to demonstrate the importance of innovation in the use of open data, the Chinese government promotes cross-government agencies, cross-fields, and public-private co-creation by providing public Internet of Things data and encouraging the integration of private data to bring together the key to the organization's boundary ecosystem. Resources, including data owners, data scientists, and domain experts, work together to accelerate the optimization of public services and the efficiency of government service innovation. It is expected that the government will provide open data and encourage the integration of private data and implement innovative services through cross-domain collaboration.

#### 4.5 Open service innovation strategy of smart environment cloud platform

The smart environment cloud platform enhances the operational efficiency of platform integration through the border cooperation resources of the "Smart Environmental One-stop". As the Chinese government pays more attention to the value of the application of public Internet of Things data for people's livelihood than ever before, the "Smart and Environmental One-Stop" program was launched in 2020. Environmental regulators accelerate the government's thinking about digital data through the configuration and operation of traditional departmental organizations. The value of the application. This kind of cross-domain one-stop service centers on user experience, and at the same time is based on life needs or public affairs. This type of information service platform becomes a more compact part of a wider administrative process; through a cross-domain one-stop platform, you can Assist the government, the public, enterprises and research institutions to maintain closer interaction.

Through "digital transformation" and "intelligent analysis", in addition to providing effective intelligence data for internal optimization of governance, decision-making judgment, resource allocation, and value-added applications in various fields, it is more important to provide people with customized information. "Precision Service: Tailored Active Delivery" makes people feel more about the government's digital services, which is in line with the "people-oriented" vision of the digital transformation promotion plan of public services, and also in line with the "convenient, efficient, and comprehensive" vision of smart government. Year-round" goal.

#### V. CONCLUSIONS AND ECOMMENDATION

This paper takes the concept of environmental data trends and open service innovation as the research foundation, and takes my country's smart environment cloud platform as the case study object to explore the current status, development strategies, and feasible practices and experiences of the application of public and biological Internet data, and at the same time reveals How the government should plan and promote environmental information open policies to increase the amount and capacity of innovative and value-added applications of environmental information. To summarize the discussion in this article: As a public innovation platform, the emergence of an open service innovation model is redefining the connotation and methods of environmental governance; the governance role played by the government has gradually shifted from the previous "public affairs management" to "public service innovation" "And "public value creation"; with the development of smart technology, the development trend of open

environmental data in various countries will also evolve from the past "technical innovation" to "product innovation", and then extend to "user experience as the core" Service Innovation".

Open service innovation is spawning innovative forms in various environmental data fields. From the perspective of governance, the government departments of advanced countries have been operating independently for a long time. Even in environmental departments and environmental-related fields, they have developed a set of independent management methods and solutions due to different national conditions. In the era of information explosion, data orientation has become the key core and new value of Industry 4.0; how to maximize the effectiveness of environmental data, how to turn the messy and diverse environmental data into useful information, and how to convert these data and data into Knowledge and wisdom will become our biggest challenge next.

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# IMPLEMENTATION OF 32-BIT 5-STAGE PIPELINED RISC PROCESSOR

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**Abstract** - A Reduced Instruction Set Computer or RISC has a small set of simple instruction exist in 8,16,32 and 64-bit, which are now used across a wide range of platforms. The low power technique, Pipelining is the process of executing the instructions in the orderly fashion. In this paper, 32-bit 5-stage pipelined RISC Processor is designed utilizing Verilog HDL. The objective of this paper is to execute 32-bit instructions set which is written using hardware description language (HDL) in pipeline process to lessen the power utilization. The processor is designed on Xilinx ISE Design Suite platform.

**Keywords** - Reduced Instruction Set Computer (RISC), Low Power, Pipelining.

## I. INTRODUCTION

Different types of processors stand in the market, out of which not many of them planned utilizing Hardware Description Language (HDL).

An Instruction Set Architecture (ISA) is a conceptual model of a system, it describes the behavior of machine language instructions. ISA common classification is

1. *Complex Instruction Set Computer (CISC)* emphasizes on hardware to optimize the instruction set. This architecture can be used with low-end applications.
2. *Reduced Instruction Set Computer (RISC)* simplifies the processor by well implementation of instructions that are frequently used in programs. Main function of this is to reduce the time of instructions execution. Both RISC and CISC architecture have been made as an aim to overcome the semantic gap. The description of semantic gap for the high-level language to be changed over to the machine level languages. IBM was the first organization to establish the RISC architecture in 1970's.

RISC based designs will continue to grow in speed and ability. Features which are typically seen in RISC based systems.

1. **Pre-fetching:** Searching for the next instruction before the current instruction is completed into an event queue.
2. **Pipelining:** Process of pipelining is, at first clock pulse, first instruction is fetched then at second clock pulse the first instruction is decoded and second instruction is fetched. At third clock pulse the first instruction is executed; second instruction is decoded and third instruction is fetched and so on based on number of stages.
3. **Superscalar operation:** This operation refers to the processor subjected to more than one instruction at once.

Some of the important features of RISC processor are as follows

- uses a smaller number of instructions
- use hardwired control unit (CU)
- uses less power and provides high performance
- easy and consistent instructions
- uses simple addressing modes
- uniformly fixed length of instruction is maintained
- registers are used

This paper explains a RISC processor design in which 32-bit instructions are executed and 5-clock cycle operation is performed using 5-stage pipelining. The proposed framework contains RISC architecture planned to execute a set of instructions to increase the speed of operation. It incorporates five stages of pipeline, they are fetching (F), decoding (D), execute (EX), memory (MEM) and write back (WB) stages. Instruction and data memory, Arithmetic logic unit (ALU), register file are the sub-blocks.

RISC processor is utilized in billions of embedded systems. This paper carries out pipeline-based RISC processor and coding is done in Verilog-HDL.

**Verilog-HDL:** Verilog is a hardware description language (HDL) used for modelling devices and describing a digital system. HDL's are independent of technology and user friendly for designing and debugging. Verilog-HDL is used for a design at many levels of abstraction. They are Behavioural level, Register-Transfer level, Gate level.

## II. LITERATURE SURVEY

Major low power techniques are pipelining, HDL representation, clock and power gating. In this overview, the various papers are referred and revealed as follows,

MIPS or Microprocessor without Interlocked Pipelined Stages based RISC architecture [1] is used to reduce the power usage. Here the author also used the Hazard Detection Unit. Author have used the 3-stage

pipeline process on MIPS based RISC Architecture [2].

Pipelining is an implementation technique to improve the ability of the processor and better usage of hardware. The goal is to meet the performance with increased throughput [3]. Low power technique, pipeline is utilized on RISC processor [4]. Carry look ahead adder is used on 16-bit RISC Processor and pipeline stages works on positive-edge and negative-edge of the clock [5]. The analysis of power usage in 16-bit RISC processor is described using pipelining implementation [6].

Clock gating strategies helps the block rest when not in use, to decrease the power of the processor. It very well may be applied to logic design, system architecture, gates, sub-blocks. This technique decreases power consumption to perform effectively [7].

For the overall power usage leakage power is the primary component. Power gating strategy is used for lessening leakage power. It is when the circuit is in dynamic mode. Enormous amount of energy utilization might happen because of repeated misprediction of control logic [8].

Sub-clock gating is another procedure to diminish the leakage power. This type gating scales the frequency and voltage. During the clock cycle power decrease is done at the dynamic mode. [9].

Another method consolidates both clock and power gating to lessen both leakage and dynamic power. To estimate helpful reasonability of the new experiment, author set up an examination device to analyse the RTL design. Here the device makes the decisions [10]. Author have utilized dynamic power management strategy, HDL modifications and state machines methods to lessen power utilization at system level. Here power is managed by units to keep up the information base of access to the input and output devices. Subsequently, this paper features on HDL adjustment with clock gating strategy [11].

Put together the study of the various papers, it is noticed that the significant work is focused on strategies, for example, pipelining, HDL modifications, clock gating, etc to decrease the complete power utilization.

### III. IMPLEMENTATION

RISC Architecture design is written in Verilog-HDL. The operation is performed by the ALU Block they are: Arithmetic (ADD, SUB, MUL), Logical (AND, OR, NOT), LOAD and STORE. The architecture representation of processor is shown in fig.1. Working of processor is explained in following stages:

**Stage one: Fetching:** This is the first phase of the processor, which gets the instruction from the instruction memory (IM) in view of the address which PC contains. The size of the PC and Instruction is 32-bit. At that point, the instruction is shipped off the following stage.

**Stage two: Decode:** In this stage the processor decodes the instruction and separates the op-code and operand from the instruction. This stage also accesses the register file and read the register.

**Stage three: Execute:** This is the stage where the main computation takes place. This stage contains ALU which performs arithmetic, logical and shift related operations based on the op-code value.

**Stage four: Memory access:** It contains data memory (DM). It performs loading and storing operations i.e., read or write.

**Stage five: Write back:** The last phase of the processor is to write back. This stage composes or stores the outcome into the register.

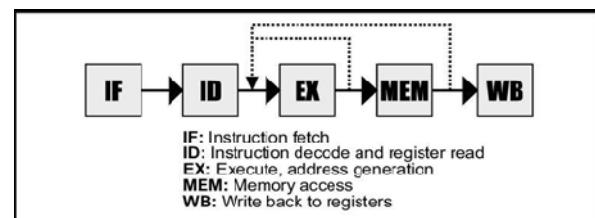


fig.1: 32-bit RISC Architecture

**Program Counter (PC)** has the address of the instruction, during the clock is high the instruction is fetched from the memory. Its count is increased by one at every pos-edge of the clock. Inputs given to the counter are data of 32-bit, clock, load and reset. Fig.2 represents the symbol of program counter.

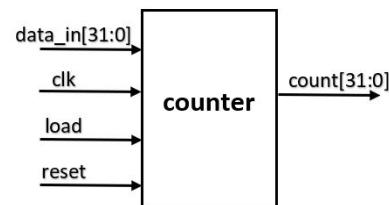


fig.2: Program counter symbol

**Decoding stage** loads the instruction from PC and data from memory. It generates the appropriate control signals for the next stage operation. Fig.3 represents the decoder symbol.

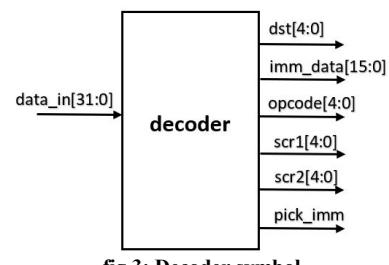


fig.3: Decoder symbol

The **execution stage**, here the main operations takes place. Calculations that should be performed are given by the control signals and executed. They are performed at every pos-edge of the clock cycle. Inputs given to ALU are opcode, operand0 and operand1. Fig.4 represents the ALU symbol.

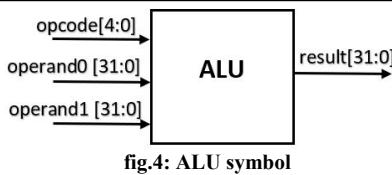


fig.4: ALU symbol

**Register File** performs the load and store operations. Registers are the faster way to execute the process. Fig.5 represents the Reg-file symbol.

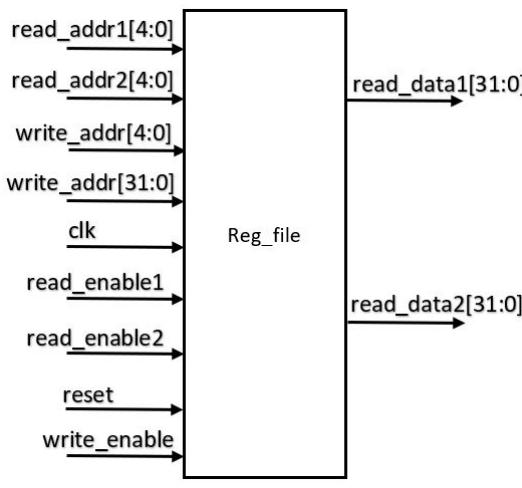


fig.5: Reg-file symbol

Register and memory blocks are interlinked. Loading the data from memory into registers and storing the data from register to memory. The final output is observed at memory block after the write back stage. Fig.6 represents the memory symbol.

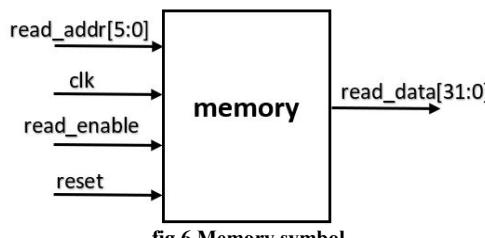


fig.6 Memory symbol

fig.7 shows the Internal RTL view of the pipelining technique.

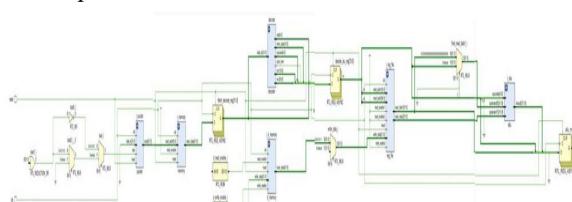


fig.7: Internal View

From the above figure step-by-step process is executed and the balance between pipeline stage is observed. The blue color blocks represent the stages and yellow color represent the gates and multiplexers.

#### IV. SIMULATION AND RESULTS

From the results it is observed that the complete processor works on the clock. Verilog HDL is utilized to describe the RISC processor. Simulation results of internal blocks are shown below:

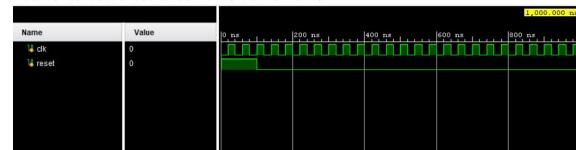


fig.8: Simulation of Processor

Processor is reset first i.e., input given is high and made low so that operation gets started.



fig.9: Simulation of program counter

Load is high, as the counter should load the instruction from memory and continuously increment at every pos-edge of clock based on the input given. Address of the instruction is given as 32-bit binary. Output of the counter is count i.e., also 32-bit binary.

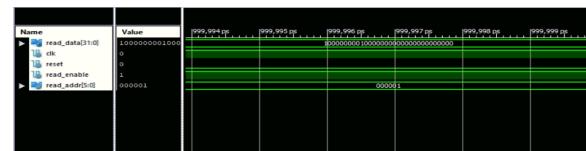


fig.10: Simulation of memory

The read enable is always high. Based on the read address the instruction is fetched from memory and given as input to the decoder.

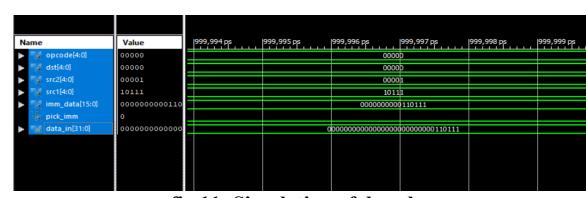


fig.11: Simulation of decoder

The instruction is given as input to the decoder. The given input is decoded accordingly. Output of the decoder is, two operands and the opcode for which operation should be performed.

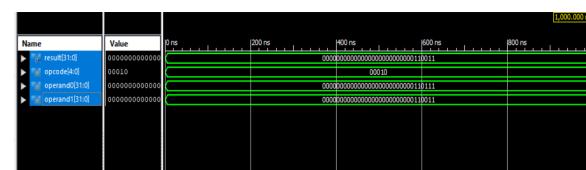


fig.12: Simulation of ALU

The two operands are given input to the ALU as 32-bit and opcode as 6-bit. ALU performs the operation based in the opcode. Output of the ALU is the result in 32-bit binary

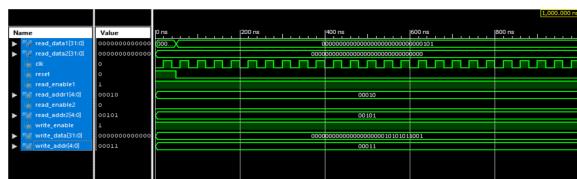


fig.13: Simulation of reg-file

The reg-file and memory act together based on the enable which is active i.e., read or write operation

## V. CONCLUSION

Processor is designed and verified using Xilinx ISE Design Suite platform with five-stage pipelining. The modules created are – Counter, Decoder, Memory, registers, ALU. By carrying out pipelining technique, the power used by the processor is reduced. In this paper, it is observed that area of the processor according to internal schematic view is increased after applying pipelining technique.

## FUTURE SCOPE

Increasing the number of instructions and reducing the pipeline stages with a smaller number of clock cycles per instruction. Different power reduction techniques can be utilized for the work.

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# LOW COMPLEXITY RECONFIGURABLE ARCHITECTURE FOR DIRECT DIGITAL FREQUENCY SYNTHESIS

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## Abstract -

With the tremendous growth in the demand for Wireless communication systems, the radio communication standards do change at a faster pace. Due to this, the hardware radio communications becomes obsolete. Software programmable or reconfigurable architecture for the implementation of radio communication system offers an efficient and cost effective solution to overcome this problem. It involves design of reconfigurable digital frequency synthesizers so that the specifications of required radio standard can be met. In this paper we propose to design reconfigurable Direct Digital Synthesizer (DDS) with reduced hardware complexity and minimum reconfiguration overhead to generate various carrier frequencies as required by the radio standard into consideration. The proposed design is implemented on various Field Programmable Gate Arrays (FPGAs) using Xilinx Vivado Design Suite and compared. It is observed that the proposed architecture not only switches the output frequencies at a faster rate with minimum overhead but also provides high frequency resolutionwhen compared with the existing DDS architectures.

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**Keywords** - DDS, Software Defined Radio, CORDIC, VHDL, FPGA

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## I. INTRODUCTION

Direct Digital Synthesizers (DDS) play a crucial role in the state-of-art wireless communication systems such as Software Defined Radio (SDR) and Cognitive Radio communication system to name a few. Hardware radio architecture is the traditional implementation platform while this has been replaced by the modern day software communication architectures. There is a tremendous growth and huge increase in demand for wireless communication systems in various fields of science and technology, applications ranging from domestic to industry and military applications. This led to the changes in radio communication standards at a faster pace.

With the advent of every new radio communication standard the traditional hardware radio architecture becomes obsolete due to deployment of fixed spectrum allocation techniques in them. In fixed spectrum allocation technique, based on the radio communication standard the end mobile user communicates with the base station on a fixed carrier frequency and the spectrum bandwidth is fixed. The spectrum allocated for a user of particular radio standard cannot be allocated to user of another radio standard even there are no users in that band. This leads to ineffective spectrum utilization.

A radio communication system is divided into three processing stages, namely, baseband (BB) processing, intermediate frequency (IF) processing and radio frequency (RF) processing. In traditional architectures all these processing is carried out by employing analog hardware which also makes the architecture inflexible to adapt to a new radio standard. Implementation of multiple radio standards on a hardware platform requires multiple sets of hardware leading to increase in hardware complexity and inefficient hardware utilization.

Reconfigurable architectures or software communication architectures with dynamic spectrum allocation techniques can overcome the limitations posed by the traditional architectures. This is possible if all the stages of radio signal processing are implemented in digital hardware leading to the concept of Software defined radio (SDR).

The term SDR was first introduced by Joseph Mitola in 1991[1]. In an ideal SDR transceiver, RF to BB processing is carried out digitally by placing data converters immediately after the antenna. However, this architecture is infeasible due to the practical limitations such as resolution, power dissipation, and spurious free dynamic range at radio frequencies posed by data converters [2]. A practical SDR architecture overcomes these limitations by carrying out digital signal processing in relatively low frequency IF and BB processing while RF signal processing in analog hardware [3]. The forthcoming high speed radio communications with increased channel bandwidth requires high IF frequencies and dynamically reconfigurable IF processing stage [4]. Quadrature mixing and frequency up/down conversion are the two main tasks needed to be performed in the digital IF stage of software radio. Hence, the design of reconfigurable IF stage requires reconfigurable quadrature mixer and digital up/down converter [5].

A quadrature mixer is implemented by multiplying the incoming signal with high frequency IF signal in quadrature. Direct digital synthesizer (DDS) can be employed to produce sinusoidal signals digitally with varied range of frequencies leading to flexible reconfiguration in the IF stage. In this paper, architecture to implement a reconfigurable quadrature mixer employing Coordinate Rotation Digital Computer (CORDIC) algorithm with low complexity and minimum reconfiguration overhead is presented.

The designed architecture is simulated using Xilinx Vivado Design Suite and implemented on various FPGAs to deduce the maximum frequency of operation and hardware is compared.

The rest of the paper is structured as follows. Section II describes DDS architecture and various techniques to implement them are presented. Section III presents CORDIC Algorithm and its implementation aspects to realize a reconfigurable DDS. FPGA implementation along with results and discussions are presented in section IV while the conclusions are drawn in section V.

## II. DIRECT DIGITAL SYNTHESIZER (DDS)

The simplified architecture of a direct digital synthesizer (DDS) is shown in figure 1. The basic blocks of a DDS consists of a phase accumulator, phase to amplitude converter, digital to analog converter (DAC) and a filter. "The phase accumulator consists of frequency register which stores a digital phase increment word followed by an adder and a phase register [6]". The digital input phase increment is entered in that frequency register which determines the number of samples to be generated in each sinusoidal cycle. On a particular clock edge transition, a new phase is generated by adding the given phase increment to the previously held phase in the phase register. The rate of phase overflow determines the output frequency and it is expressed as:

$$f_{out} = \frac{\Delta P \times f_c}{2^n} \quad (1)$$

Where,  $f_{out}$  = output frequency of the DDS,  $\Delta P$  = binary tuning word,  $f_c$  = System clock frequency

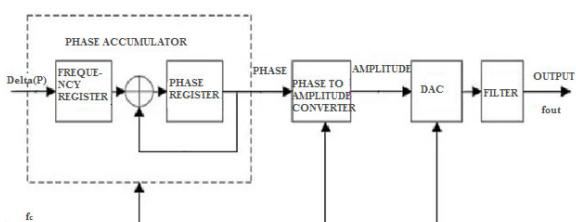


Figure 1: Conventional Direct Digital Synthesis

The following block of DDS is a phase to amplitude converter which generates output waveform as a binary output and the accuracy and resolution of the output waveform is proportional to the number of bits employed in its representation. Various digital patterns based on the required output waveform such as square wave, triangular wave, saw-tooth wave, sinusoidal wave etc can be mapped to the output of a phase to amplitude converter.

In communication systems, as the message signal is modulated with a sinusoidal carrier, the focus of this paper is to map the output of phase to amplitude converter with a digital pattern which can synthesize variable frequency sine waves. Moreover, in radio communications it is required to generate high IF

frequency so that multiple channels of any existing radio communication standard can be accommodated. Apart from this, if any forthcoming standard requires high bandwidth then it is required to reconfigure IF frequency with low reconfiguration overhead.

Phase Locked Loop (PLL) is the one of the traditional methods which can be employed for the implementation of a frequency synthesizer. High phase noise and low frequency switching speed, consumption of significant area on chip die or system board, frequency resolution and narrow frequency lock-in range are the limitations posed by PLLs [7]. In mobile, wireless and satellite communications, developments of DDSs are perfect replacement to PLLs.

Various methods for generation of sinusoidal wave are based upon series expansion, interpolation, look-up-table (LUTs), Phase Locked Loops (PLLs), COordinate Rotation DIgital Computer (CORDIC) based algorithm [8]. Series expansion, interpolation methods involve high computational complexity and hence unsuitable for reconfiguration. LUT based method lowers the computational complexity while the contents of LUTs are filled with the sinusoidal values which are computed offline. In addition to this, the number of pre-computations and the depth of LUT double with increase in 1-bit phase resolution leading to high reconfiguration overhead.

DDS architecture for sine wave generation based on CORDIC algorithm overcomes the above disadvantages as it involves online computation. CORDIC architectures can also perform the task of mixing and frequency synthesis simultaneously; hence they eliminate the need of explicit multipliers as required for carrier modulation in communication systems leading to decrement in computational complexity. In the present work, a DDS based on CORDIC architectures to achieve low computational complexity and minimum reconfiguration overhead is presented. An overview of CORDIC algorithm and its implementation aspects are presented.

## III. CORDIC ALGORITHM

CORDIC an abbreviation for COordinate Rotation DIgital Computer algorithm was first developed by Volder in 1959 for the simpler computation of the trigonometric functions. Later, J.S. Walther [9] has proposed a unified CORDIC algorithm for the computation of trigonometric functions, hyperbolic functions and the result of multiplication/division operations. CORDIC algorithm for the implementation of DDS employs the principle of rotation of Cartesian-coordinates. It can be expressed as:

$$\begin{pmatrix} x_{new} \\ y_{new} \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \quad (2)$$

With algebraic manipulations the above equation can be expressed as

$$\begin{pmatrix} x_{new} \\ y_{new} \end{pmatrix} = \cos\theta \begin{pmatrix} 1 & -\tan\theta \\ \tan\theta & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \quad (3)$$

Where,  $\theta$  = required angle of rotation.

In CORDIC algorithm the required rotation is attained by rotating the vector iteratively either in anti-clock wise or clock-wise direction with small pre-defined angular steps. Eq. (3) in the  $i^{\text{th}}$  iteration can be rewritten as:

$$\begin{pmatrix} x_{i+1} \\ y_{i+1} \end{pmatrix} = \cos(\alpha_i) \begin{pmatrix} 1 & -\text{sign}(z_i)\tan(\alpha_i) \\ \text{sign}(z_i)\tan(\alpha_i) & 1 \end{pmatrix} \begin{pmatrix} x_i \\ y_i \end{pmatrix} \quad (4)$$

where,  $\alpha_i$  = Angle of rotation in the  $i^{\text{th}}$  iteration;  
 $z_i$  = Required angle of rotation at the start of  $i^{\text{th}}$  iteration;

Further, if  $\alpha_i$  is the pre-defined angular step equated to  $\tan^{-1}(2^{-i})$  the above equation can be rewritten as:

$$\begin{pmatrix} x_{i+1} \\ y_{i+1} \end{pmatrix} = \cos(\alpha_i) \begin{pmatrix} 1 & -\text{sign}(z_i)2^{-i} \\ \text{sign}(z_i)2^{-i} & 1 \end{pmatrix} \begin{pmatrix} x_i \\ y_i \end{pmatrix} \quad (5)$$

The residual angle of rotation  $z_{i+1}$  is computed as:

$$z_{i+1} = z_i - \text{sign}(z_i)\alpha_i \quad (6)$$

It may be noted that the rotation of a vector by required angle involves rotation in fixed angular steps,  $\alpha_i$ . Due to this the contribution of term  $\cos(\alpha_i)$  becomes a constant. Neglecting this, the CORDIC equations are now expressed as:

$$\begin{pmatrix} x_{i+1} \\ y_{i+1} \end{pmatrix} = \begin{pmatrix} 1 & -\text{sign}(z_i)2^{-i} \\ \text{sign}(z_i)2^{-i} & 1 \end{pmatrix} \begin{pmatrix} x_i \\ y_i \end{pmatrix} \quad (7)$$

From Eq.(7) it is observed that the new coordinates can be easily computed by employing shift and add operations which can be implemented by employing registers and adders instead of multiplications, leading to significant reduction in hardware resources.

Various architectures for the implementation of the iterative CORDIC algorithm are presented in the literature. Pipelined CORDIC architecture in which a pipelined register is introduced between two successive iteration stages improves the speed of the architecture at the cost of high latency. It may be inferred that by employing techniques such as redundant number system, canonic signed digit representation, sign pre-computation the speed and latency of the architecture can be improved at the cost of high hardware complexity. With the current state of art FPGAs, high speed and low latency can be achieved even with the simple pipelined architecture. This is due to reduction in technology size in modern FPGAs. In the next subsection, pipelined architecture for the implementation of CORDIC algorithm is presented.

#### IV. ARCHITECTURE

The hardware implementation for CORDIC algorithm is shown in figure.2. It requires three registers X, Y

and Z, a LUT to store the values of  $\alpha_i$ . All the multiplication and accumulation operations are reduced to shift and add operations. The branch involves of adder-subtractor combination, a shift unit and a register are used for buffering the output. The CORDIC algorithm also performs as a quadrature phase to amplitude converter, it generates sine and cosine waveforms [10]. “The advantage of using CORDIC based DDS with respect to LUT based methods, it can achieve high phase resolution as well as high quality with lower hardware cost [11]”. One of the difference in both methods are, in phase accumulator generates an integer value that addresses an LUT in LUT based method while it generates an angle in CORDIC based DDS.

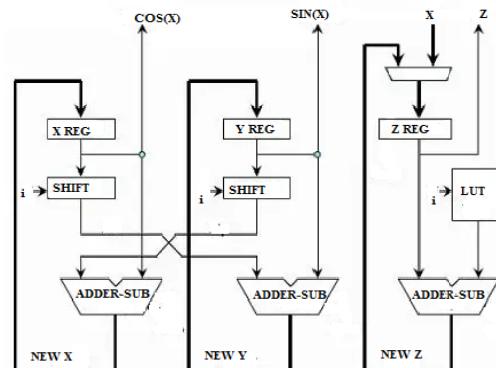


figure.2: Architecture of CORDIC

#### V. SIMULATION RESULTS:

DDS produces an analog waveform, basically a sinusoidal wave by generating a time-varying digital signal and which is converted into analog signal by employing digital to analog conversion. The proposed architecture is implemented using Verilog HDL and synthesized in Xilinx vivado 2016.4. to estimate the hardware resources and maximum frequency of operation by employing various state-of-art seventh generation Xilinx FPGAs such as Artix-7, Kintex-7 and Zynq7000.

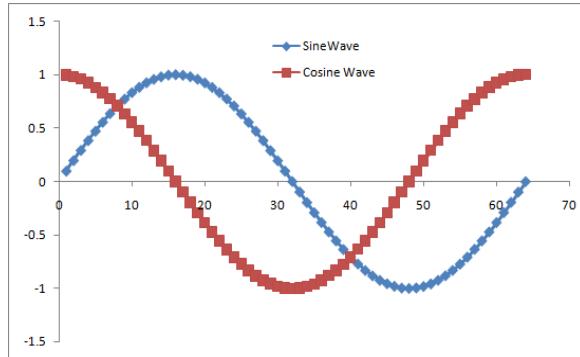
Many design architectures were employed to implement DDS. A standard DDS is a mixed signal device which generates an analog sinusoidal signal. It is observed that the proposed CORDIC based DDS architecture is simpler in terms of its design aspects and has very low reconfiguration overhead when related with the existing architectures in the literature.



Figure.3: Simulation Results of a Direct Digital Synthesizer

This is due to the fact that the new frequency analog signals are generated based on the rotation of a fixed initial vector and the angle vector is initialized with

the desired rotation angle which is also called as Frequency Control Word. We have simulated the proposed architecture by employing various FPGAs and the simulation results are presented in figure.3 and figure.4. It is observed that the proposed algorithm generates waveform in quadrature whose frequencies can be flexibly altered with the frequency control word.



**Figure.4: Quadrature Waveform Plot**

The implementation result shows hardware resource estimation of 890 LUTs and LUT-FF pairs and maximum frequency of operation as 332MHz. It may be noted that as the technology shrinks the maximum frequency of operation increases thereby making the proposed DDS architecture suitable in the development of 5G applications. It is also observed that the proposed architecture has faster switching speed due to its pipelined implementation at the cost of pipeline latency. It may be noted that though the architecture is suitable for generation of high frequency signals, it may result in poor frequency resolution due to finite word-length of the CORDIC parameters and employing longer word-lengths increases latency of the architecture.

## VII. CONCLUSION

This paper is reported to implement FPGA based direct digital synthesizers using CORDIC algorithm. DDS is a very suitable technique that can be applied

to generate any waveform at any frequency. DDS when implemented along with signal processing techniques, it can modulate or encode any digital signal and generate it. Moreover, it can also be interfaced with computer and in turn provides access the waveforms generated by FPGA. The design of DDS based on CORDIC algorithm is always a better option for implementation on digital circuits as its hardware complexity is equal to that of three multipliers, hence requires very low hardware and flexibly reconfigured with minimum reconfiguration overhead.

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# ROBOT TEACHING LABORATORY DEVELOPMENT FOR EFFECTIVE REMOTE DELIVERY

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**Abstract** - Teaching Laboratories are the essential learning activities for the engineering education field. During the laboratory period, there are several learning activities, including theoretical review, equipment setup, data or result collecting, and analysis of the results. However, handling laboratory with social distancing during the pandemic of COVID-19 is hard to deal with onsite laboratory. Focusing on the industrial robot laboratories in the mechatronics engineering curriculum of the Suranaree University of Technology, this paper covers a remote robot laboratory design state using a computer programming technique to achieve the industrial robot laboratory and hardware design for robot programming tasks. There are three keys to practicing robot control, jogging, teaching, and programming. Students can remote access the university laboratory from distant areas, and they can book any time during the day and night shift. This paper can help educators deal with robot laboratories or other related laboratories in the social distancing situation.

**Keywords** - Remote laboratory, Industrial Robot Laboratory, Distance Learning

## I. INTRODUCTION

In the context of a Thailand pandemic due to COVID-19, educational institutions, including schools and universities, are advised to enhance their teaching and learning activities in the physical distancing procedure. During the first period of lockdown in Thailand, It is at the end of the semester. Students were in their homes already, so the curfew announcement was delivered. Traveling across provinces was against this law. Consequently, students are advised not to come to university and stay home for online lectures and laboratories. Most teachers had no concrete experience of distance learning and little or no skill in using the technological devices and appropriate software to provide this distance education [1]. There are types of problems of distance learning, and online learning must be concerned.

- Technical problems: difficult or impossible connection for teachers and students
- pedagogical issues: the difficulty of staying focused on learning for hours on-screen communication and mutual assistance hampered by distance, despite the private practice of social networks. It is well known that these daily private practices are not so easily transferred to education [2].

The lecture course remained almost unchanged and delivered in an online classroom, such as in the zoom application. On the other hand, the laboratory courses must be re-designed because it is hard to teach their laboratory lessons or laboratory skills in truly virtual classrooms. The traditional laboratory must be developed to serve engineering students. The process for transforming currently in-person experiential learning activities to those suitable for remote

delivery depends on several factors such as the nature of the experiment (simulation heavy vs. hands-on heavy) and the available time and resources. Some educators may adapt hands-on experiments for remote delivery, while others may restructure the activity altogether by concentrating on learning objectives[3].

Focusing on one of the industrial robot laboratories, called the cartesian robot. There are three modes of robot control

- Jogging mode: to perform the robot any position in its workspace by using pulse command
- Teaching mode: after jogging a robot to the desired position. To save the current position of jogging mode, called teaching mode.
- Programming mode: the last process of robot control after the two previous modes. Moving a robot in a sequence of positions, the user needs to program using its programming language.

This research aims to design and develop computer programming to communicate between the controller of the robot and the personal computer of students. Students can access the robot laboratory anywhere they are, and anytime they want. IAI robots are selected to develop the remote laboratory to serve students, who enrolled the industrial robot class.

## II. DESIGN OF SYSTEM OVERVIEW

### 2.1. System Design Concept

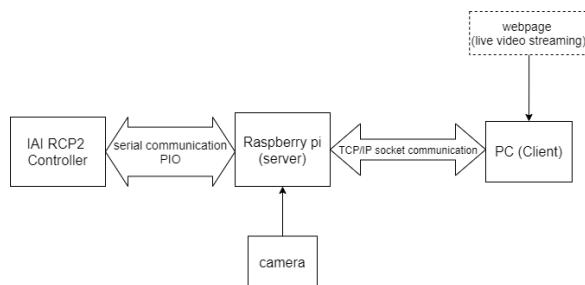
The key concept is to design the remote robot laboratory for the industrial robot laboratory class using the assumption that students who enrolled in this laboratory class have their laptops or personal

computers. This laboratory can access through the global network, which means that they can do a laboratory where ever they want. “WebLabs” type option, where the students can control and operate the equipment remotely[4][5][6].

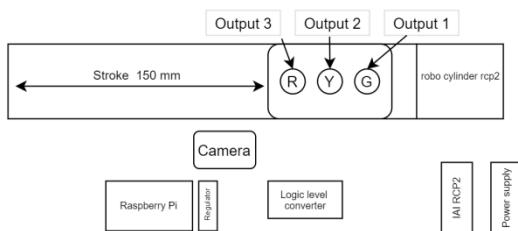
## 2.2. System Overview

There are four primary devices in this system, including a personal computer, raspberry pi as a server for communication between robot and computer, an IAI RCP2 robot controller to drive the robot, and a camera for real-time monitoring (Fig.1.). TCP/IP protocol is selected to communicate the controlling signal from a user to the central server. After a user commands the robot on the user interface, the controlling data will be sent to the server via TCP/IP. Then, the server will send the actual commands to the robot controller via serial PIO communication. And a robot will be moved by its controller. We use the camera to monitor the movement of a robot to show that a robot moves to the desired position by broadcasting a real-time video streaming to the web page.

The system layout as seen in Fig.2. The main robot (IAI Robot) has the operation stroke of 150 mm and three of output on its. A monitoring camera is located on the top of this plate for catch-up every components to broadcast to Graphic User Interface (GUI) on PC.



**Fig.1 System Overview of Remote Robot Laboratory**



**Fig.2 Equipment Layout of Remote Robot Laboratory**

## III. METHODOGY AND RESULT

### 3.1. IAI RCP2 Command

Command messages are sent from Raspberry-Pi to RCP2 controller via TCP/IP protocol. String of one message is combined with 16 long ASCII code. The start character is [STX] and end with [ETX]. For the validation of each message, there is the checksum of the last two characters of the continuous messages. The checksum character can be calculated by sum of

the whole messages without the start bit character. Then end the message with [ETX] character. It can be seen the way to calculate the two checksum characters in Fig.3.

Status	STX	Axis#	'n'	10 continuous 0's								BCC	ETX
Inquiry	02		6E	30	30	30	30	30	30	30	30	30	03

BCC Data

**Fig.3 Message Detail for RCP2 Controller**

### 3.2. ASCII Messages for RCP2 Controller

There are eight standard messages for using the IAI robot in the laboratory. The First two major commands are HOME and STOP. When the electrical power of the robot was connected, the first command that the student has to send to the controller immediately is a HOME command for homing it and let the robot stayed in its home position before use. Servo ON and Servo OFF is the critical command for active the servo motor of the IAI robot before JOG or movement by increment. Students can move the robot manually by using JOG Forward and JOG Backward functions. While the robot moves, students can monitor its movement via the onboard camera in the robot station. A monitoring camera can show the near real-time situation. The list of messages of the above command is in Table.1. below.

Command	ASCII Characters
HOME	[STX]0e07000000007B[ETX]
Servo On	[STX]0q10000000007E[ETX]
Servo Off	[STX]0q00000000007F[ETX]
Jog Forward	[STX]0aFFFF65430025[ETX]
Jog Backward	[STX]0aFFFFFFF00DF[ETX]
Stop	[STX]0d00000000008C[ETX]
Position Inquiry	[STX]0R40000740008F[ETX]
Increment Move 80mm	[STX]0aFFFD6550013[ETX]

**Table.1. List of messages for RCP2 Controller Command.**

### 3.3. Sequencing the Robot Command

If the command messages were used separately, there is an essential operation for using the IAI robot in the laboratory. Students have to command the robot in sequence to achieve the robot task. We create the computer programming command to deal with this IAI robot. The flowchart of this programming as can see in the Fig.3. After the program start, users or students have to write the sequence text of operation in one string with the following text.

“MX” stands for moving the robot into a specific position, X represents the position number.

“OX” stands for state changing of the output relay, X represents the output number to change the state ON or OFF.

“TX” stands for delay time for moving to the following command, X represents the time in seconds to delay.

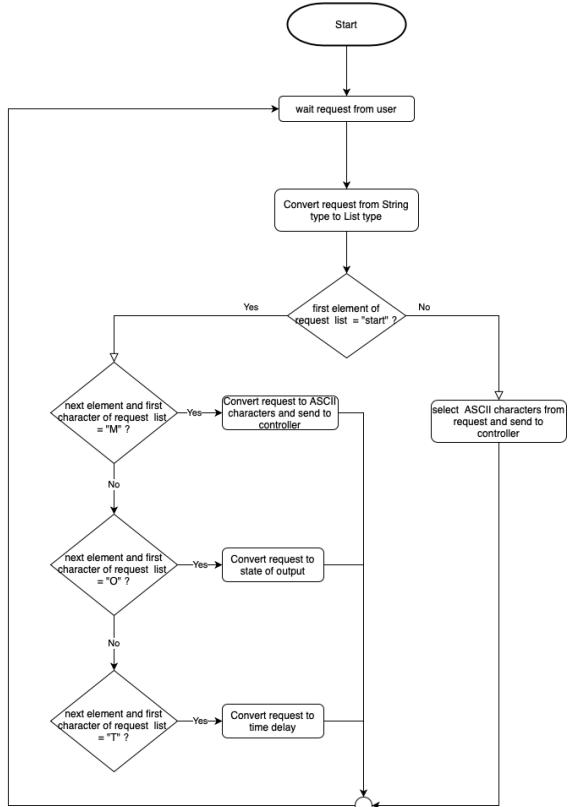


Fig.4 Flowchart of Robot Operation Programming

The first exercise of the robot teaching laboratory is to teach the desired position the robot controller. By using the GUI for manually control and then check the “save position” block. Then the current position has been saved to the controller. The example of this operation as see in the Fig.5.



Fig.5 Example for Robot Position Teaching

### 3.4 Laboratory Task

The students will be assigned by the teacher assistant a task. They have to teach and programming the IAI robot to achieve the task, which, combined with moving to some position, changes the state of outputs and waits for the following command.

For example in Fig.6, the series of command is “P0-O11-P4-T3-O10-P1-O31-P3-T3-O30”. The steps of this command are following,

1. Move to position number “0”

2. Change state of output number “1” to active high (ON).
3. Move to position number “4”
4. Delay for 3 seconds
5. Change state of output number “1” to active low (OFF).
6. Move to position number “1”
7. Change state of output number “3” to active high (ON).
8. Move to position number “3”
9. Delay for 3 seconds
10. Change state of output number “3” to active low (OFF).

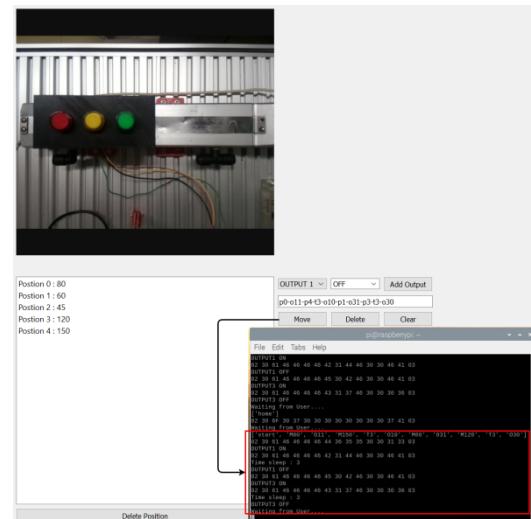


Fig.6 Example of Sequence Command of Robot Laboratory Task

## IV. RESULTS

After this remote laboratory has been used for one semester, the students can appreciate the robot with online or distance learning methods. And they can access this laboratory at any time of learning. Because this laboratory open 24 hours a day. Student can book their slots on google sheet and using the user and password to enter them during their period.

As a result of teacher assistance, it is more comfortable to teach the laboratory with real robots in an online situation. Before this remote laboratory was launch, the teacher assistants have to do this robot task by themselves without practicing with students

## V. CONCLUSION

The results show that this remote laboratory can be used in an industrial robot laboratory for robot class in SUT. These can also help the teacher assistance can teach their students with the actual situation commands and tasks without social distancing or physical distancing problems.

Students can get more flexible of using university laboratory on the period they want. With this condition, they can book their learning period

online and log in to the remote learning page to do their task.

We have to extend this remote platform to every industrial robot laboratory for the near future, for example, Articulated Arm Robot, SCARA Robot, and Cartesian Robot. If the pandemic situation of COVID-19 still makes an impact on our world. The remote laboratory is the key to the success of engineering laboratory in teaching and learning methods.

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# AN IMPLEMENTATION OF OBJECT TRACKING METHODS ON PAN AND TILT MANIPULATOR FOR TEACHER TRACKING IN HYBRID CLASSROOM

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**Abstract** - Hybrid Classroom due to the pandemic of COVID-19, the key to success for a digital classroom of the Suranaree University of Technology is broadcasting the teaching and learning activities onsite classroom via zoom application. One problem about the students who take this classroom online can not meet their teacher because the integrated camera on the classroom computer is stacked on the table in front of the class. The reason why there can not sense to teachers acts in the classroom. This paper aims to implement the object tracking method to the pan and tilt manipulator, a camera integrated. The results show that the three selected methods can achieve this task. The best accuracy for teacher tracking is the CSRT method with an IoU of 0.77 at 410 x 308 pixels.

**Keywords** - Teacher Tracking, Object Tracking, Camera Tracking, Pan and Tilt

## I. INTRODUCTION

Due to the pandemic of COVID-19, physical distancing is the critical rule for university teaching and learning activities. Laboratories are essentials classes for the engineering education field. Online classrooms are not the key to success for these cases. A hybrid classroom was selected. They are focusing on large size industrial robot laboratories. These are the essential laboratory for undergraduate students who are majoring in a mechatronics engineering curriculum. The teacher assistants need to use the monitoring camera to present the movement of robots and robot teaching situations. Sometimes the size of the robot is a large size, consequently the detail of robot could not be collected.

Due to the above problem, the aim of this research is to develop the tracking base for teacher monitoring camera. Real-time video will be used for image processing to achieve the tracking task and will be recorded for e-courseware stuff. By implementing the three onshelf tracking algorithm to the pan and tilt angle base which panning by DC stepper and tilting by servo motor.

## II. SYSTEM DESCRIPTION

### A. Hardware configuration

The range of the pan angle is from 0 – 360 degrees left to right and the tilt angle range is from 0 – 90 degrees from ground to air as in Fig.1.

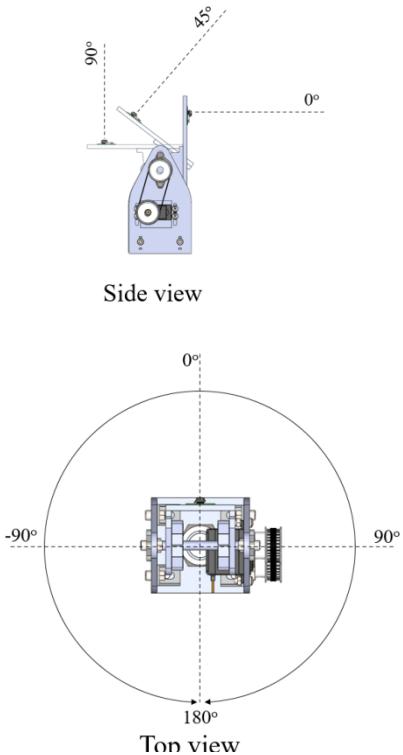


Figure 1: Operating Range of Pan and Tilt Angles

There are three main components as in Fig.2. Using the robot operating system (ROS) network to be a server for data communication. Firstly, the image processing module are included with raspberry pi and pi-camera. The second is the input command, this module will help the user set the parameter for tracking algorithm and starting the system.

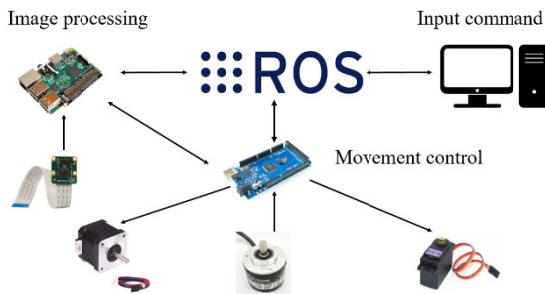


Figure 2: Hardware Overview

Input Command will be sent to the image processing module via ROS network. The tracking data is a region of interest (ROI) from the user. After a user created the ROI from the raw picture, the ROI data will be sent to the image processing module for making the decision. The making decision algorithm was integrated into the Raspberry Pi 4 controllers. Python programming was developed be a computational module. The last section, the movement module, will be received the position command from raspberry pi 4 to activate the pan and tilt base. An Arduino mega controller was selected to control these two motors at the same time. P-controller is integrated into the stepper control algorithm for stability movement.

#### B. Software descriptions

Robot Operating System(ROS) is commonly used for the robot task framework to develop the software and hardware related to the robots. They were using of ROS Noetic version and Ubuntu 20.04 focal fossa as the system environment. Python language is used for algorithm development. The imageprocessing software is developed based on the OpenCV version 4.3. Moreover, the last section is motors controllers, Arduino IDE, to create the P-controller programming for stepper motor and servo motor controller. The Arduino controller received the orientation from previous software via ROS node and controlled the motor simultaneously. The maximum range of pan limit is -180 degrees and 180 degrees, andthe overall pan angle is 360 degrees. P-controller is the optimized controller for use in this position control case because the speed of the stepper motor to achieve the task is still slow.

The system workflow of this system can be presented as the flowchart in Fig.3.

1) The real-time picture, captured from pi-camera, with desired quality of pixel. The more pixels of the picture, the more processing time need to use in the image processing period.A size of 410x308 pixels or lower were selected to deal with. The captured picture will be sent to the next node throughthe ROS master server.

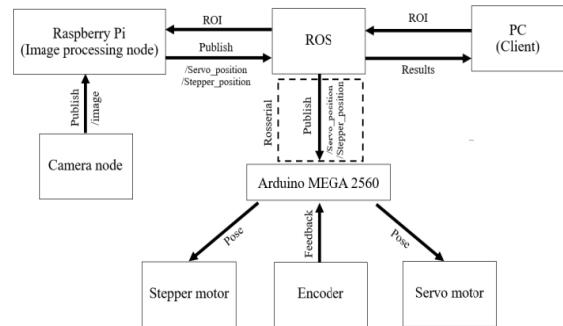


Figure3:System WorkFlow

2) Processing node received the captured picture and compared it with ROI from a user. In this case, we selected the teacher as ROI for the tracking system during the class periodby marking a blue square bounding box. Three methods of tracking system were implemented into this system, KCF, MOSSE, and CSRT. For easy monitoring of the operation of the image processing module, a square bounding box is marked by green bounding box as in Fig.8.

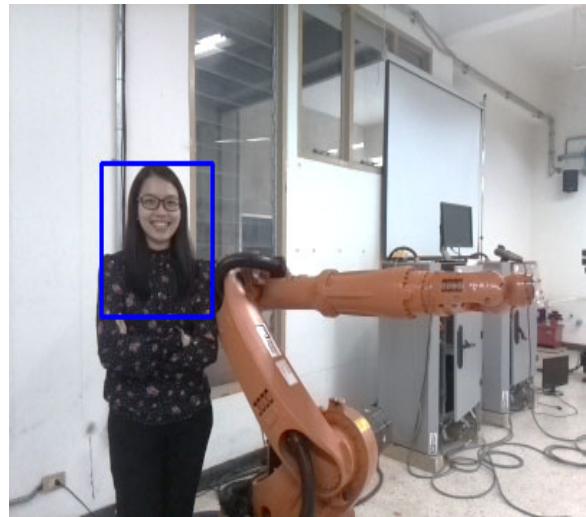


Figure 4:Example of Target Selection

3) Using the mathematical equation to compute [6] the centroid of the tracking object in vertical and horizontal directions. Coordinate from this equation will be the centroid of a tracking box.

4) If the center of the tracking box is not located in the center of the camera frame, the pan and tilt commands will send the movement angle to the movement controller to respond to this situation. The automatic control concept is to center the teacher in the middle of the camera frame.

5) Movement Controller receives the angle data from the ROS node and takes action to the pan and tilt angle with each motor controller.

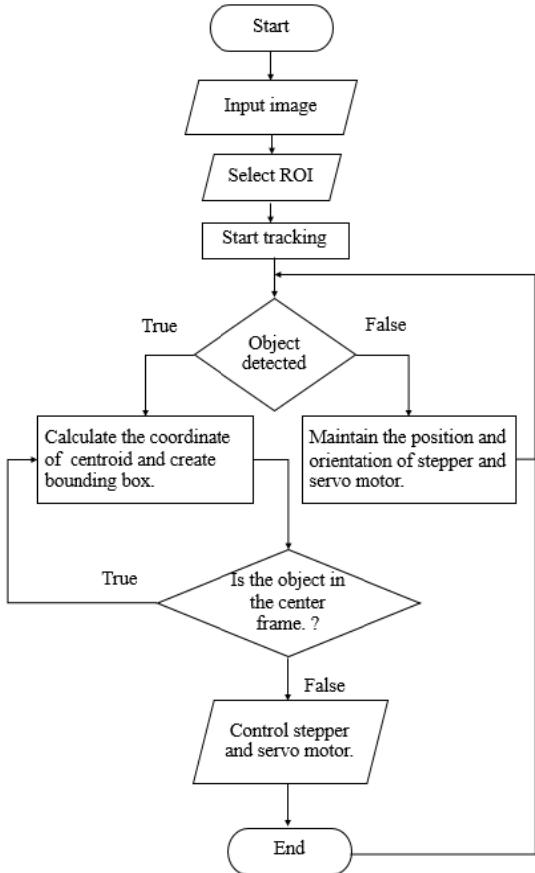


Figure 5: Algorithm Work Flow

### C. Object tracking method

The solution of the teacher tracking method has to use the object tracking method. In this research, we implement on-shelf object tracking algorithms to perform this task. KCF, MOSSE, and CSRT were selected for the accuracy test. This group of algorithms uses a low level of computational cost. KCF [1],[2] (Kernelized Correlation Filters) is the object tracking algorithm that uses the correlation value to match the sample. In object tracking, the correlation value between the ROI patch in the future frame and the original translated patch will be the highest. The KCF algorithm tends to be more accurate than the MOSSE algorithm.

MOSSE [5] (Minimum Output Sum of Squared Error) is the algorithm that used the MOSSE filter, which can discriminate between the ROI and the background image. This algorithm performs well in the change of rotation, light, brightness, and object scale. The MOSSE algorithm tends to much faster than KCF and CSRT, the accuracy less than KCF and CSRT algorithm.

CSRT[3],[4](Channel and Spatial Reliability Tracker) is the object tracking model which improved the Discriminative Correlation Filter (DCF) algorithm with spatial and channel reliability. The spatial reliability map makes the CSRT can adjust the filter size, which makes the CSRT model better than the DCF algorithm and can handle non-

rectangular shape ROI. The CSRT algorithm tends to be more accurate than the KCF algorithm but slightly slower than KCF.

## III. EXPERIMENT RESULTS

### A. Evaluation method

For the method of testing the tracking method, accuracy on pan and tilt angle manipulator. By using the three algorithms mentioned in the previous chapter. We divide the captured picture into three parts of the experiment, including 205x154 308x231, and 410 x308 pixels, respectively. The target moves at the same track, and time is the controlled parameter of this experiment. Then measuring the [7] Intersection over Union (IoU) of each track is used to determine the first accuracy of the tracking method. IoU is one measuring value to measure the intersection of area between the ideal frame and the actual frame. The output value of IoU falls into the range of 0 to 1 (equation 1).

$$\text{Intersection over union (IOU)} = \frac{\text{Intersect area}}{\text{Union area}} \quad Eq. 1$$

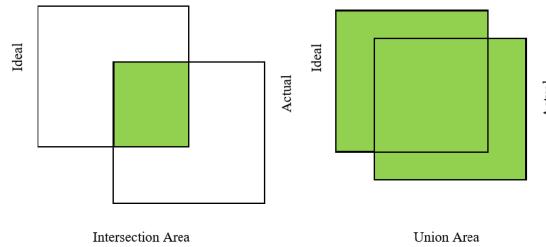


Figure 6: Intersection over Union (IoU)

If the value of IoU is higher and close to 1 is a sign that the actual and ideal area is located in the same frame. If the value of IoU is one shows that the tracking area and the ROI area are located in the same frame.

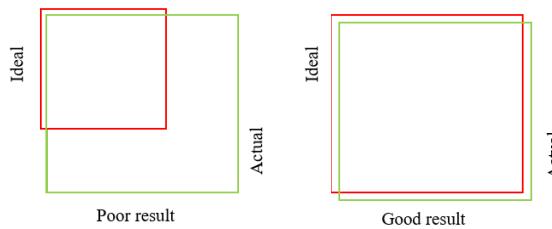


Figure 7: Result of the Value of IoUs. Accuracy

In the second accuracy test, the difference between the actual frame and ideal is compared. In this test, the Euclidean Distance Expression in Eq.2 for measuring the distance between two centroids was used.

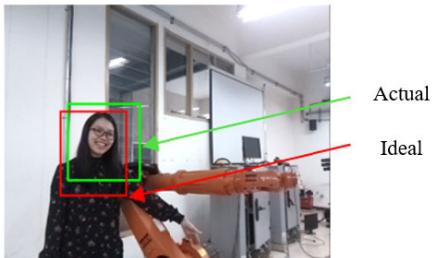
$$d(x, y) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad Eq. 2$$

On the other hand, compared with the IoU value, the value of the Euclidean distance must be closed to Zero, the accuracy of the tracking method will be better than others. For easy understanding of this value, the percent of centroid error (C.E.) is calculated by Eq.3.

$$C.E. = \left| \frac{d_{actual} - d_{ideal}}{d_{actual}} \right| \times 100\% \quad Eq. 3$$

### B. Results

The result of IoU and C.E. of the experiment was shown in Tables 1 and 2. The example of the tracking method is shown in Fig.8. The red bounding box represents the ideal ROI, and the green one represents the actual one.



**Figure 8:Intersection over Union of the Actual and Ideal Frame**

From Table 1, The result shows that if the number of pixels is increasing, the more accuracy in IoU. MOSSE algorithm returns the highest value of IoU in 205x154 pixels condition. On the other hand, CSRT returns the highest value of the IoU.

Image Pixel	Model	(IOU)
205x154	CSRT	0.74
	KCF	0.71
	MOSSE	0.86
308x231	CSRT	0.79
	KCF	0.72
	MOSSE	0.70
410x308	CSRT	0.77
	KCF	0.73
	MOSSE	0.69

**Table1: Intersection over Union (IoU)Results**

From Table 2, the result shows that the centroid error of the tracking methods is in the same way—the

overall centroid error of each tracking condition not over than 2% error. KCF returns the highest centroid error in all conditions of image pixels.

Image Pixel	Model	C.E. [%]
205x154	CSRT	1.79
	KCF	1.59
	MOSSE	0.30
308x231	CSRT	1.33
	KCF	1.72
	MOSSE	1.64
410x308	CSRT	0.88
	KCF	1.60
	MOSSE	1.16

**Table2: Centroid error (C.E) Results**

## IV. CONCLUSION

This paper presents the accuracy testing result from the three on-shelf tracking object algorithms to the teacher tracking task in the robot laboratory class in university. The three selected algorithms are KCF, MOSSE, and CSRT. By implementing the tracking algorithm results to the pan and tilt manipulator, the camera is integrated to track the teacher in a laboratory. Stepper motor and servo motor are integrated to control pan and tilt motions for centering the ROI in the middle of the frame. The result shows that the accuracy of the CSRT both in IoU and centroid error returns the accuracy of IoU value of 0.77 and centroid error of 0.88 in a condition of 410x380 pixels. In conclusion, the CSRT algorithm is the best choice in three selected algorithms to deal with teacher tracking in the laboratory classroom.

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# ONLINE GAME ITEM PRICING: FACTORS AFFECTING SKIN ITEM'S PRICE IN COUNTER-STRIKE: GLOBAL OFFENSIVE

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**Abstract** - This paper presents an analysis of factors affecting skin item's price in Counter-Strike: Global Offensive online game. Skin item is a kind of virtual product whose price cannot be properly estimated by its cost. This study wants to uncover the characteristics of skin item by analyzing the price from some game's unique factors such as types of weapons, StatTrak™ property, or rarity using the linear regression technique. The analysis is operated through a dataset retrieved from the Steam Platform. This study found that all these factors significantly affect the skin item's price. Still, the StatTrak™ property affect the price negatively, while the rests affect the price in positive way.

**Keywords** - Pricing, Online Game, Virtual Product, Price Analysis.

## I. INTRODUCTION

The skin item is an online game item in the Counter Strike: Global Offensive (CS:GO) online game which changes an appearance of weapons in the game. It only effects the appearance of the weapon, there isno additional benefit to its owner. SomeCS:GO players own skin item for personal purpose such as psychological boost or self-confidence. However, the other players own it for commercial purposes. They sell or buy skin using actual currency through the Steam Community Market, CS:GO contributor's platform.

Since the skin item is a kind of virtual product which cannot be evaluated its value properly. It is difficult to inspectthat how much the skin item costs.Most products can be evaluated by its cost, but the skin item does not. The price of skin items may be assessed by many factors such as the type of weapon, theirrarity, or some special properties like StatTrak™ or Souvenir item. The combination between some or allthese factors are likely to be appropriate for estimating the price.

Using regression, this study aims to analyze whether the three factors (type of weapon, rarity, StatTrak™ property) could explain its skin item's price.

## II. SKIN ITEM'S PRICE AND PROPERTIES

According to the previous literature, theprice of a skin item may depend on its propertieswhich is types of weapons, rarity, and StatTrak™ property. Each of these properties has unique characteristics and makes the price different. In this section will describes what each property is.

The skin itemprice in this study is the average price of skin items which were sold onSteam Community Market, the platform for buying or selling game item.Player has to top up with any currency of money in order to spend for a skin item. This study used Thai

currency (THB) because researcher is used to it. This skin item price is the dependent variable of this study.

CS:GO is an online shooting game which players are assigned to eliminate the other players using a gun weapon, ora knife.There are several types of weaponswhich players must choose at the beginning of each round of a match. All 61 types of weapons can becategorized into three groups, 34 of whichare guns,the other 19 are knives, and the rest eight are gloves.The skin item can be attached on a weapon to change the weapon's appearance. The various types of weapons may cause their price to be different. Players can obtain a skin item froma loot box called the container.The chance to get each kind of skin item is instinctive.CS:GO has seven tier of rarity level of skin items. The higher tier of rarity level, the lesser chance to obtain. Moreover, the skin item of a knife is especially rare.Via one loot box will have 0.26 percentof opportunity to earna special item including a knife or a glove, which is considered a highvalue skin item. In conclusion, the rarity level of skin item seems to make the price be more valuable.

StatTrak™ is the skin item's property that counts how many enemies a player has taken down.The kill counting number is displayed on some part of the skin item. This property is unique to the CS:GO game.Players whose guns have the StatTrak™status often proud of themselves, sometimes it boosts players to be more confident. The skin item with this property tends to be more expensive than that without it. However, the kill counting number will be reset if the owner sells it to others.

## III. DATA ACCUMULATION AND PROCESSING

This study used sell-listings ofthe Counter-Strike: Global Offensive skin items as the sample data. Steam allows its users to access data from the Steam Community Market using Steam API, a service for

accessing Steam Community Market's public data. We developed a Python language program to retrieve the data. This process took about 10 hours to record 9,516 records. Furthermore, the data received from Steam API consists of many attributes, so we had to filter the data with the fields such as item name, item type (which later be extracted into weapon types), and rarity.

As said earlier, the dependent variable in this study is the average price of the skin item. Unfortunately, the average price was unable to acquire from the API directly. Herein, this average price was calculated using the skin item prices in three days as presented in the API.

#### IV. VARIABLE EXPLANATION

This section will describe the characteristic of each variable.

Starting with the dependent variable, the skin item price is an average price of a skin item which was calculated according to the price history. This numeric variable was developed in Thai currency (THB).

The first independent variable whether the skin item is a StatTrak™ item. It is binary.

The second independent variable was types of weapons. This variable lists the skin item in groups of weapons. We tried to adjust the types of weapons to be more ordinal by asking experts to make a ranking of types of weapons. The ranking was arranged from the cheap price to the expensive one. This technique could make this variable to be treated as an ordinal variable.

The last independent variable was rarity. Each skin item has its own rarity level which indicates the probability to earn the skin item. There were seven levels of rarity represented as number one to seven as Table 4.1. Thus, the variable of rarity level was ordinal.

Rarity Tier	Level of Rarity
Consumer Grade	1
Industrial Grade	2
Mil-Spec	3
Restricted	4
Classified	5
Covert	6
Special Item	7

Table 4.1 Rarity level

#### V. ANALYSIS AND RESULT

This study used the linear regression method to analyze the affecting factors on skin item price. The analysis was held on IBM SPSS Statistics 22 software.

To understand these variables overview, the descriptive statistics could be appropriate to explain characteristic of variables. Table 5.1 presents the descriptive statistics analysis result of the price variable.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AveragePrice	9499	.56	47802.52	2344.9895	4887.61829
Valid N (listwise)	9499				

Table 5.1 Descriptive Statistics table of price variable.

From table 5.1, the mean of this variable was 2,344.99 baht with standard deviation of 4,887.62 and the range was 48,701.96 which was an extremely huge gap. Distribution of this variable is explained in Table 5.2.

Descriptive Statistics

	N	Skewness		Kurtosis	
		Statistic	Statistic	Std. Error	Statistic
AveragePrice	9499	3.971	.025	21.669	.050
Valid N (listwise)	9499				

Table 5.2 Skewness and kurtosis of price variable.

The price's skewness statistic was 3.971 which was positive with the kurtosis 21.669. These lead to a conclusion that its distribution was not normal.

For StatTrak™ variable, because this variable was a binary variable, so explanation was applied by a frequency table in Table 5.3.

Statistics

StatTrak™		
N	Valid	9513
	Missing	0
Sum		3214

StatTrak™

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	6299	66.2	66.2
1	3214	33.8	33.8	100.0
Total	9513	100.0	100.0	

Table 5.3 Frequency table of the StatTrak™ variable.

From Figure 5.3, there were 3,214 skin items with the StatTrak™ property, which made up for 33.8 percent. On the other hand, common skin items, the skin item without StatTrak™ property, were about two times more than the StatTrak™ skins, which made up for 66.2 percent of the dataset.

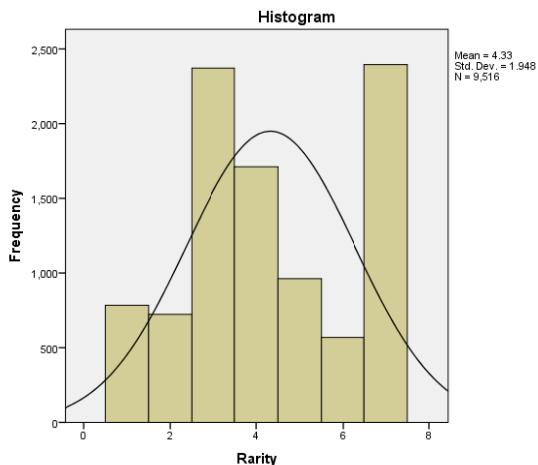
Rarity

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	784	8.2	8.2
2	723	7.6	7.6	15.8
3	2372	24.9	24.9	40.8
4	1711	18.0	18.0	58.7
5	962	10.1	10.1	68.9
6	569	6.0	6.0	74.8
7	2395	25.2	25.2	100.0
Total	9516	100.0	100.0	

Table 5.4 Frequency table of rarity level variable.

Similarly, the rarity level's frequency distribution is in Table 5.4 and Figure 5.5.

In Table 5.4, the highest number of skin items was number three and number seven, replacing to Table 4.1, there are Mil-Spec and SpecialItem respectively. Sincerarity level number seven provided the skin item of knives and gloves which was the most valuable item in the game, this might be inferred that players preferred to sell these items because these items might made them more profit. So, there were a huge number of knives and gloves were sold in the Steam Community Market.



**Figure 5.5** Histogram of rarity level variable.

In Figure 5.5, shows a histogram of rarity level variable which was held by IBM SPSS Statistics 22. Distribution of this variable seemed to be a normal distribution.

The result of linear regression process is displayed in Table 5.6, which is a summary of the regression model.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.647 <sup>a</sup>	.418	.418	3729.10679

a. Predictors: (Constant), Rarity, StatTrak™, types\_of\_weapons

**Table 5.6** Summary of linear regression.

An adjusted R-square value showed in Figure 5.6 was 0.418, which meant the three independent variables could explained 41.8 percent of the skin item price significantly.

In Table 5.7 are the coefficients of the regression. All independent variables are significant statistically. This could be concluded that all independent variables significantly affected to the prices.

Model	Coefficients <sup>a</sup>			t	Sig.
	B	Unstandardized Coefficients	Standardized Coefficients		
1	(Constant)	-3765.803	94.132		-40.006 .000
	StatTrak™	-333.747	83.011	-.032	-4.021 .000
	types_of_weapons	161.244	4.147	.458	38.881 .000
	Rarity	580.133	29.990	.231	19.344 .000

a. Dependent Variable: AveragePrice

**Table 5.7** Coefficients of linear regression.

The coefficients of the types of weapons and rarity were 161.244 and 580.133 respectively, which were positive. It meant that both variables effected the prices positively. On the contrary, the coefficient of StatTrak™ variable was -333.747 which was negative, which could be assumed that StatTrak™ property caused the prices to be lower.

Since the coefficient of the types of weapons was positive, we can conclude that the popularity of weapons could increase its prices.

This study found that StatTrak™ property had a negative impact to the skin item prices. The findings were inconsistent with the initial hypothesis that the StatTrak™ property raises the skin item prices.

## VI. CONCLUSION

All independent variables have affected the skin item price significantly and could explain the price at nearly half. Item's types of weapons and its rarity made the price to be higher, but the StatTrak™ degraded it. However, the price of skin items was not in normal distribution which was not suitable in using linear regression method. This finding diminished the reliability of the analysis process.

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# FACULTY RESEARCHERS AND NON-RESEARCHERS IN THE CONTEXT OF TEACHING PERFORMANCE AND PERSONAL PROFILE

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**Abstract** - Every Higher Education Institution needs to develop faculty researchers from its faculty line up who can share their time and expertise to produce research outputs while performing their responsibilities as classroom teachers and sometimes as school managers. This study aims to compare the result of faculty performance evaluation from students and the faculty profile when they are categorized based on their research involvement. Descriptive type of research method with inferential statistics using Chi-square test and Guttman's Coefficient of predictability as statistical tools was utilized to describe the result of the study. Results showed that there are more female master's degree holders with hourly rate from Php 251 to 350 who have active research involvement than males and bachelor's degree and doctorate degree holders. Faculty researchers have significantly higher performance evaluation rating from the students compared to non-researchers. Those with higher Instructional and Diagnostic expertise among faculty members showed higher possibility of becoming faculty researcher. Faculty members may also be required to write books or instructional manuals as a form of research output. If they will be written their own material to be utilized in their own respective classes, mastery or the subject expertise may be fully achieved. They were encouraged to conduct more funded researches from the government and private agencies during the transition period of the Philippine Education in the K-12 implementation.

**Keywords** - Faculty Member, Researcher, Non-Researcher, Teaching Performance.

## I. INTRODUCTION

Research cannot be taken away from the important functions of teachers especially in higher education institutions. Being the facilitators of learning process, they are equipped with various teaching strategies and research skills on how to address educational problems and issues of the academic community. Elton [1] emphasized that it has become increasingly clear over the past decade that the question of a positive link between research and teaching has no simple or general answer. At the same time, there may well be a positive link under particular conditions. Borg and Liu's [2] study problematizes the notion of teacher as researcher by highlighting many interactive personal, interpersonal, and institutional factors which shape the extent to which teachers can be research-engaged.

Teaching effectiveness and research productivity are complementary. Much of the rationale for the existence of research universities is that these two activities are so mutually reinforcing that they must co-exist in the same institutions [3]. Studies have assumed the nature of this relation and characterized it as one that exists between externally defined indicators such as teaching effectiveness and research productivity [4].

Aside from delivering instruction, teachers are also responsible in conducting research for personal and professional growth as well as part of the continuous improvement of the university where they belong. This is also an important part of the faculty performance evaluation aside from teaching performance. Teaching performance could not only be measured through classroom instruction. In fact,

Lyceum of the Philippines University – Batangas (LPU-B) has continually enhancing its faculty evaluation instrument through the initiative of Human Resource Management and Development Office and Research and Statistics Center wherein research involvement is part of the consideration in assessing the performance of faculty members. Candidates who may be effective classroom teachers may not be as skilled in writing about their instructional practice [5]. Teachers' engagement in doing research is less frequent, with three main reasons given: lack of time, interest and motivation. The motivations for doing research, however, tend to be more extrinsic than intrinsic; the majority reported doing research for promotion or graduation, while few do it to improve teaching or out of personal interest [6].

Determining if the majority of researchers are dominated by young ones or old ones, single or married, with doctorate, master's or just bachelor's degree holders. Sometimes, age doesn't matter in conducting research, but others might believe that the older teachers with higher educational attainment and experience in teaching and research could contribute and conduct better research outputs than young ones. According Reid et al.[7] that large numbers of teacher education research academics nearing retirement; a diminishing capacity among faculties to recruit young academics in the discipline who are both 'research ready' and 'teaching ready'.

Viewing the image of research benefits not as a whole but through its part specifically during its production process where great learning occurs and transpires to the team members of the organization would create clear reflections on how to become critical thinkers as

well as systematic, organize, innovative, creative, dynamic and proactive professionals.

Favilla and Bloch [8] found out that researchers were more likely to have received research training than non-researchers, spent more hours a week on research at the time of the survey and during the previous 5 years. Researchers devoted more time to academic teaching and acquisition of higher degrees. Twice as many researchers as non-researchers had published peer-reviewed articles; the average number was substantially greater. The researchers had obtained funding for their studies far more often than their non-researching counterparts; the average amount was 100 times greater.

Sharing what they have learned through conducting researches to the students and to the academic community would make them better learners, effective teachers and nation builders while reaching the borders of competitive world.

This study is intended to determine the significant relationship and differences of faculty researchers and non-researchers. On this context, it is delimited to the concept that faculty researchers are those faculty members who fervently conducting institutional research studies for their respective departments with at least one completed research either institutional or college for the last three years while the result of students' evaluation on teaching performance will be taken for the last three years. Non-researchers are faculty members without completed institutional research and they will be drawn randomly from the roster of faculty members of different colleges to compare their faculty performance evaluation results against the performance of considered active researchers.

There is also consideration in civil status and gender issues between single and married faculty members. Singles have fewer responsibilities against mothers with more obligations and tasks to attend to at home than fathers with also lots of responsibilities but more on related to their job which is also in teaching profession. These could somehow be their reasons for engaging or rejecting research undertakings of the university.

Furthermore, educational attainment has something to contribute to the amount of hourly rate. Could it be true that faculty members with higher hourly rate have more number of completed institutional researches than with lower salaries or maybe the full-time teachers specifically the plain teachers have more time to conduct researches than those part-timers?

There are few studies differentiated the teaching performance and profile between faculty researchers and non-researchers, thus this study was pursued. The findings of the study would serve as a reference for the faculty members to enhance or improve their teaching strategies through conducting either action or institutional research. Since it is not only the responsibility of the Faculty members to focus on instruction but also to engage their quality time in

providing substantial research outputs to be utilized by the students, the organization and the community at large.

## **II. OBJECTIVES OF THE STUDY**

The study aimed to determine the preliminary identity sketch of the faculty researchers and non-researchers in terms of age, gender, civil status, employment status, educational attainment and hourly rate; and students' evaluation of teaching performance result from 2010 – 2013; to compare the result of the teaching performance and test the differences between researchers and non-researchers; to test the difference in the profile variable between two the groups; to determine the differences between faculty researchers and non-researchers when they were grouped according to profile variables; and to determine which profile variable included in the study and which teaching performance criteria best predicts the possibility of becoming a faculty researcher.

Ho: There is no significant difference between faculty researchers and non-researchers when they were grouped according to profile variables.

## **III. METHODS**

### *A. Research Design*

The study will use a descriptive type of research method using documentary analysis in data gathering wherein the names of the faculty members with completed and on-going Institutional researches were obtained from the Research and Statistics Center of the University while the results of faculty performance evaluation result were obtained from the Human Resource Management and Development Office through the assistance of Management Information System (MIS).

### *B. Participants*

This study focuses on the faculty members with at least one institutional research conducted for the last three years is considered as faculty researcher and those without any recorded research output from the Research and Statistics Center is considered as non-researcher. The faculty non-researchers were chosen from the roster of faculty members from different colleges and obtained to compare their faculty performance evaluation results with those of faculty researchers. Personal profile like age, gender, civil status, employment status, educational attainment and hourly rate were considered. Total population of 107 faculty researchers was used in the study while random sampling technique was used to identify the sample respondents for 109 non-researchers which number is closely the same with the other group.

### *C. Procedure*

Documentary analysis was used as data gathering procedure for the study. The result of students'

evaluation of teaching performance from SY 2010-2011 to SY 2012-2013 was obtained from the Management Information System (MIS) of the university while the records of the research outputs of the faculty members were taken from the Research and Statistics Center.

#### *D. Data Analysis*

Frequency count and percentage were used to analyze the result of the profile variables while arithmetic mean was used to interpret the teaching performance of the faculty members. T-test was used to determine the difference on teaching performance between the non-researchers and researchers. Chi-square test was used to determine the differences between the two groups when they were grouped according to profile variables. Guttman's Coefficient of predictability was used to determine which profile variable included in the study best predicts the possibility of becoming a faculty researcher.

## **IV. RESULTS AND DISCUSSION**

#### *A. Relationship with the profile variable and category of faculty members*

There is a difference of 9.7 percent in favor of male non-researchers while there is 8.8 percent difference in favor of female researchers. Therefore, female faculty members have significantly higher tendency of becoming researchers than males in the university since they have certain characteristics between genders in terms of writing communication skills that females have more adept than males.

There is no significant difference between the category of faculty members and their age bracket. There is a greater number of researchers in the 31-40 age bracket but lesser number in 21-30 and 41 and above age brackets compared to non-researchers. Age cannot be considered a factor in determining the possibility of faculty members in becoming a researcher compared to educational attainment because there are faculty members belong to 31 years old and above who are still pursuing their graduate studies.

Civil status is not also a factor that determines the involvement in research as denoted by the p-value of .153 which is greater than the 0.05 level of significance. There is a difference of 3.8 percent in favor of unmarried researchers but there is a difference of 2.9 percent in favor of married non-researchers wherein the differences do not signify any distinct attribute from single and married faculty members.

There is a significant relationship between non-researcher and researchers in terms of their educational attainment. There are more Bachelor's and Master's Degree holders who are non-researchers compared to Doctorate Degree holders. There is a difference of 10.2 percent among Bachelor's degree holder in favor of non-researchers but there is a little difference of 3.9 percent in favor of non-researchers

who are master's degree holders while 12.1 percent difference in favor of researchers who are doctorate degree holders. The computed differences marked distinct characteristics where those faculty members who finished their graduate studies and those who still pursue advanced studies are more involved in research. Therefore, the higher the educational attainment of the faculty members, there is also a higher tendency of engaging into research activities. There are more part-time faculty members who are not providing research output to the university with a difference of 6.3 percent compared to faculty researchers while there is 3.9 percent difference of full time faculty members in favor of the researchers. It is good to note that four (4) in every ten part time faculty members are already engaged in research activities of the university while there is only 5 out of 10 full time faculty members who were engaged in research wherein the university is expecting to have more than this figure. Therefore, employment status is not a strong factor but can still be considered to determine the research involvement of the teachers because the computed p-value of 0.079 is already closed to 0.05 level of significance. This signifies that both part-time and full-time faculty members can either contribute to the research production of the university or not. The educational attainment of the faculty members is one of the bases of the amount of their Hourly rate but there are other factors included in the faculty classification which are not part anymore of the profile variable. The hourly rate is considered a factor that can possibly determine the research involvement of the faculty members as denoted by the computed p-value of .004 which is less than the 0.05 level of significance. There are more faculty members with hourly rate of P200-250 who are non-researchers but there are more researchers who belong to hourly rate with P251 and above. This signifies that the higher the hourly rate of the faculty, they have higher tendency in becoming faculty researchers also considering their educational qualification which is somehow related to their hourly rate.

#### *B. Difference of Students' Evaluation on Teaching Between Researchers and Non-researchers*

Faculty researchers (4.24) have significantly higher faculty performance rating in all areas of evaluation from students than non-researchers (4.10) as denoted by the computed p-value of 0.001 which is less than the 0.05 level of significance, therefore the null hypothesis is rejected. This signifies that the faculty researchers really perform better in delivering instruction and other academic related expertise to effectively transfer and share the knowledge and skills from one person to another.

The faculty researchers (4.25) obtain significantly higher teaching performance rating than non-researchers (4.10) on subject expertise specifically on stating clearly the objectives of the lesson, presenting ideas or concepts clearly and

relating subjects to other fields and life situation. Faculty researchers may have this characteristic of making clear the purpose of certain teaching and learning activity before starting doing it like what in research process of understanding the objectives to justify the most appropriate methodology and data analysis. Findings of related researches to the topic being discussed may also be shared by the teachers to relate the subject to the real life scenario. Faculty researchers may somehow adapt the same in delivering classroom instructions.

Classroom management including instruction may also be associated in any research activity because it is one of the attributes of researchers as being keen observer especially when it comes to students' behavior. Lattimer [9] found out that doing action research had helped the participants to gain greater ownership over their instructional practice in the classroom and they became more confident making instructional decisions and more independent in their lesson planning, implementation, and assessment process.

Meanwhile, understanding the individual differences of each member of the class can also be addressed through undertaking action research. Attendance and class performance can be considered as the results of the measures and assessment done inside or outside the classroom which can be utilized as important primary data for research. Uncovering the attitude of the students towards any school related factors may better explain their actions.

They obtained high performance in communication skills (4.19) with 4.27 for researchers and 4.11 for non-researchers followed by a total computed mean of 4.17 for subject expertise and instructional expertise while relational expertise obtained the least total score of 4.15. Communication skills of teachers either in oral or written should be demonstrated appropriately during the delivery of instruction. Expression of thoughts, ideas and suggestions related to the issues being discussed should always reach a certain level of expertise and professionalism.

Researchers have higher ability to identify the needs or problems of the students because it is one of the basic processes in conducting a research study. Determining what supposed to achieve is being identified first before giving anything to the receiver. Effective instruction would be supported by the result of diagnostic.

Everything happens in the classroom boils down to addressing the needs of the students. Therefore, being approachable and answerable to their needs and providing them their expectations would really demonstrate the relational expertise of the teachers. Being keen observant and sensitive to their needs would give numerous data and how to process them one by one would lead the faculty researcher to formulate research questions on how to address these effectively and efficiently. Faculty researchers who understand the problem are the teachers with longer

patience.

Faculty Researchers have significantly higher teaching performance based on the students' evaluation for the last three years compared to the performance of non-researchers.

#### *C. Predictor of Research Involvement from the Profile*

Educational Attainment is considered a factor that affects the faculty members to be involved in the research activities of the university. If gender will also be considered as well as the age of the faculty members would increase the possibility of having engaged in the research undertakings. Those middle aged female master's degree holders have the higher tendency to get involved in research. The ability to write is closer to the characteristics of female than male; therefore, there are more female faculty members who were engaged into research writing than their male counterpart. Knowledge and experience in writing research is being developed during the completion of baccalaureate degrees but it is sometimes being enhanced in continuing advanced studies in the Graduate School and most of the teachers have already completed their master's degree during the middle age.

#### *D. Predictor of Research Involvement from the Faculty Performance Evaluation*

Instructional Expertise is considered as the best predictor of having possibility of becoming a researcher with combined diagnostic expertise. Knowing through assessing the existing or current knowledge of the students before providing any additional information would give the preliminary profile of a larger image of what still needs to be improved from the students. Giving them pretest and post test and analyzing the result after giving some sort of intervention measures based on the pretest to enhance the specific skills or expertise of the students is considered an action research which only needs to put into writing. Therefore, identifying the strengths and weaknesses of the students through research would provide better understanding on their individual and group differences.

## **V. CONCLUSION AND RECOMMENDATION**

Faculty Researchers have significantly higher teaching performance based on the students' evaluation for the last three years compared to the performance of non-researchers. Female faculty members have significantly higher tendency of becoming researchers than males. Age, civil status and employment status were not factors that influence the faculty members to have an active research involvement. Faculty members with higher educational attainment at the same time with higher hourly rate have significantly higher possibility to be involved in research activities. Since research is an important part of the faculty performance evaluation, teachers who really maintain their position within the upper 25% in the Annual Top

Faculty Performer Award given by the university would pursue to accomplish researches before the evaluation period starts so that they would be given higher scores in the area of research while those teachers who wanted to be included in the reclassification to increase their hourly rate, they also tend to produce researches for them to be included in the upper 50% of the faculty performance evaluation. Some of them conduct researches for monetary reward after the completion of the research as honorarium and the chance to go abroad for research presentation. However, those teachers who may not have any intention to be an awardee, to go abroad and be reclassified, they tend not to submit any research proposal given all the benefits provided for them by the university. Other factors may still hinder their participation like teaching work load, inadequate research writing skills, attitude or interest towards research. The orientation of research interests, however, is only the first step to becoming a researcher [6].

Teachers manage personal, workplace, and socio-cultural influences with their agency. With or without external support, teachers need to rely more on themselves to cultivate their research interest, seek professional advice and establish their own position in the academy by publishing their work [6].

The results of this study may serve as an eye-opener for faculty members who are not interested to adapt the research culture of the University. They may somehow realize the benefits and advantages of being Faculty Researcher and get involved in the research endeavors of the academic community. Male faculty members may be provided greater attention in making them interested to write research papers either for classroom use or institutional development. Bachelor's degree holders or the younger faculty members may do collaborative research to let them learn from faculty members with Master's degrees or those from the middle age group.

It is recommended that faculty members may provide necessary diagnostic test if applicable before to start giving lecture or demonstration just to determine the extent of knowledge they still need to obtain certain student outcomes. This is the initial step on gaining curiosity; learning how to identify the problems and finding solutions to make every student's life meaningful inside the classroom.

Faculty members may also be required to write books or instructional manuals as a form of research output. If they will be written their own material to be utilized in their own respective classes, mastery of the subject expertise may be fully achieved. Sending them to seminars and training workshop that would develop their skills in book or module writing may encourage them to contribute in the content of the manual to be developed in their respective discipline.

In the advent of K-12, most of the teachers from Higher Education Institutions may not be given enough teaching load compared to the previous years

due to some general education subjects which will now be transferred to senior high school. This is a national dilemma of most General Education and even Professional Education Faculty members. They do not know definitely where to go but to teach in senior high school but they may not be given the same teaching rate. With that given scenario, faculty members may now have enough time due to lesser teaching load to conduct researches funded by the government or from any private agencies that provide research grants.

It is clear that strengthening the preparation of educational researchers in all fields is vital if meaningful empirical contributions to the collective knowledge of teaching and teacher education are to be made through research [10].

The findings also provide insights whether they wanted to enhance their performance and share some experiences of the research process to their students. The culture of research must start within the circle of Faculty Members before it proliferates down to the students. Research is one of the keys in achieving and sustaining excellence and quality in education. Therefore, there is no way but to adapt and make research as a way of life and a habit to contribute in the advancement of knowledge towards the achievement of the true essence of quality through continuous improvement.

The new evaluation instrument was proposed with the end view of increasing the awareness of the teachers that they will be evaluated not only based on their one-time big-time participation in research but even their little contribution and involvement related to research activity will be accounted for their evaluation. This is to concretize the areas of evaluation and defining other research related activities where the teachers might be involved that would help them improve their research performance.

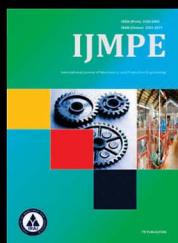
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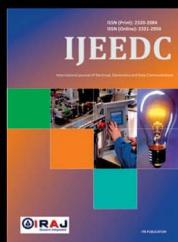
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