FINAL REVIEW

NEW PRODUCT DEVELOPMENT

DOMAIN: Artificial Intelligence

PRODUCT: Camera advanced with computer vision

TEAM: Jerrin Bright – 18BME1004

Rohith R – 18BME1020

Nishanth R – 18BME1024

BRIEF: We have actually planned to integrate surveillance cameras with AI and drones when required. This will in turn reduce the human error rates and enhances the message transfer faster. We have in particular described about 4 different cases for which our product can be customized depending on the requirement and the environment. Few of the cases where this can be very efficient are:

1.) High ways

Basically, when an accident happens in highways, what normally happens is first someone has to come forward and call the ambulance and inform the police, but this time delay might just be the time which could have saved the life of the injured. So, by bringing in AI into picture, once an accident is detected in the camera, the nearest police station and hospital will be informed immediately using GSM.

2.) Swimming arena

Placing waterproof cameras in water. We can trace the movement of a person in water and using AI's pose estimation we can identify if the person in water is swimming/drowning

3.) Road-side Safety

Again, done using pose-estimation and human facial expressions reader, can be used in the following cases when someone snatches something and runs, jumping off a wall. This could raise false alarms, as there will always be billions of things happening every day in roads. Thus, this method can be used in particular to warn the nearest police station/ watchman that an anomalous activity is happening in the particular area which then by live monitoring the location detected by AI, the authorities can thereby confirm. This reduces 24*7 monitoring.

4.) Drones for tracking

Tracking with the help of autonomous drone, which takes feed from surveillance camera and knows exact location of the tracking person/ vehicle which has an additional advantage of navigating in places where the camera surveillance is impossible. So, linking the drone with the surveillance camera, it will know the initial location rather than a human interfering. This saves time and thus increasing efficiency of finding the person faster

TARGET: We will ensure to finish the following before the end of the coursework:

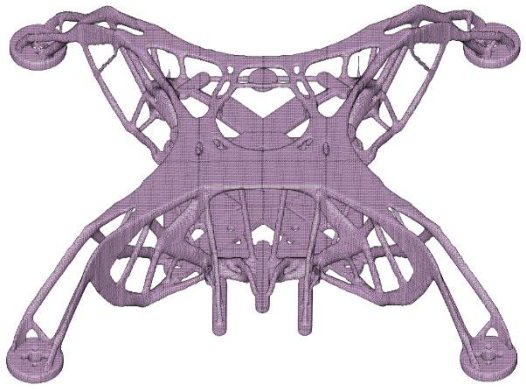
1.) Design of the drone including testing Vibration test, Stress, Strain analysis, Generative designing.
2.) Complete design of the Camera including the components required for implementing AI in it.
3.) Coding for the 4 different cases mentioned above.
4.) Training and deploying using frameworks including TensorFlow, OpenCV, Keras.
5.) Implementing a strategy to deploy our merchandise into the market.

CONCEPTUALS AND IN-DEPT ANALYSIS

The project has 3 major sub-domains involved to reach the apex of the product's result. They are listed as follows:

1) Understanding the properties and latest updates in computer vision/AI and developing its code depending on a number of standards.
2) Understanding the drone working and studying its properties and restricting its behavior.
3) Knowing each part of the camera and establishing a suitable link between the camera and the controller which will enable us to implement computer vision.

DRONE FRAMEWORK



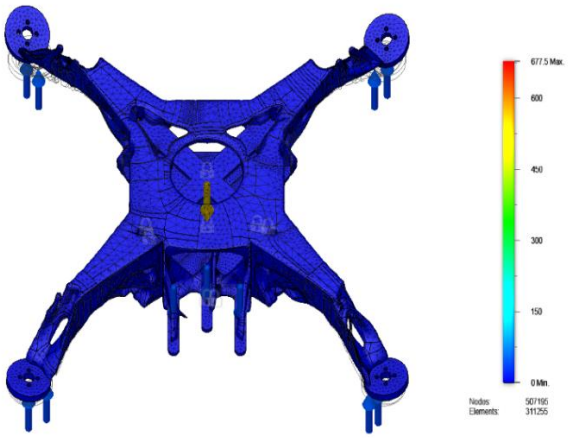
Designed in Fusion360 using various tools keeping in mind the cost and efficiency of the drone. Implemented Generative design to the drone. Generative design is a design exploration process. Designers or engineers input design goals into the generative design software, along with parameters such as performance or spatial requirements, materials, manufacturing methods, and cost constraints. The software explores all the possible permutations of a solution, quickly generating design alternatives. It tests and learns from each iteration what works and what doesn't.

For more info on the drone frame, refer the google drive,

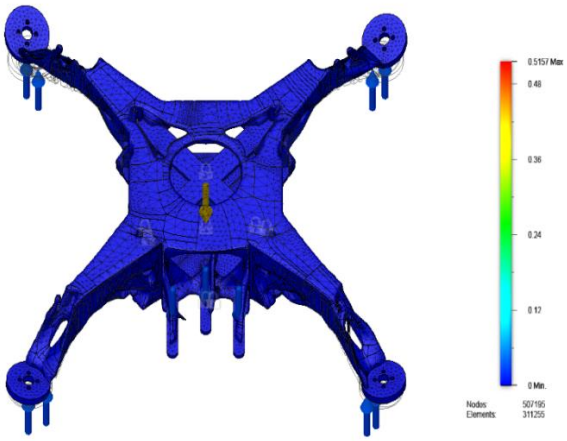
https://drive.google.com/file/d/1THhytq9-oQUkYg6_JfrPD37C8jiJ4Np_/view?usp=sharing

The google drive link consists of the paper to be published soon on IOP publications, consisting of the strategy used to efficiently design a drone frame which will be perfect for our case.

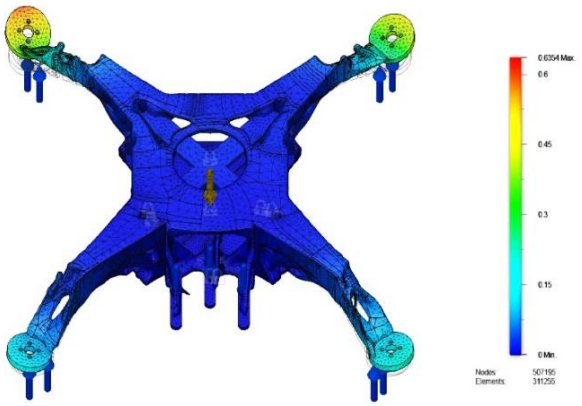
DRONE FRAME ANALYSIS



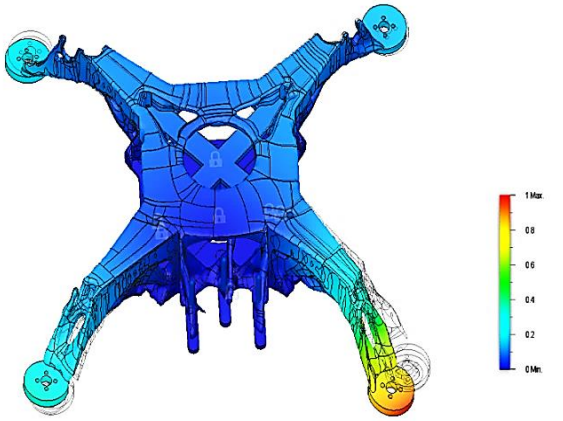
VON-MISES STRESS



STATIC STRAIN



GLOBAL DISPLACEMENT



MODULAR FREQUENCY

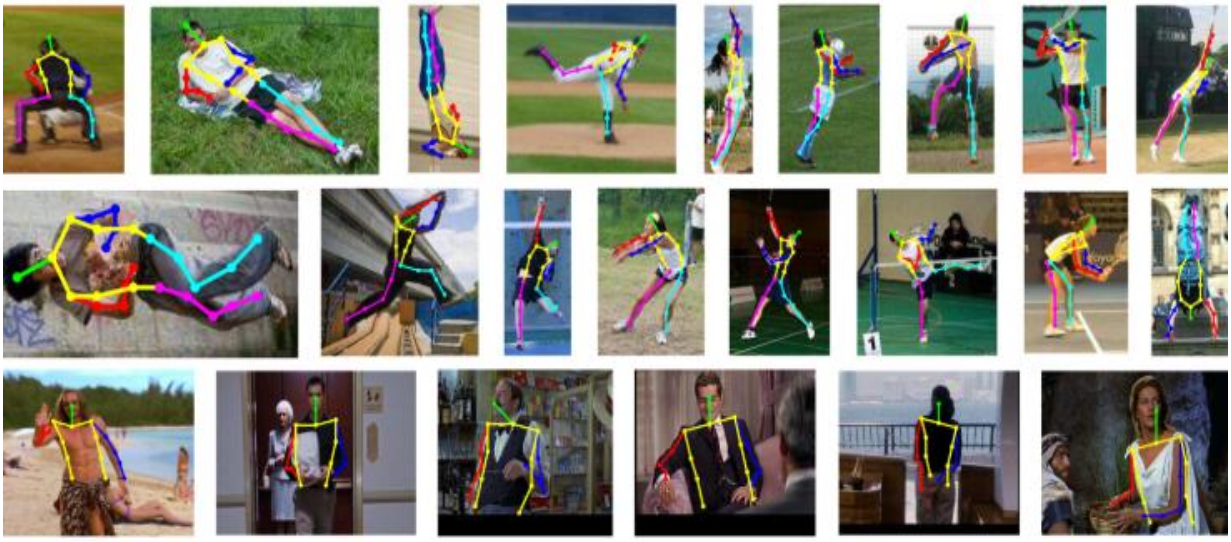
The human computer interaction targeting the generative design process can be divided into three dynamic phases- Define; Generate and Explore. Define is principally the phase we find our problem and convey it to the computer via fixing the goals and constraints. Generate is the place where the computer will look into the design and constraints defined by the user and works through those options in various different angles. Explore is where the computer will show the user, the options the computer devised using the conditions defined in the Explore phase. Explore phase is a decision making and interaction phase between the computer and the user. The generative design process is done as said with the help of AI algorithms including convolutional neural networks, Generative adversarial networks [GANs].

ARTIFICIAL INTELLIGENCE

Pose estimation is a computer vision task that infers the pose of a person or object in an image or video. We can also think of pose estimation as the problem of determining the position and orientation of a camera relative to the given person or object.

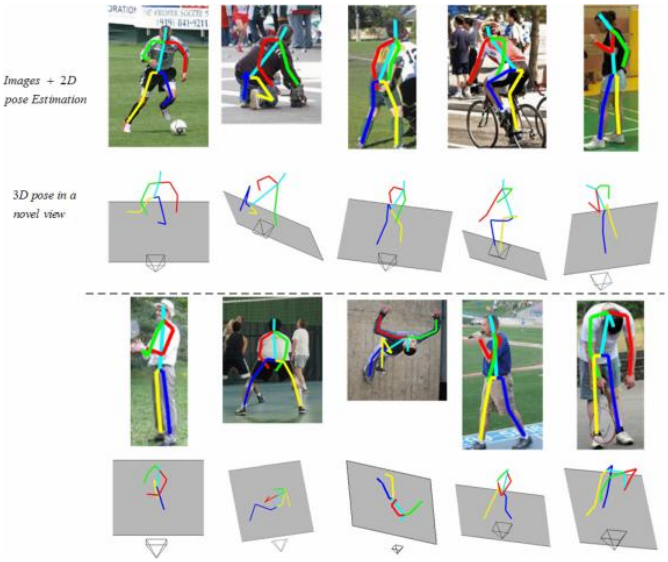
This is typically done by identifying, locating and tracking a number of key points on a given object or person. For objects, this could be corners or other significant features. And for humans, these key points represent major joints like elbow or knee.

The goal of our machine learning models is to track these key points in image or videos just as observed in the image above.



One of the clearest areas in which pose estimation is applicable is in tracking and measuring human movement. But tracking movement in and of itself isn't something you can put into production, generally speaking. With a little creative thinking, however the applications resulting from tracking this movement are dynamic and far-reaching.

Consider, as an example, an AI-powered personal trainer that works simply by pointing a camera at a person completing a workout, and having a human pose estimation model (trained on a number of specific poses related to a workout regimen) indicate whether or not a given exercise has been completed properly.

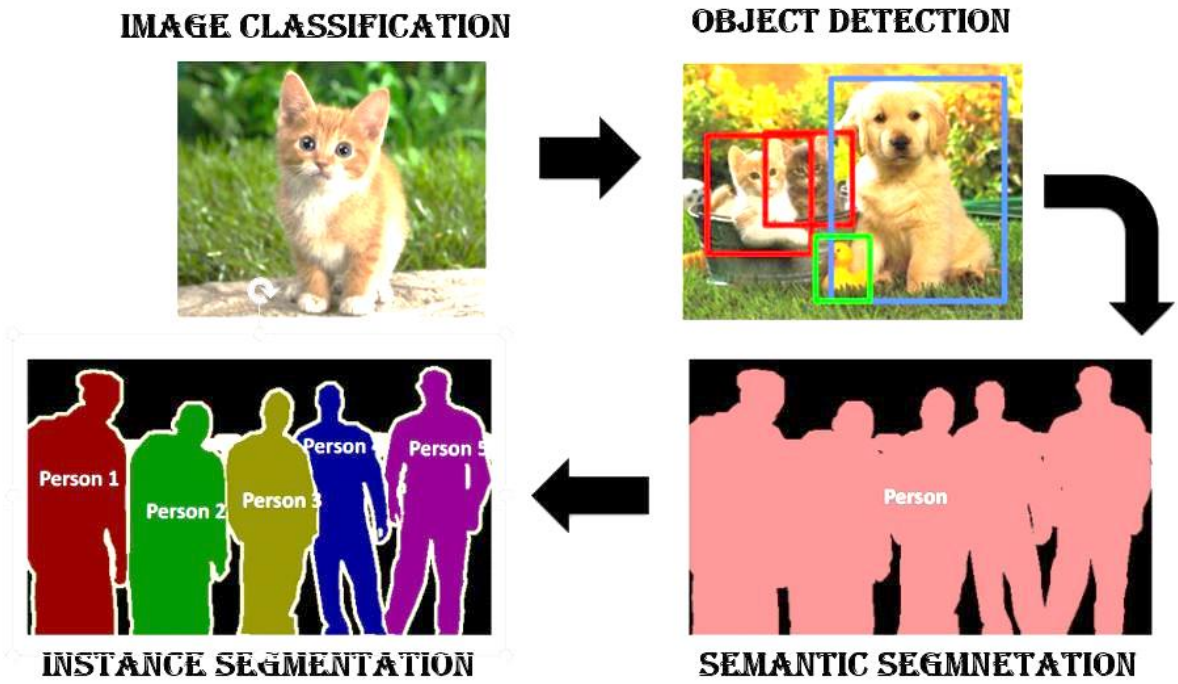


This kind of application could enable safer and more inspirational home workout routines, while also increasing the accessibility and decreasing the costs associated with professional physical trainers.

And given that pose estimation models can now run on mobile devices and without internet access, this kind of application could easily extend the access of this kind of expertise to remote or otherwise hard-to-reach places.

Using AI powered human pose estimation to track human movement could also power a number of other experiences, including but not limited to:

- AI-powered sports coaches
- Workplace activity monitoring
- Crowd counting and tracking (e.g. for retail outlets measuring foot traffic)
- Swimming pool surveillance



In **Image classification**, it takes an image as an input and outputs the classification label of that image with some metric (probability, loss, accuracy, etc.). For Example: An image of a cat can be classified as a class label "cat" or an image of Dog can be classified as a class label "dog" with some probability.

In **object detection**, the bounding boxes are always rectangular. So, it does not help with determining the shape of objects if the object contains the curvature part.

Object detection cannot accurately estimate some measurements such as the area of an object, perimeter of an object from image.

Instance Segmentation: Identifying the boundaries of the object and label their pixel with different colors.

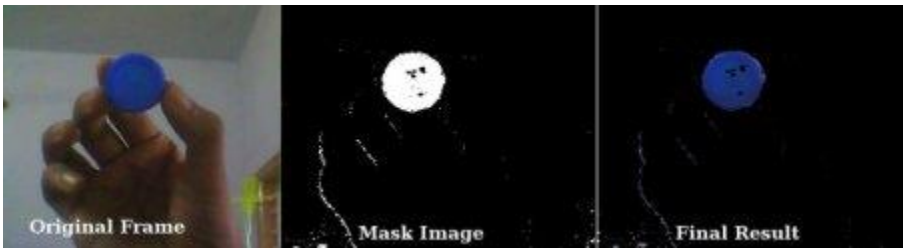
Semantic Segmentation: Labeling each pixel in the image (including background) with different colors based on their category class or class label.

The above-discussed techniques can be utilized in many fields such as:

- **Driver-less Cars:** Object Recognition is used for detecting road signs, other vehicles, etc.
- **Medical Image Processing:** Object Recognition and Image Processing techniques can help detect disease more accurately. For Example, Google AI for breast cancer detection detects more accurately than doctors.
- **Surveillance and Security:** such as Face Recognition, Object Tracking, Activity Recognition, etc.

Semantic Segmentation

The above shows images been intensified using K-Means clustering algorithm, where we will be extracting the pixels, clustering it.



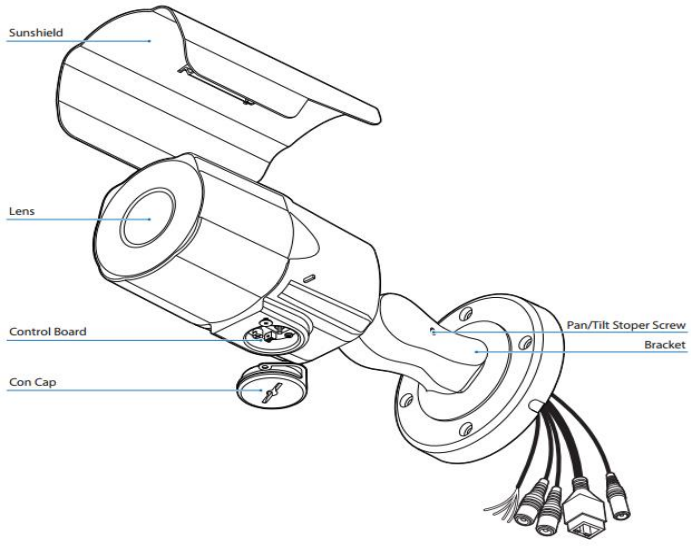
Hue-Saturation-Value [HSV]

This image after undergoing Semantic Segmentation can be passed to HSV also termed Hue-Saturation-Value to remove the background that's, the noise. This image can then be fed to the pose estimation process to get a very efficient and accurate process, thus very efficient results.

BULLET CAMERA

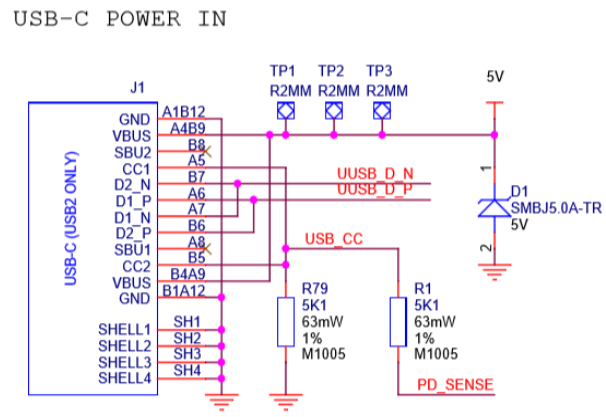
1. Camera lens
2. Infra-Red LED – part of the IR array
3. Zoom and focus adjusters – please note that to ensure full IP66 rating these are caps that cover the adjusters.
4. Cowling – can be moved forwards or backwards to reduce glare into the camera from the sun. Not to be moved too far forward otherwise can interfere with the infra-red at night
5. Bracket – this can be adjusted in almost any direction giving great flexibility in mounting location. A couple of hex keys are required to make full adjustments.

These are included Camera pictured is our Long-Range Bullet Camera with 5-50mm Lens. The fixed lens bullet cameras that we offer are very similar in design, just a little smaller in size.



The image alongside shows what lies inside the bullet camera. It has lens, control board, sunshield, con cap, pan/tilt stoper screw and the bracket. We will have to modify only its controller board to match our cases. We will thus, place the controller that helps us process the AI algorithms alongside the Control board part of the bullet camera. This addition of an extra part to the original bullet camera enlarges its initial orientation. Therefore, we have chosen an alternative that's PCBs, which will be discussed in the upcoming slides.

CONTROLLER CIRCUIT



This is the circuit diagram of the controller [Raspberry Pi 4] we are going to use. This is also available readily in market but then will be larger in size and with extra pins and functionalities which we won't be needing. So, we will make a printed circuit board [PCB] with the necessary pins alone, which will be studied and merged with the control board in the bullet camera. Hence, we will be maintaining the initial bullet camera design with AI processing tech embedded in its interiors.

AI ALGORITHM

TensorFlow is an end-to-end open-source platform for machine learning. It's a comprehensive and flexible ecosystem of tools, libraries and other resources that provide workflows with high-level APIs. The framework offers various levels of concepts for you to choose the one you need to build and deploy machine learning models.

For instance, if you need to do some large machine learning tasks, you can use the Distribution Strategy API in order to perform distributed hardware configurations and if you need a full production machine learning pipeline, you can simply use TensorFlow Extended (TFX). Some of the salient features are described below:

There are several differences between these two frameworks. Keras is a neural network library while TensorFlow is the open-source library for a number of various tasks in machine learning. TensorFlow provides both high-level and low-level APIs while Keras provides only high-level APIs. In terms of flexibility, TensorFlow's eager execution allows for immediate iteration along with intuitive debugging. Keras offers simple and consistent high-level APIs and follows best practices to reduce the

cognitive load for the users. Both frameworks thus provide high-level APIs for building and training models with ease. Keras is built in Python which makes it way more user-friendly than TensorFlow.

The codes used in this project are given as links which can be accessed directly from our GitHub page.

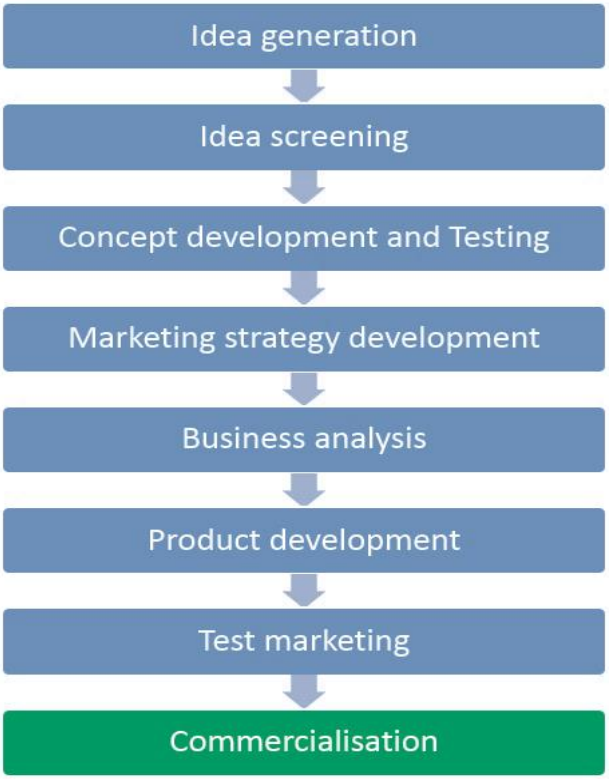
Link for the python script for segmenting:

https://github.com/jerrie-bright/Semantic_Segmentation/blob/master/deeplab.ipynb

In the link mentioned above, you can see the concept to be implemented to segment and track a thing/ person cut it from real life backgrounds, thus isolating and tracking precisely and with ease.

MARKETING STRATEGEMS

PLANNING TO EXECUTION



ANALYSIS

FAILURE MODE AND EFFECT ANALYSIS

Failure Modes and Effects Analysis (FMEA) is a systematic, proactive method for evaluating a process to identify where and how it might fail and to assess the relative impact of different failures, in order to identify the parts of the process that are most in need of change.

FMEA includes review of the following:

- Steps in the process
- Failure modes (What could go wrong?)
- Failure causes (Why would the failure happen?)
- Failure effects (What would be the consequences of each failure?)

Teams use FMEA to evaluate processes for possible failures and to prevent them by correcting the processes proactively rather than reacting to adverse events after failures have occurred. This emphasis on prevention may reduce risk of harm to both patients and staff. FMEA is particularly useful in evaluating a new process prior to implementation and in assessing the impact of a proposed change to an existing process.

PFMEA Process Failure Mode and Effects Analysis													
Product / Part:	CAMERA AND DRONE		Team:										
Project:	SURVEILLANCE WITH VISION		Engineer:	MECHANICAL						Revision Date:			9/11
Item	Functions	Failure Mode	Effects	Severity	Causes	Occurrence	Detection	RPN	Recommended Action Action	Result Severity	Occurrence	Detection	RPN
CAMERA	PURPOSE OF OBSERVING AN AREA	24 hr HUMAN SURVEILLANCE NOT PRACTICALLY POSSIBLE	THEFT MIGHT HAPPEN	9	DANGER	6	6	324	IMPLEMENTING COMPUTER VISION	5	3	4	60
DRONE	SURVEILLANCE	BATTERY LIFE	LESS FLIGHT TIME	7	FAIL TO REACH DESIRED DESTINATION	7	7	343	INCREASING BATTERY CAPACITY	4	4	4	64
													124

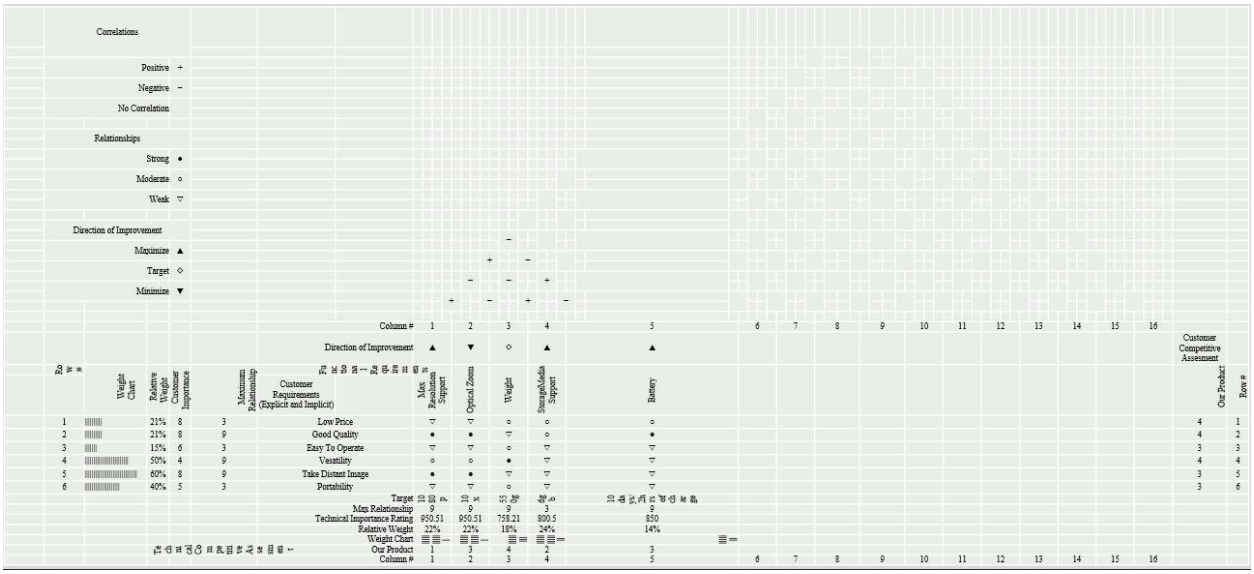
HOUSE OF QUALITY CHART

The House of Quality (HOQ) is defined as a product planning matrix that is built to show how customer requirements relate directly to the ways and methods companies can use to achieve those requirements. House of Quality diagrams use a design that resembles the outline of a house and can be created using technical and competitive benchmarking data. HOQ is considered the primary tool used during quality function deployment to help facilitate group decision making.

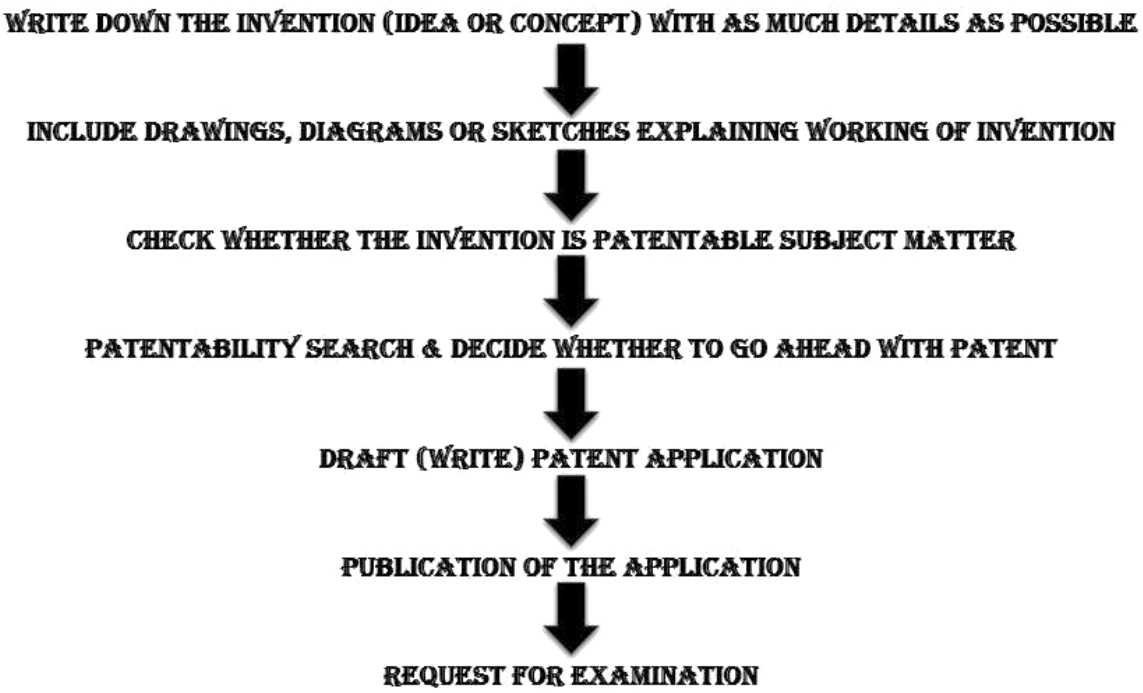
Benefits of building a House of Quality include:

- A customer's needs and requirements are established, then used to build and prioritize service offerings and products.
- Identifying customer needs and requirements, then ensuring they are achieved, leads to customer satisfaction and loyalty.
- Improving a company's understanding of its customers, which leads to better customer utilization, overall sales, and share of wallet.

House of Quality diagrams rely heavily on identifying and maintaining the voice of the customer (VOC). VOC is a way of obtaining and implementing the customer's stated needs and requirements for their services or products.



PATENT



RESULT: A surveillance camera integrated with AI technology, which is customizable depending on the needs and requirements of the consumers like the 4 mentioned cases above is manufactured and integrated to the bullet camera and a detailed study was laid using various new product development methods and stratagems to bring the product to the market.