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CCTV-Based Surveillance System with Face Recognition Feature

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ABSTRACT

Closed-Circuit Television (CCTV) is a device generally used for security, and it is widely installed and utilized in shopping malls, grocery stores, offices, industries, housing, factories, transportation units, and other public places. CCTV can be further optimized to integrate facial recognition so as not only to utilize it to document crimes but to detect criminals at large and alert law enforcers via text message on their presence. This research used descriptive and system development methods and employed RAD methodology in developing a CCTV-Based Surveillance System with a face recognition feature. The study explored the application of the thee face recognition algorithms, namely Local Binary Pattern Histogram, Eigenface, and Fisherface. The LBPH algorithm was determined to have the highest face recognition rate, with a 95.92% accuracy rate. The developed system adopted the LBPH algorithm. The validation process was performed to assess compliance with ISO 25010-2015 Software Quality Requirements for the established framework. Ilagan City 's staff and IT experts from the Philippine National Police (PNP) gave an overall weighted mean of 4.82 with a qualitative definition of Very High Enforcement. This study sought the implementation of the developed system in the PNP to help detect the presence of the criminals in an area and deter crime from happening.

Key words: CCTV, Eigenface, Face Recognition, Fisherface, ISO, LBPH, PNP

1. INTRODUCTION

The state of peace and order in the city or town plays a critical role in social development. The vulnerability of higher level of crime is the result of the rise in the place 's population.With the growing number of people creates the risk of an increase in crimes. Criminals at large in public places become difficult to recognize. Even law enforcers may not be able to detect their presence. Criminals may just be loitering around without being detected, and this threatens public safety. One of the remedies undertaken to detect crimes is the use of Closed-Circuit Television (CCTV). There has been extensive research on the value of CCTV for preventing crimes [7]. To keep track of fraud and illegal activity, facial recognition has been used widely to build security systems as well as the surveillance system [6].CCTV frequently is used as the basis for investigating crimes by armed forces such as militaries and police officers. It provides the trail for enforcers to understand how these series of atrocities were committed. With the usefulness of CCTV, recently, it is widely installed and utilized in shopping malls, grocery stores, offices, industries, housing, factories, transportation units, air stations, and other public places.

In its Memorandum Circular No. 2014-119, the Department of the Interior and Local Government (DILG) directed cities and capital cities to allow the particular business establishment to install CCTV pursuant to Section 16(General Welfare Clause) of RA No. 7160 to promote the preservation of peace , order and public safety [1]. WhileIn its 2015 Memorandum Circular Number 5, the Philippine National Police (PNP) recognized the importance of the CCTV mounted in every institution to assist them with their criminal investigations. The PNP's efficiency in solving a crime was improved with the help of CCTV Cameras [2]. The video recording done by the CCTV provides essential evidence in crime analysis.

The face is a 3D space sum of large no polygon that can be represented by pixel, and facial features are related to face geometry [4]. Owing to the wide spectrum of applications such as entertainment, smart card, information security, law enforcement, and surveillance, computer vision face recognition has gained a lot of popularity. In pattern recognition , computer vision, and image processing it is a important subject [5]. Facial scan systems through CCTVs have software solutions that processes image existing in CCTV cameras and processing systems with facial recognition technology. Human face detection is in the domain of computer vision applications focused on the recognition and location of the image of a human face in the picture regardless of the size, position and condition [3]. Several studies, as shown in Table 1, have contributed to the increase of functionalities of CCTV. These studies have encouraged the researchers to explore further the development of application software that is focused on using CCTV to identify if there is a criminal when the face is captured by the device.

Table 1: Studies Conducted Related to Increasing the functionalities of the CCTV

Author	Title	Nature of the System Developed	Contribution, Similarities or Differences with this study
Abdullah Ahmad Basuhail and Ahmed AbdulQadir Al-bakeri, [11]	Notification System Based on Face Detection and Recognition: A Novel Approach	The study developed a notification system using face detection and recognition to alert visitors 'house owners by using the SMTP to send an email containing certain visitors' names and phone numbers.	The system focuses on home security. The concept on notification system was done through email. This study proposed the use of SMS in notification process.
DhanarIntan Surya Saputra and Kamal Miftahul Amin [3]	Face Detection and Tracking Using Live Video Acquisition in Camera Closed Circuit Television and Webcam	The use of face detection CCTV is supposed to look at the actual condition and identify any human appearance on the screen. This research has examined the monitoring and face recognition technology. In live footage, the device was able to detect human presence.	This previous study contributed much as the point of reference for this present study that live video can capture and detect human a face.
Kennedy Okokpujie et al. [12]	A face recognition attendance system with GSM notification	This research used face detection as a test of attendance of the biometric class. This also has the added novelty of relaying crucial class attendance information to mobile devices via any cellular network available.	This study increased the functionality of the face recognition in the school setting. The messaging on cellular network in this study was made similarly done in this present study. While in this study maximized the used of the CCTV cameras for face recognition.
Mahdi, F. P., Habib, M., Ahad, M., Rahman, A., Mckeever, S., Moslehuddin, A. S. M., & Vasant, P.. [13]	Face Recognition-based Real-time System for Surveillance	The system built in the study can be applied in various restricted areas, such as in a person's office or house or at the entrance to a sensitive installation ..	This study focused on enhancing home security. The datasets included the faces of the members of the family or authorized persons and if the system would detect face that is not found in the datasets, it will provide the notification. The developed system in the study is reversed because it will send a notification if the detected face in the CCTV is found in the datasets.
Abdullah, N. A., Saidi, M. J., Rahman, N. H. A., Wen, C. C., & Hamid, I.	Face recognition for criminal identification: An implementati	This program was able to automatically detect face and	Though this system was utilized in law enforcement similar to this developed

R. A. [15]	on of principal component analysis for face recognition	identify face. This helps the law enforcement identify or remember perpetrators of the crime if there is no thumbprint on the scene. The results show that the template data can match approximately 80 per cent of the input picture.	study but this previous study was focused on the crime scene documentation and analysis. It has no SMS feature. The developed system in this study has the goal of detecting criminals at large present in public places where there is CCTV camera.
Peace Muyambo [6]	An Investigation on the Use of LBPH Algorithm for Face Recognition to Find Missing People in Zimbabwe	The researcher used the LBPH (Local Binary Patterns Histograms) algorithm in this paper to create a prototype of a device that uses facial recognition to identify the missing persons.	This previous study used LBPH algorithm similar to this study but its functionality is not for law enforcement purposes.
Ahn, E. M., & Kim, D. H. [14]	Implementation of Integrated Platform of Face Recognition CCTV and Home IOT	This paper proposed an integrated platform that constitutes the CCTV and home Internet of Things(IoT) as one hardware component using Raspberry Pi and shows each result on one screen through Smartphone application. The implemented system measures temperature, humidity, gas, and dust, and implements face recognition technology on a screen shot through a Pi camera, allowing it to be seen at a glance with a Smartphone	The previous study focused on developing a product for the home environment. The study did not focus only on face recognition but on other aspects of the home environment.

Ilagan City has a land area of 116, 626 hectares with 91 barangays, and 151,115 population in the 2018 census. In the same year, Ilagan City had 103 policemen. They were assigned to various sections like investigation, operation, patrol, warrant, and supply sections; intelligence units; and women and children protection desk. With this number, identifying the criminal at large, especially in public places, could be very challenging for the police personnel. Other than the limitation of their number, not all staff would know who from the roaming persons have an arrest warrant or are detainees escaped from penal establishments.

This study produced a CCTV-Based Surveillance System with a face recognition feature for the PNP of Ilagan City. It aimed to detect the presence of criminals at large when the CCTV captures a human face in real-time, so message alert is sent to the PNP unit. One aim of modern video-surveillance technology is to catch real-time criminal activity. [9]. In short, the developed system will trigger an alert message when it identifies a person from the watch list of Police Station in Ilagan City. It features technology for finding persons with an arrest warrant or involved in crime and remain criminal at large. This current research sought to achieve the desired goal of detecting the face of criminals to help capture them and thereby deterring crimes from happening.

2. METHODOLOGY

The study used descriptive and system development methods. The descriptive approach was used to explain the Ilagan City PNP 's situation, role, and processes in the identification and apprehension of offenders at large. This paper [17], [18] and [19] are used by the researchers as guide for the crafting of procedure on how to develop the system. The software methodology for Rapid Application Development (RAD) has been chosen due to its suitability to the nature of the project, technological architecture, data and specifications in this report. Figure 1 depicts the [16,17] RAD model adopted in this analysis.

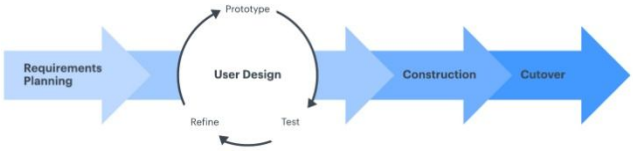

Figure 1: Rapid Application Development

In this study, three face recognition algorithms namely LBPH, Eigenface, and Fisherface were explored and tried out to determine their accuracy in face detection. LBPH is a simple but very powerful texture operator that labels the pixels of a picture by thresholding each pixel's neighborhood and views the results as a binary number and views the results as a histogram. Eigenface uses Analysis of Principal Components (PCA).It's an approach focused on appearance that captures the difference in a series of facial pictures. Then, it uses this data to holistically compare various face pictures. Although Fisherface is an improvement of the Eigenface process. It employs Linear Discriminant Analysis to reduce dimensionality.

The ratio of the number of right faces found with the total number of faces tested was determined to determine the accuracy of the algorithms. The highest computed accuracy rate of the three algorithms was the algorithm adopted in the developed system. The program developed was provided for review by the PNP staff and IT experts. 49 participants from Isabela State University-San Mariano Campus participated in the research process to assess the ability of the established system to recognize faces.The participants were asked to sign a consent form. Their pictures were taken and were part of the datasets. The captured faces of the participants were stored and trained with the developed system for recognition. The study underwent ethics review at St. Paul University Philippines.

```
if(recognizer_mode.get()==1):
    print("Use  LBPH FaceRecognizer")
    face_recognizer = cv2.face.LBPHFaceRecognizer_create()
elif(recognizer_mode.get()==2):
    print("Use  Eigenface Recognizer")
    face_recognizer = cv2.face.EigenFaceRecognizer_create()
elif(recognizer_mode.get()==3):
    print("Use  Fisherface Recognizer")
    face_recognizer = cv2.face.FisherFaceRecognizer_create()
else:
    print("No Selected!");
    messagebox.showinfo("WARNING", "Please select algorigthm!")
    return False
```

Figure 2: Algorithms used

Figure 2 shows the three algorithms to be tried out in the developed system to determine which have a high accuracy to be used in the developed system.

```
face_recognizer.train(faces, np.array(labels))

if(recognizer_mode.get()==1):
    print("Save  LBPH FaceRecognizer")
    face_recognizer.save('lbph_trainer.yml')
elif(recognizer_mode.get()==2):
    print("Save  Eigenface Recognizer")
    face_recognizer.save('eigen_trainer.yml')
elif(recognizer_mode.get()==3):
    print("Save  Fisherface Recognizer")
    face_recognizer.save('fisher_trainer.yml')
else:
    print("No Selected!");
    messagebox.showinfo("WARNING", "Please select algorigthm!")
    return False
```

Figure 3: Trained datasets

Figure 3 shows the trained datasets sets of the three algorithms for face recognition.

3. RESULTS AND DISCUSSIONS

3.1. Face recognition algorithms that can be used in the development system

In this study the three algorithms considered in this analysis were Eigenface, Fisherface, and Local Binary Pattern Histogram (LBPH). 49 employees of the ISU-San Mariano Campus were used as test data to test the accuracy of the algorithms.Table 2 presents the results of the evaluation of the correct face recognition.

Table 2: Accuracy Rates of the Algorithms

Algorithm	Speed	Total Face	Correct Face	Accuracy %
LBPH	30ms	49	47	95.92%
Fisherface	5ms	49	40	81.63%
Eigenface	20ms	49	25	51.02%

Table 2 shows that the LBPH algorithm got the highest face recognition accuracy rate with 95.92%. While Fisherface has 81.63% and Eigenface51.02%accuracy rate. With the above algorithms, the LBPH has the highest accuracy rate. The LBPH algorithm got the highest accuracy rate, the researcher adopted this algorithm in the development of the proposed system.Fig. 4 shows the designs work structure of the developed system

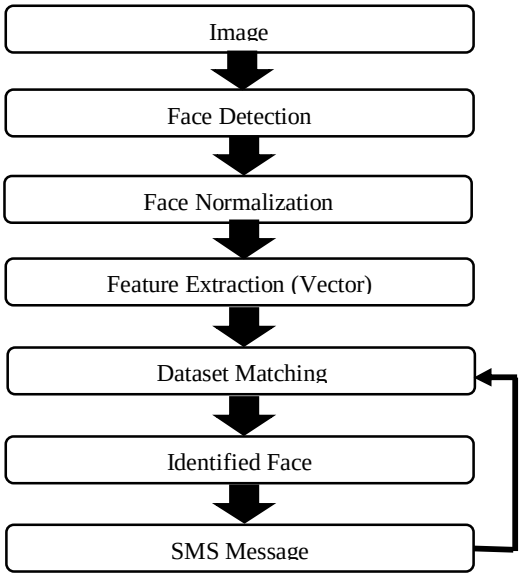

Figure 4: The System Feature Structure

Figure 4 describes the internal entities of the developed system. The entry point of the developed system was image acquisitions. These images were stored on the datasets for training. Face detection automated the face recognition processes. Its reliability had a significant performance in the usability of the developed system. Face normalization was applied in every image before the feature extraction was included in the image processing to improve the quality of the input image. The feature extraction found effective information that was useful for identifying faces of different persons. LBPH algorithm analyzed its images independently by creating a histogram for each region, and all the histograms of an image were merged into a single histogram called feature vector of an image. Feature matching determined the identity on an input image based on the comparison of all the images on the trained datasets. Entry number, case number, and name were stored on the database. These were shown on the image output if the developed system recognized the image. The SMS notification sent a text message if an input image matched the datasets.

Table 3 and 4 presents thesoftware and hardware specifications used in the developed system. Python, OpenCV library, Haar Cascade Classifier, and SQLite were used to develop the CCTV-Based Surveillance System with Face Recognition Feature.

Table 3: Software Specification

Components	**Version**
Windows 10	64bit
Python	2.7
OpenCV	4.0
Sub lime	3
SQL	Lite

Table 4: Hardware Specification

Components	**Used**
Laptop	Acer P-249-G2
Memory	4GB
Processor	Core i3
Hard disk	1 TB
Sricam	SPO19 2MP
Dome Ip Camera	C-P08-10 model 2MP

Fig. 5, 6, and 7 show the screenshots of the developed system.

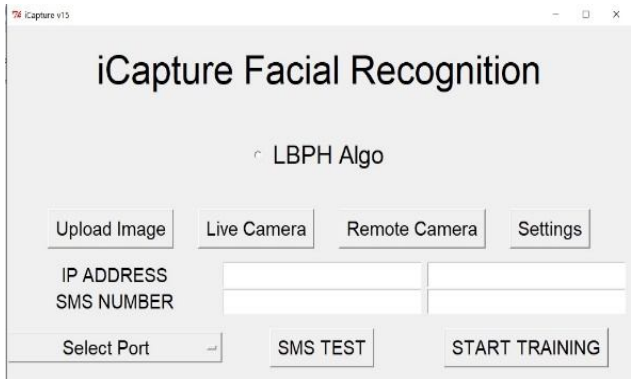

Figure 5: Main window

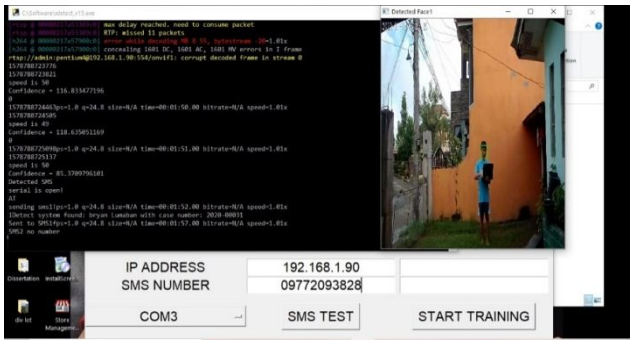

Figure6: Video Captured for Face Recognition

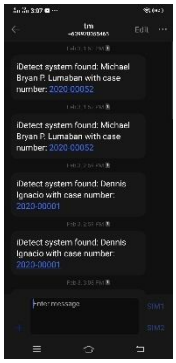

Figure 7: Text Message

3.2. The extent of compliance to ISO 25010-2015 Software Quality Standards

The overall result of evaluating the established framework using ISO 25010:2015 Software Quality Standards is Very High Enforcement Extension as evaluated by PNP users and IT experts. The system developed was evaluated based on functionality, suitability, performance , efficiency,

compatibility, usability , reliability, security, maintainability and portability.Table 5 illustrates the weighted means of the assessment.

Table 5: Summary of the system compliance on ISO 25010:2015 Software Quality Standard

Category	PNP – Users		IT Experts		Overall	
	Weighted Mean	Description	Weighted Mean	Description	Weighted Mean	Description
Functionality	5.00	VHE	4.80	VHE	4.90	VHE
Performance	5.00	VHE	4.67	VHE	4.83	VHE
Compatibility	5.00	VHE	4.65	VHE	4.83	VHE
Usability	5.00	VHE	4.75	VHE	4.87	VHE
Reliability	5.00	VHE	4.35	VHE	4.68	VHE
Security	5.00	VHE	4.62	VHE	4.81	VHE
Maintainability	5.00	VHE	4.68	VHE	4.84	VHE
Portability	5.00	VHE	4.53	VHE	4.77	VHE
Overall Mean	**5.00**	**VHE**	**4.63**	**VHE**	**4.82**	**VHE**

VHE – Very High Extent

All the police-participants who assessed the developed system gave the highest score of 5 in all the areas of the ISO standards. This implies that as users of the developed system, they were satisfied with its features and value of this product in their work. The IT expert-participants had the overall weighted mean assessment of 4.82 which means that they evaluated the developed system as a very high extent compliance with the ISO standards.

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4. CONCLUSION AND FUTURE WORK

LBPH algorithm is the most suited algorithm for face recognition from CCTV images. The developed system in this study can be effectively used in Ilagan City for the PNP personnel to be alerted when there are criminals at large as captured by the CCTV. The developed framework met the ISO 25010:2015 standard for software quality. The evolved system could be improved, integrating other features of face recognition such as skin color variation, facial expression, occlusion, and human face recognition, even with change over time.

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REFERENCES

1. Department of the Interior and Local Government (2014), **Memorandum Circular No. 2014-119**, downloaded from https://dilg.gov.ph/PDF_File/issuances/memo_circulars/dilg-memocircular-2014915_5284ea9a47.pdf
2. Philippine National Police (2015), **Memorandum Circular Number 5**, downloaded from http://www.pnp.gov.ph/images/Downloads/pnpmc2015.pdf
3. D. I. S. Saputra and K. M. Amin**, "Face detection and tracking using live video acquisition in camera closed circuit television and webcam,"** 2016 1st International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE), Yogyakarta, 2016, pp. 154-157. doi: 10.1109/ICITISEE.2016.7803065
4. Zaeri, Naser. (2011). **3D Face Recognition**. 10.5772/18696.
5. NawafHazimBarnouti, Sinan Sameer Mahmood Al-dabbagh and WaelEsamMatti. **Face Recognition: A Literature Review**. International Journal of Applied Information Systems 11(4):21-31, September 2016.
6. Muyambo, P. (2018) **An Investigation on the Use of LBPH Algorithm for Face Recognition to Find Missing People in Zimbabwe**, International Journal of Engineering Research and Technology (IJERT) Volume 07, Issue 07 (July 2018)
7. Ashby, M.P.J. Eur J **Crim Policy Res** (2017) 23: 441. https://doi.org/10.1007/s10610-017-9341-6
8. Gustav Alexandrie (2017) **Surveillance cameras and crime:** a review of randomized and natural experiments, Journal of Scandinavian Studies in Criminology and Crime Prevention, 18:2, 210-222, DOI: 10.1080/14043858.2017.1387410
9. Roberts, M. R. (2007**). Video surveillance: Not just for criminals. Mobile Radio Technology**, 25(12), 58. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=28535038&site=ehost-live
10. Ahmed, A., Guo, J., Ali, F., Deeba, F., & Ahmed, A. (2018, May). **LBPH based improved face recognition at low resolution**. In 2018 International Conference on Artificial Intelligence and Big Data (ICAIBD) (pp. 144-147). IEEE.
11. البـــاكري, احمـــد&Basuhail, Abdullah. (2016). **Notification System Based on Face Detection and Recognition: A Novel Approach.** International Journal of Computer Science and Information Security (IJCSIS). 14. 5.
12. Okokpujie, Kennedy & Noma-Osaghae, Etinosa& John, Samuel & Grace, Kalu-Anyah&Okokpujie, Imhade. (2017). **A face recognition attendance system with GSM notification.** 239-244. 10.1109/NIGERCON.2017.8281895.

13. Mahdi, F. P., Habib, M., Ahad, M., Rahman, A., Mckeever, S., Moslehuddin, A. S. M., & Vasant, P. (2017). **Face recognition-based real-time system for surveillance.** Intelligent Decision Technologies, 11(1), 79-92.
14. Ahn, E. M., & Kim, D. H. (2018). **Implementation of Integrated Platform of Face Recognition CCTV and Home IOT.** Journal of Digital Contents Society, 19(2), 393-399.
15. Abdullah, N. A., Saidi, M. J., Rahman, N. H. A., Wen, C. C., & Hamid, I. R. A. (2017, October). **Face recognition for criminal identification: An implementation of principal component analysis for face recognition.** In AIP Conference Proceedings (Vol. 1891, No. 1, p. 020002). AIP Publishing LLC.
16. Babaei, H. R., Molalapata, O., &Pandor, A. A. (2012). **Face Recognition Application for Automatic Teller Machines (ATM).** In ICIKM (Vol. 45, pp. 211-216).
17. Arispe, Maria. (2020). **Integrating Spatial Data Analysis for Road Traffic Incident Response System**. International Journal of Advanced Trends in Computer Science and Engineering. 9. 218-223. 10.30534/ijatcse/2020/3291.22020.
18. Telen, Mary. (2020). **Blimp Stabilization Controller Optimization using Fuzzy Logic.** International Journal of Advanced Trends in Computer Science and Engineering. 9. 76-83. 10.30534/ijatcse/2020/1391.22020.
19. Mata, Khatalyn. (2020). **Intelligent Agent Using Artificial Neural Network for E-Service of Bureau of Fire Protection.** International Journal of Advanced Trends in Computer Science and Engineering. 9. 58-62. 10.30534/ijatcse/2020/1091.22020.