**CHAPTER II**

**REVIEW OF RELATED LITERATURES AND STUDIES**

The review of related literature is created to provide a summary of existing research or studies related to this project. This chapter contains the related literatures and related studies.

* 1. **Related Literature**

**2.1.1 Literature on CCTV**

CCTV's were first invented and used in Germany. It was a system developed to monitor the countries V-2 rockets. Until people realized its usefulness, it was launched commercially in 1949 for the public. Years have passed from the time it was invented, and CCTV's evolve into state-of-the-art equipment with several applications in many businesses and homes during this period.

According to Koorsen Fire & Security, CCTV is everywhere these days. You'll find them in pretty much every bank, school, hospital, and business of every size, even in many homes. Wherever you find them, they act as an extra eye for whenever people are not around. They are there to prevent crime, monitor the environment, and, most importantly, record video footage that may be important. What does CCTV mean, and How does it work? Closed Circuit Television (CCTV) or simply Video Surveillance Systems are unique cameras that people use to monitor security and other reasons. For the CCTV to work, it must have these four parts; cameras, recording devices, monitors, and video management software. (Koorsen Fire & Security , 2021)

Schools these days are also implementing the use of CCTV to benefit from its usefulness, whether campus security, attendance system, automated registration, and emotion detection.

**2.1.2 Facial Recognition**

According to a study by Parekh Payal and Mahesh M. Goyani, Face Recognition identifies and verifies faces. Face recognition has vast importance in Security, Healthcare, Banking, Criminal Identification, Payment, and Advertising. The study determines various challenges and techniques for face recognition. Challenges such as illumination, pose variation, facial expressions, occlusions, aging, etc., are the critical challenges to face recognition. The methods used for facial recognition to work are pre-processing, Face Detection, Feature Extraction, Optimal Feature Selection, and Classification are the primary steps in any face recognition system. The study also states that facial extraction is the most crucial stage for any facial recognition system to work and the deep learning method helps the user by freeing them from handcrafting the features. (Payal & Goyani, 2020)

Another study by Serign Modou Bah and Fang Ming states that a lot of development has been made in the area of facial recognition and detection for security, identification, and attendance purposes. Still, it turns out that there are still issues that hinder progress from reaching or surpassing human-level accuracy. These issues are varieties in human facial appearance such as; changing lighting condition, clamor in confront pictures, scale, posture, etc. With these challenges to consider, the researchers of this study used another method by using Local Binary Pattern (LBP) algorithm combined with advanced image processing techniques such as Contrast Adjustment, Bilateral Filter, Histogram Equalization, and Image Blending. These solve some of the issues hampering face recognition accuracy to improve the LBP codes, thus improve the accuracy of the overall face recognition system. (Serign & Ming, 2019)

**2.1.3 Neural Network**

In a research done by Naoyuki Kubota (2011) titled “ Applying Artificial Neural Networks for Face Recognition” in the process of identifying or analyzing the facial land points the researcher used hybrid model combining AdaBoost and Artificial Neural Network (ABANN) to improve the efficiency of facial recognition; the system consist of four modules : detection, alignment, feature extraction, and matching ; The research done by Naoyuki Kabuto provides some basic neural network models and efficiently applies these models in modules of face recognition system. For face detection module, a three-layer feedforward artificial neural network with Tanh activation function is proposed that combines AdaBoost to detect human faces so that face detecting rate is rather high. (Kubota, 2011)

The Naoyuki Kubota facial recognition with neural network basically uses three-layer feedforward artificial neural network and AdaBoost for detecting human faces which in comparison with traditional technique shows higher identifying and detecting rate.

While in a research done by Juan Pablo Balarini, Sergio Nesmachnow and Martín Rodríguez of Universidad de la República, Facultad de Ingeniería titled “ Facial Recognition Using Neural Networks over GPGPU” they introduce the use of parallel neural network approach which also use the processing power of Graphic Processing Unit (GPU); in their studies the three researcher thought that the efficiency of Neural network processing image in detecting facial points would be effective and efficient with the help of GPU which they stated that “GPU implementations allow obtaining significant reduction in the execution times of complex problems when compared with traditional sequential implementations on CPU” and with the use of sequential algorithm by Shufelt and Mitchell for recognizing if a given picture is of a certain person. (Balarini, Nesmachnow, & Rodríguez, 2012)

**2.1.4 Deep Learning**

Deep Learning is a subfield of Machine Learning which uses a ‘layered’ architecture to learn representations. Each successive layer in the layered architecture works with more meaningful and sophisticated representations; in a research done by Diego Andina (2017) titled “Deep Learning for Computer Vision” he talks about how deep learning evolve in short span of time according to Diego Andina “Deep learning methods have been shown to outperform previous state-of-the-art machine learning techniques in several fields, with computer vision being one of the most prominent cases” which is correct from unlocking your smartphone to facebook improve tagging system; deep learning really evolve on how computer interpret and analyzing data, in his research he stated that Deep learning allows computational models of multiple processing layers to learn and represent data with multiple levels of abstraction mimicking how the brain perceives and understands multimodal information. (Andina, 2018)

The researcher Diego Andina also indicates that there are 4 most significant deep learning schemes used in computer vision problems, that is, Convolutional Neural Networks, Deep Boltzmann Machines and Deep Belief Networks, and Stacked Denoising Autoencoders which can be used for system like object detection, face recognition, action and activity recognition, and human pose estimation.

In a research done by Md Nazmus Saadat and Muhammad Shuaib (2020) titled “ Advancements in Deep Learning Theory and Applications: Perspective in 2020 and beyond “ the researcher talk how deep learning works; the researcher stated that there are two types of machine learning ; first is the supervised learning, the machine can only give you correct output when the input is already experienced in training phase; it is based on experience; the more is the training dataset or experience of your machine the higher is the chances of getting the actual output, and the second is unsupervised learning, supervision of a model is not needed, rather the model work on its own catches new data and discovers the information inside the data. It usually deals with label-less data; compared to supervised learning, unsupervised learning is more complicated. It is usually used to find features and unknown patterns. (Saadat & Shuaib, 2020)

* 1. **Foreign Studies**

**2.2.1 Motion Detection and Face Recognition for CCTV Surveillance System**

According to this study development of the use of CCTV has transformed from a simple passive surveillance into an integrated intelligent control system. This CCTV video processing provides three outputs, a motion detection information, a face detection information and a face identification information. Accumulative Differences Images (ADI) used for motion detection, and Haar Classifiers Cascade used for facial segmentation. Feature extraction is done with Speeded-Up Robust Features (SURF) and Principal Component Analysis (PCA). The features was trained by Counter-Propagation Network (CPN). Offline tests performed on 45 CCTV video. The test results obtained a motion detection success rate of 92,655%, a face detection success rate of 76%, and a face detection success rate of 60%. The results concluded that the process of faces identification through CCTV video with natural background have not been able to obtain optimal results. The motion detection process is ideal to be applied to real-time conditions. But in combination with face recognition process, there is a significant delay time. (Nurhopipah & Harjoko, 2018)

**2.2.2 Face Recognition-based Real-time System For Surveillance**

According to this research paper the ability to automatically recognize human faces based on dynamic facial images is important in security, surveillance and the health/independent living domains. Specific applications include access control to secure environments, identification of individuals at a particular place and intruder detection. This research proposes a real-time system for surveillance using cameras. The process is broken into two steps: (1) face detection and (2) face recognition to identify particular persons. For the first step, the system tracks and selects the faces of the detected persons. An efficient recognition algorithm is then used to recognize detected faces with a known database. The proposed approach exploits the Viola-Jones method for face detection, the Kanade-Lucas-Tomasi algorithm as a feature tracker and Principal Component Analysis (PCA) for face recognition. This system can be implemented at different restricted areas, such as at the office or house of a suspicious person or at the entrance of a sensitive installation. The system works almost perfectly under reasonable lighting conditions and image depths. (Fahad , Habib, Vasant, Mckeever, & Ahad, 2016)

This research paper is related to our study for it tackled the use of CCTV in implementing facial recognition systems at different restricted facilities, such as workplaces, houses, and schools. The study also aims to use the system for crime monitoring and prevention and detection of suspicious individuals, which is the same objective that our research has.

* 1. **Local Studies**

**2.3.1Student Monitoring System Of Our Lady Of Fatima University Using Face Recognition**

This research paper concludes that the rapid development of face recognition is due to a combination of factors: active development of algorithms, the availability of large databases of facial images, and a method for evaluating the performance of face recognition algorithms. The system covers any departments, agencies or companies which require personal identification and security to their employees. The face recognition system covers multiple face photos, matching of faces, head rotations, detects 66 facial feature points (eyes, eyebrows, mouth and nose) and all data are placed in a database. Additional enrolments will be required upon various changes in registered faces. The said system only limits to personal identification which contains certain fields about the registered user, it cannot detect the skin color and age of a person and the system is not a video- based face recognition system. This system does not expect to solve all the issues in face recognition, such as extreme facial expression, wearing on the face, great age discrepancy and extreme lightning condition and without frontal face information. (Alolor, et al., 2014)

**2.3.2 Deep Learning**

Deep learning technologies include facial recognition, optical character recognition that could automatically read documents, natural language processing and voice recognition; in an article by Noemi Lardizabal-Dado of Manila Times she stated that “Artificial intelligence (AI) will be more than just talk in 2020” I fully agree to this sentence; in the midst of covid-19 we must take advantage of latest technology to solve problems like in security, education and healthcare; AI technology could help the Philippines bounce back from the coronavirus disease 2019, the article by Neomi Lardizabal-Dabo mainly talks about Deep learning technologies include facial recognition, optical character recognition that could automatically read documents, natural language processing and voice recognition.

We’ve seen how e-commerce and food delivery industries are essential services during this pandemic. But what happens when lockdowns mean e-commerce platforms could not physically meet and onboard new suppliers or restaurants? The researcher said that AI could help retail and e-commerce players recover by facilitating contactless payments, digital onboarding of new customers or suppliers, preventing fraud or fake accounts when ordering/paying, logistics and inventory management. The list goes on.

AI can help sort and categorize relevant health data on millions of patients in the Philippines into a single unified view. This can then be used across airlines, immigration, work permits, embassies, hospitals and even travel insurance industries without a lot of manual paperwork required.

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