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Research Paper

Human Face Recognition and Attendance Recording with Surveillance Videos Using Convolutional Neural Networks (CNNs)

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Abstract: **Objectives:** Nowadays, the advancement of technology has made attendance automation an indispensable factor which schools and organizations need to implement in educational and organizational settings. **Methods:** This research paper uses and examines how Convolutional Neural Networks (CNNs) build an accurate automated attendance management system through facial recognition technology. **Findings:** Surveillance videos used by the proposed system offer highly reliable real-time attendance recording while eliminating the tedious mistakes that manual and traditional methods would produce. **Novelty:** The performance evaluation demonstrates that the CNN-based system surpasses HOG and KCF algorithms because it achieves 99% accuracy and 95% precision and 94% recall rates thus providing educational institutions with an effective solution to their modern surveillance needs.

Keywords: Automated Attendance; Convolutional Neural Networks; Facial Recognition; Surveillance Video; Deep Learning

I. Introduction

The current procedures for attendance tracking through manual writing and barcode systems require too much time along with a high potential for mistakes and are prone to errors. Modern technology, particularly machine learning, allows the creation of improved systems developed to automate this process. This research focuses on using CNNs for facial recognition to provide an efficient and reliable solution for attendance management. CNN is an abbreviation for Convolutional Neural Networks, which is defined as a deep learning neural network used to analyze visual images. These algorithms work by converting images into feature maps. Most modern and advanced face recognition models and systems use CNN [1].

The attendance recording task is often difficult to control, due to the increasing number of students enrolled in the institution. This technology easily gets rid of this problem. The goal of this research paper is to introduce and validate a system that addresses the challenge of time-consuming traditional methods of taking and monitoring attendance [2]. Machine learning algorithms have revolutionized real world applications and research by enabling intelligent, automated systems to handle complex data. They excel in knowledge acquisition, prediction, and problem solving, transforming industries like healthcare, finance, manufacturing, and technology, driving innovation and efficiency [3].

These automated systems may help us track and monitor students' classroom attendance, but they may not be able to provide the necessary insight into their behavior [4]. The system introduced by this research paper is not just about recording video or face but could be used to detect and track humans on a large scale as some systems use the Internet of Things aiming to change the manual attendance system with an automated attendance system [5]. The system aims to address attendance issues, reducing teacher workload and time loss, by using facial recognition to identify human faces quickly and accurately through photos or surveillance videos [6].

Manual attendance tracking is inefficient and susceptible to inaccuracies. There is a need for an automated system that can accurately track and identify individuals in real-time using surveillance videos. A primary goal of this investigation involves building an automatic system that delivers precise person and group recognition in monitoring footage particularly intended for educational institution attendance verification. The proposed research develops a tracking solution that delivers highly precise identification while reducing mistakes and achieving enhanced operational performance.

When students attend classes their attendance becomes more accurate because convolutional neural networks handle the record-keeping process. The skill of pattern recognition enables convolutional neural networks (CNNs) to provide accurate identification and logging of student attendance. Not only does this ensure the accurate data needed for administrative purposes, but it also reduces errors. Efficiency automating attendance

with CNN saves time and effort for both teachers and students. No need to manually record attendance saves critical instructional time. Real-Time Monitoring with a CNN-based attendance management solution, teachers can track attendance in real time. This allows them to quickly intervene to help students who need additional encouragement and support.

Insights from the data institutions can gain insights by examining the data collected through attendance systems that utilize CNN technology. This analysis can help identify attendance patterns, adapt teaching methods, and make decisions. Optimize resources by leveraging real attendance data, you can automate attendance tracking and determine resource allocation options to increase employee and facility efficiency. Enhanced safety measures implementing a CNN-based attendance system will enhance safety measures by ensuring that authorized personnel have access to educational resources and facilities.

Numerous studies have explored various algorithms and techniques for automated attendance systems. Some studies have utilized barcodes, Haar cascades with OpenCV, and Python-based solutions. However, the use of facial recognition, particularly with CNNs, has shown significant potential in enhancing accuracy and reliability. This paper aims to address gaps in the existing research by optimizing models and benchmarking different methods to identify the most effective approach for attendance systems.

The author in [7] conducted research proposing an attendance system using facial recognition technology for Android devices. Registered students scan the QR code displayed in the classroom interface using their smartphones. They also take a photo of their face using the same device. Experimental results show that the proposition attendance system realizes a face recognition performance of 97.29% by using LDA and only needs 0.000096 seconds for the face recognition operation in the server.

In [8], the researchers focused on creating an automated student attendance system utilizing facial recognition through Convolutional Neural Networks (CNNs). The system encompasses processes such as data entry, dataset training, face detection, and attendance recording. It is capable of identifying and recognizing multiple faces from a video stream, and subsequently logging daily attendance automatically. The developed system attained an average recognition accuracy of approximately 92%. The implemented system enables automatic recording of attendance which eliminates the chance of human mistakes.

An effective system for student attendance monitoring has become essential due to rising online coursework. The current manual recording methods use too much time and remain inefficient. Researchers in [9] established automatic attendance marking systems through the process of matching video frame facial images with database images. OpenCV handles face detection and recognition through its video processing system for identifying several faces during lectures. The system has shown potential for real-time applications even though it does not operate in real time yet. The system depends on Convolutional

Neural Networks (CNN) together with VGG16 architecture and Haar features to reach high accuracy and robustness across different poses. The framework detects faces then recognizes them during preset monitoring periods to ensure both correct attendance registration and halt any instances of online class cheating or attendance evasion.

The researchers in [10] presented a technology that uses intelligence to handle and document student attendance information. The proven facial recognition system achieved an accuracy rate of 99.75% after undergoing different usage tests. The system successfully maintained effective person registration during lecture sessions.

The research in [11] focuses on building a face recognition system for educational institutions to monitor student attendance because the authors seek to improve current systems to boost efficiency and enhance effectiveness. The existing system is plagued by ambiguities that lead to inaccurate and inefficient attendance recording. Additionally, enforcing attendance regulations is problematic under the old system. The face recognition technology utilized in this project leverages the uniqueness of human facial features, which are difficult to duplicate or alter. The system involves creating face databases to feed data into the recognition algorithm. During attendance sessions, the system compares faces against the database to identify individuals, automatically recording attendance and saving the relevant information into an Excel sheet. This automation streamlines the process and addresses the shortcomings of the traditional system.

Research work done in [12] developed a real-time automated attendance system based on human face detection and recognition using augmentation. The comparison is made between HOG, Viola Jones (Haar cascade), and CNN methods for face detection. Then it is observed that Haar Cascade performs better than any other method. Face detection and recognition were done by using the well-known Haar Cascade and CNN algorithms that achieved 94.6% accuracy on a real time database for an attendance system.

According to the proposal recently made by author [13], he believes that the conversion of the current manual attendance recording system will make it efficient and error-free attendance using IoT-based smart attendance system with RFID. Information can easily be transmitted with this method. Schools, colleges and organizations will greatly benefit from this proposed method in tracking students or staff. However, there are other methods which involve managing employee or student's attendance, but this proposed approach is user friendly and suitable for any business. The suggested system is highly reliable and time-saving.

The rest of this paper is organized as follows: Section II describes the proposed algorithm, in Section III the results and discussion are clearly highlighted using real dataset, finally, conclusion is presented in Section IV.

II. Methodology

Face recognition methodology will be used in this paper. It is an artificial intelligence-based technology used to locate and identify human faces in surveillance video. Face detection technology is frequently used to track and monitor people in real time. Face identification employs machine learning and an artificial neural network. Figure 1 shows the basic processes that the methodology will go through: the system is able to record the attendance if the same face recognized in the real time video surveillance is having the same features of the image available in the image dataset.

In the following step the overall performed task will be explained briefly:

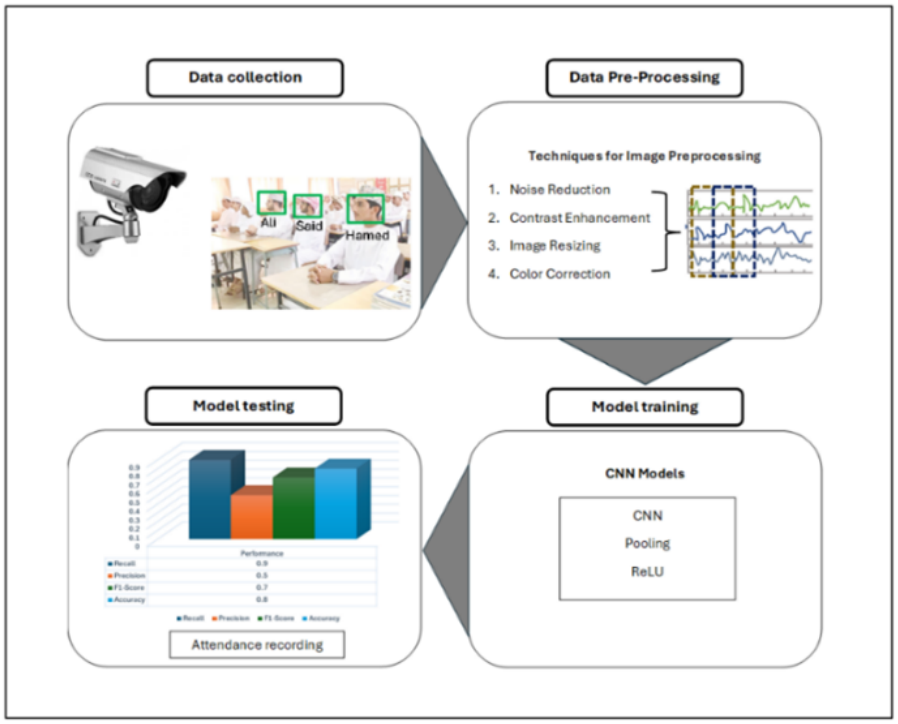

Figure 1: The Methodology Framework

II.1 Creating Face Database

In this first step, a database is created to record information about people's faces. Everyone's face is associated with unique IDs or records, which can include elements such as name, student ID, or any other pertinent information for attendance tracking. A video recording system is used to collect footage of people entering a class or a specific place where attendance must be tracked. Surveillance cameras can be used to do this.

II.2 Preprocessing

II.2.1 Face Detection

It is the process of recognizing faces in video footage. This stage employs computer vision algorithms capable of analyzing each frame of video to detect the presence of faces. When a face is spotted, its coordinates inside the frame are determined.

II.2.2 Face Recognition

After faces are discovered, face recognition technology is used to match these detected faces with the faces in the previously established face database. This entails comparing the identified face's facial traits (such as the arrangement of the eyes, nose, and mouth) with those in the database to locate a likely match. Face recognition models and machine learning algorithms may be used to perform this task.

II.3 Attendance Recording

After the face being recognized, the method will compare the recognized face with the faces available in the face dataset. In other words, the image recognized through the video surveillance will act as a testing image that will be compared with the trained image, which is available in the face dataset, also considered as the students registered in the courses.

III. Results and Discussion

Based on the training and testing done through the system, the following figures show the capability of the systems in detecting, recognizing, and recording the attendance.

In Figure 2: Through the student registration section, we registered groups or "courses" and information about the students, such as name, address, contact, gender, age, and date of birth, as well as choosing the course or group in which we will register students, such as the "STD" group or electronic security, and others. The application can add, delete, and modify the data entered in it, and it also has a search feature to speed up searches and obtain information quickly.

In Figure 3 shows the process of the training system. Here a photo must be taken of each student. The first step is to press the Start Detection and Recognition button in the empty space for the ID, after which the list of data that we stored in the previous step will appear and then choose the name of the device. As shown, the student's information will be included directly in the email. Finally, we click on "Add Photo", here the student's

Figure 2: Registration Page

Figure 3: Training Page

black and white photo will be saved in a database. The system allows taking different photos of the student from all sides to learn more about the student when recording attendance via video. In this step, you must consider the lighting and the appropriate location to place the camera in the classroom.

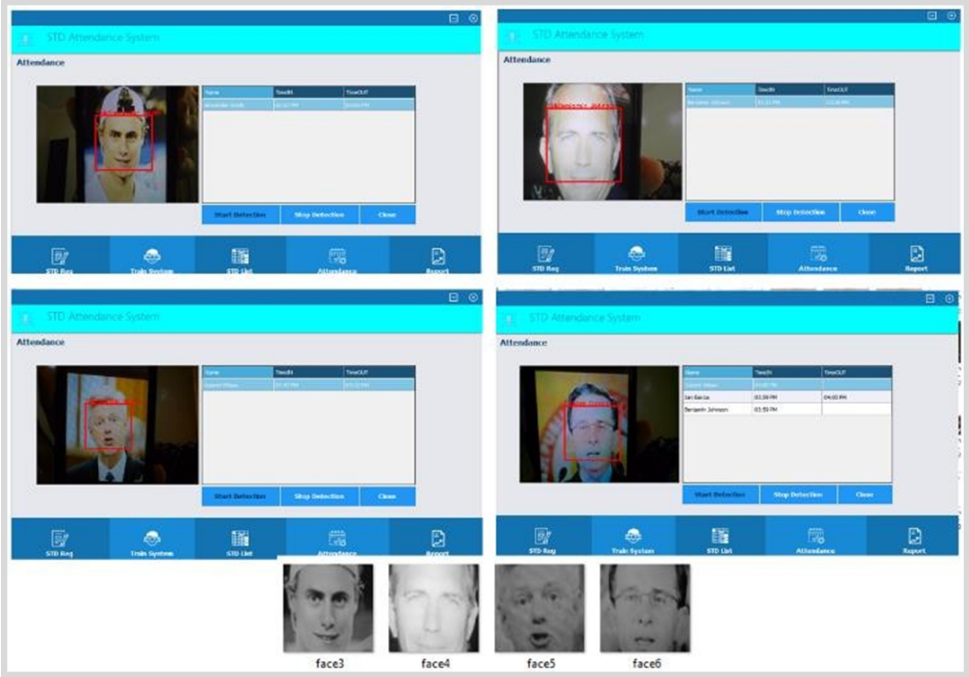

Figure 4: Taking a Picture from Phone

Figure 4: The system also allows taking a picture of the person from the phone and placing it directly on the camera.

Figure 5: Dataset for 41 Persons

A dataset was taken from some employees and students at the University of Nizwa. The data consists of more than 40 images of different faces of students and staff to train

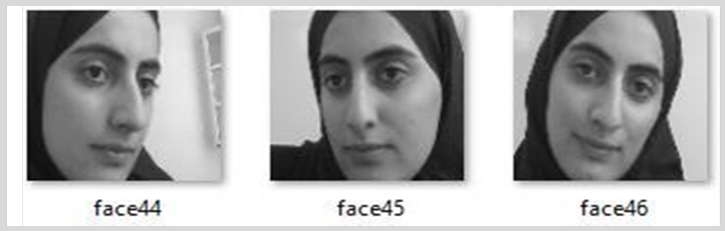

Figure 6: Face with Different Directions

the system. The system allows more than one photo of a person from different directions, as shown in Figures 5 and 6 respectively.

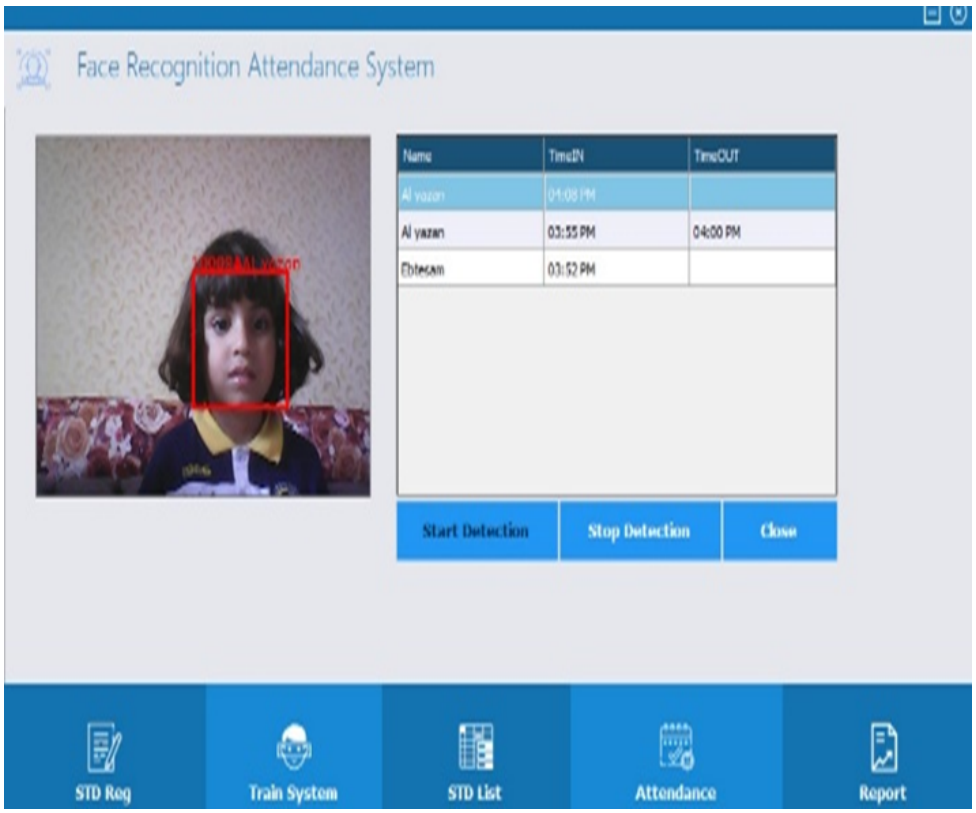

Figure 7: Testing Page

In Figure 7: In the system testing section, here the system begins recognizing the students' faces by clicking on the "Start Detection" button and comparing the image with the images in the database that we previously stored. If the photo is the same as the one in the database, the student's face will be recognized. If the student's face is not recognized, "Unknown" will appear in the photo frame, but here in Figure 7, the student Al-Yazan has been identified, and his name appears at the top of the photo frame. The system then calculates the student's entry and exit times as shown in the picture.

In Figure 8: In the "Report" section, the registration process that we carried out in the previous step (Figure 7) will appear in the form of a table containing the date of

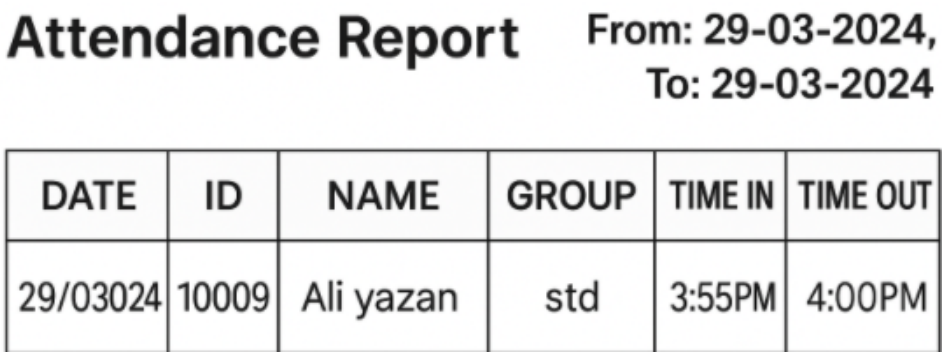

Figure 8: Attendance Page

attendance registration, the name of the student, from which group or course, and the time of his entry and exit. Here the report helps professors and administrators to analyze the attendance and absence of students during lectures and thus helps to take appropriate measures to raise the academic level.

III.1 Performance Evaluation

Facial recognition technology is a technology of great importance in multiple fields, including security, surveillance, attendance recording, and human-computer interaction, as it is a technology that does not require human intervention. With the advancement of deep learning techniques, convolutional neural networks (CNNs) have emerged as a powerful tool for realizing face recognition systems due to their accuracy and reliability. In contrast, there are other algorithms that have been refined and have provided a basis for face recognition, such as HOG [14] and KCF [15].

Table 1: Classification Models Accuracy

Algorithm	**Accuracy (%)**	**Precision (%)**	**Recall (%)**
CNN	99	95	94
HOG	94	85	86
KCF	95.3	92	91

Table 1 and Figure 9 show the three facial recognition algorithms evaluation in this study for human face detection. The tested algorithms included Convolutional Neural Networks (CNN), Histogram of Oriented Gradients (HOG), Kernelized Correlation Filters (KCF). Three main metrics evaluated the models including their accuracy rate and precision level together with recall statistics.

Testing of the facial recognition models indicated CNN delivered the most outstanding results by reaching 99% accuracy alongside 95% precision and 94% recall. The performance statistics of KCF included 95.3% accuracy along with 92% precision and 91% recall

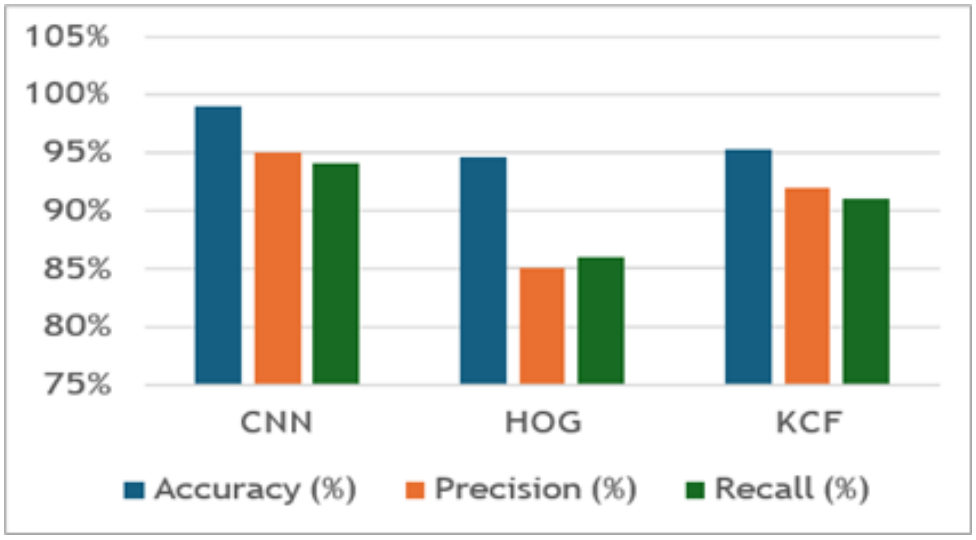

Figure 9: Classification Models Accuracy

whereas HOG generated 94% accuracy but fell short with 85% precision and 86% recall.

The CNN-based model delivers superior outcomes than all other examined algorithms in terms of performance metrics. The core value of CNN consists of automatic feature extraction from raw images that enables identification of detailed spatial elements in facial forms. The system performs better than HOG because it utilizes hand-crafted fixed features that struggle with lighting changes and pose modifications and occlusions. The object tracking efficiency of KCF together with its high precision operates poorly in complex face recognition tasks because it fails to learn deep representation from CNNs.

Research findings show that CNN outperformed other methods in this study because deep learning models now lead the field of computer vision accuracy and reliability improvements. The research results demonstrate that CNN represents an excellent choice for real-time surveillance-based applications requiring high recognition accuracy and reliability in automated attendance systems. The experimental results demonstrate conclusive evidence supporting CNN usage in real-world security implementations especially for schools along with offices and public areas.

IV. Conclusion

The research utilized surveillance systems through the combination of Convolutional Neural Networks (CNNs) which detected humans and processed automatic attendance data. The main goal involves designing a strong real-time system which solves the problems of traditional manual attendance systems operating within educational institutions. The implementation of a CNN-based detection model succeeded in reaching high evaluation performance by achieving 99% accuracy as well as 95% precision and 94% recall metrics

when processing real-world surveillance videos.

The proposed system stands out because it combines complete automation with real-time operations of a recognized facial detection method and facial recognition and deep learning-based attendance recording mechanisms. The CNN-based model outperformed traditional systems and classical algorithms (HOG or KCF) through superior accuracy and strong robustness in various conditions that involve poor lighting along with occlusions. Previous models show a notable advancement compared to this new version of the system.

The system implements a built-in method which starts with face database development followed by real-time video stream face analysis and results in precise matching for attendance tracking purposes. The implementation method reduces both administrative expenses and human mistakes between database installation and result recording. The system demonstrates suitable application potential in educational and corporate settings and for ATM fraud prevention and attendance control within public organizations.

The present operational framework of the system contains specific limitations that need attention. A consistent camera-view assumption exists together with requirements for top-quality training samples. The system shows declining performance when dealing with complete video blockages or when using low-definition camera feeds. The system lacks dynamic temporal tracking functionality between video frames as a means to enhance stability in continuous video monitoring.

Author Contributions

Conceptualization, S.M.A.R., E.A.S. and S.O.F.K.; methodology, S.M.A.R.; validation, S.O.F.K.; formal analysis, E.A.S.; investigation, S.M.A.R. and E.A.S.; resources, S.O.F.K.; data curation, S.M.A.R.; writing—original draft preparation, S.M.A.R. and E.A.S.; writing—review and editing, S.O.F.K.; visualization, E.A.S.; supervision, S.O.F.K.; project administration, S.M.A.R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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