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In Partnership with: Tadulako University

DROWSINESS DETECTION AND ALERT SYSTEM USING FACE RECOGNITION WITH RASPBERRY PI

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Abstract— **Recently, drowsiness detection has garnered significant attention due to its crucial implications in various industries, such as transportation, healthcare, and workplace safety. Drowsiness, often caused by exhaustion or lack of sleep, poses serious risks to people's safety and well-being. Even in less critical situations, like during online classes, feeling sleepy negatively impacts students' learning and academic performance. The occurrence of accidents and errors resulting from drowsiness has underscored the need for effective detection technologies to mitigate these risks. The main objective of this project is to develop a drowsiness detection and alert system using a Raspberry Pi. The technology aims to analyse facial features in real-time, efficiently identifying key markers of drowsiness through computer vision techniques and machine learning algorithms. Leveraging Raspberry Pi as the camera component offers a portable and cost-effective solution suitable for various settings. The solution integrates a Telegram bot for streamlined communication, utilizing PiCamera to capture facial photos and promptly detect signs of drowsiness. This bot sends rapid alert messages to users' mobile phones or laptops, enabling swift responses to any concerns related to potential drowsiness, thereby enhancing safety and well-being. The system also proficiently records essential drowsiness data in a MySQL database, allowing for further analysis and insights to continuously improve and enhance effectiveness in reducing drowsiness-related incidents.**

Keywords— drowsiness detection, Raspberry Pi, facial recognition, machine learning, workplace safety

I. INTRODUCTION

Facial recognition is a biometric technique which is a method of recognizing or verifying a person's identification that makes use of the head and face to confirm a person's identity using their facial biometric pattern and data. To identify, verify, and authenticate a person, the technology gathers a collection of specific biometric information about everyone related with their face and facial expression. Drowsiness describes short bursts of sleep, usually lasting one to several seconds. These episodes might cause people to fall asleep without even recognizing it. It can happen anywhere, including at work, school, or while watching TV. Drowsiness is a risky condition since it can occur while operating machinery or while driving and they may occur at any time when you lack sleep. Due to its great significance, drowsiness or microsleep detection systems has been an essential part of machine vision and image processing that uses vision-based methods like eyes detection, yawning, and nodding [1]. Following the Coronavirus disease (COVID-19) pandemic, educational institutions all over the world have quickly switched to online learning platforms to maintain academic activity while putting the health and safety of students first. As a result, online classes are now the norm, and it is more difficult to keep students engaged and focused during online learning sessions. The literature in this field has recently made note of several research projects. Leveraging advancements in computational technology, it has now become feasible to devise intelligent facial detection systems. A person's facial expressions can be used to estimate their level of drowsiness. In this study, deep learning is used to examine actual human behaviour during drowsiness episodes that concentrate on facial feature characteristics [2]. This project aims to engage drowsiness detection algorithms to detect levels of drowsiness using Raspberry Pi and provide real-time alerts via Telegram bot.

II. MATERIALS

A. Raspberry Pi

Raspberry Pi is a single-board computer the size of a credit card and is now generally acknowledged as a component of developing computer technology [3]. It is a programmable device that although lacks internal storage and peripherals, has all the essential components of a motherboard of a typical computer. The desktop performance of the Raspberry Pi 4 Model B is comparable to that of entry-level x86 PC systems for the user. A high-performance 64-bit quad-core processor, hardware video decoding at up to 4Kp60, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, up to 4GB of RAM, 12 dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, and USB 3.0 are some of the key features of this product. As a result, this model was used to create this project.

B. Raspberry Pi Camera Module

The Raspberry Pi Camera Module, also known as the 5 Megapixel, Rev 1.3 camera module is used for this project. It is a specially created Raspberry Pi accessory that works with all Raspberry Pi models, including the Zero, Raspberry Pi 3, and Raspberry Pi 4 Model B. It connects to the Raspberry Pi using one of the two tiny connections with the name "CAMERA" on the board's upper surface. This interface utilizes the specific CSI interface, which was made specifically for interacting with cameras. The picture resolution is 2592 x 1944, and the video supports 1080p at 30fps, 720p at 60fps and 640x480p 60/90 recording.

III. METHODS

For the purpose of detecting drowsiness, various machine learning methods can be applied. This section will discuss the algorithms and methods being deployed for the project.

A. OpenCV

Open Source Computer Vision Library (OpenCV) is a sizable open-source library for image processing, machine learning, and computer vision. It now plays a significant part in real-time operation, which is crucial in modern systems. Users can process photos and videos using OpenCV to recognize objects, people, and even a person's handwriting. To begin facial recognition, the 5MP camera board for Raspberry Pi is attached to Raspberry Pi 4 model B and then it will take a picture of the user’s face. To train the Raspberry Pi for face recognition based on a set of photographs that have already been collected and made available as our MRL eye dataset, the OpenCV, face recognition, and imutils packages are used. A window in OpenCV displaying the live stream from Raspberry Pi camera will emerge after roughly 40 seconds. After identifying the face, the system will begin recording eye movement. This eye movement will be trained against the MRL dataset to detect two classes, labelled Open Eye and Closed Eye. The dataset is publicly available from the MRL website and offers a large-scale human eyes images for training the machine learning algorithm for drowsiness detection [4].

B. Haar Cascade

Haar cascade is one of the algorithms that can be used to identify drowsiness. In addition to detecting faces, Haar Features were also utilized to identify license plates, eyes, and lips. This algorithm is readily available as a library for use in OpenCV. This algorithm can operate in real-time and is not overly complex. In a hierarchical fashion, Haar cascade is also capable of detecting many objects in a single frame [5]. Once the photos taken from the Pi Camera is trained with the MRL eye dataset, the Haar cascade is used to calculate the value for detecting drowsiness. If the value is greater than three, drowsiness will be detected and an alert will be sent to the Telegram bot.

C. Telegram Messenger

Telegram is a cloud-based instant messaging platform. This service application is accessible on Linux, macOS, Windows NT, Android, iOS, and Windows Phone. The system integrates Telegram with Python using a feature called Telegram Bot. There are some settings that must be done, such as inputting the code, to get Telegram interfaced with Python. There are two sections to the project. The sender unit is one, while the receiver unit is the other. Python will retrieve the data string and builds a https datastring using the CHAT_ID and BOTtoken before sending it to Telegram using a http.GET ().

D. Python

Python version 3 is used to develop this project and integrate the individual components. A few libraries namely TensorFlow and numpy is used to help create data analysis and machine learning applications more rapidly and effectively. Fig. 1 displays the system architecture for this project.

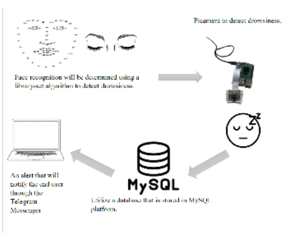

Fig. 1. System Architecture

IV. RESULTS AND FINDINGS

The system's implementation made use of the OpenCV package and the Haar Cascade technique for face recognition and image processing in Python. The client, a Raspberry Pi, communicated with the server, a laptop, via the same network. The server handled processing the drowsiness detection algorithm and distributing alerts to the Telegram accounts of lecturer. The drowsiness detection model was trained using the collected dataset for a total of 4 hours, allowing the model to learn and generalize from the diverse instances of drowsiness in the dataset.

A. Data Collection

To train and test the drowsiness detection algorithm, a dataset of human eye images was collected, utilizing the MRL Eye dataset. The MRL Eye dataset is a sizable collection of 84,898 human eye pictures that were taken from 37 different people. This dataset includes information regarding the use of spectacles and is specifically designed to capture variations in eye states which are open and closed [6].

B. Telegram Bot

The bot has three commands: "/start" to start the program, "/detect" to turn on the camera to detect drowsiness, "/analysis" to create and send graphs of the detected cases of drowsiness via the Telegram bot and "/stop" to stop the program. Fig. 2 displays the results of executing these commands.

Fig. 2. Telegram bot

C. Alert System Performance

The alert system, which relates to the drowsiness detection system, effectively transmitted real-time messages to the Telegram accounts of lecturer in 97% of the cases where drowsiness was detected, indicating its great dependability and efficiency. To ensure precise and prompt alerts for possible drowsiness occurrences, the system showed a limited number of false positives and false negatives.

D. Drowsiness Occurrence Reporting

The collected data from the drowsiness detection system is stored in MySQL database. This provided valuable insights into the occurrences of drowsiness and is presented in the format of a bar chart. Fig. 3 below shows one example which represents camera ID 22 and displays the time-series chart that detected drowsiness patterns seen in a single participant on a particular day.

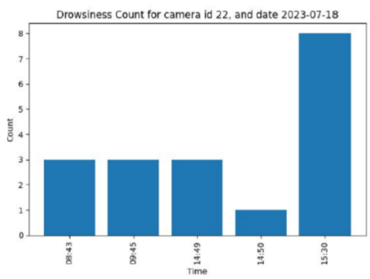

Fig. 3. Bar chart for drowsiness detection pattern of a single participant

V. CONCLUSIONS

In conclusion, the system has demonstrated promising results in resolving the described problems for drowsiness detection. It acts as a proof of concept and is highly adaptable in crucial application domains such as healthcare, transportation and workplace or factory operations which require a high level of alertness for the human employees. Admittedly, some issues may still need to be addressed such as increasing the dataset size and diversity. Delays in the delivery of alerts may be caused by network latency or other variables, which may affect how quickly they receive notifications. The alert system can be enhanced in the future to guarantee rapid and trustworthy notification delivery.

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