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Automated Driver Drowsiness Monitoring System

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Abstract
This presentation introduces an innovative end-to-end non-intrusive IoT-based automated frame work designed for logistic and public transport applications, aiming to address the exponential growth in road accidents. Leveraging behaviour analysis-based approaches and computer vision techniques, the framework detects and monitors driver behaviours such as drowsiness, sleeping, yawning, and distractions. Comprising embedded systems, edge computing, cloud modules, and a mobile app, the solution ensures real-time monitoring and evaluation. With a focus on minimizing latency and enhancing accuracy, the framework achieves a remarkable 96% overall accuracy in experimental testing. This comprehensive solution offers heightened road safety through its robust, portable, and user-friendly design, making it a valuable tool for proactive driver behaviour management.

***Keywords**: Raspberry Pi, Accident Alert, Web Camera.*

1. Introduction
This presentation introduces an innovative end-to-end non-intrusive IoT-based automated framework designed for logistic and public transport applications, aiming to address the exponential growth in road accidents. Leveraging behaviour analysis-based approaches and computer vision techniques, the framework detects and monitors driver behaviors such as drowsiness, sleeping, yawning, and distractions. Comprising embedded systems, edge computing, cloud modules, and a mobile app, the solution ensures real-time monitoring and evaluation. With a focus on minimizing latency and enhancing accuracy, the framework achieves a remarkable 96% overall accuracy in experimental testing. This comprehensive solution offers heightened road safety through its robust, portable, and user-friendly design, making it a valuable tool for proactive driver behavior management.

1.1 Introduction to Embedded Systems
An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In general, "embedded

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system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be load and peripherals to be connected. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation [1]. Certain operating systems or language platforms are tailored for the embedded market, such as Embedded Java and Windows XP Embedded. However, some low-end consumer products use very inexpensive microprocessors and limited storage, with the application and operating system both part of a single program. The program is written permanently into the system's memory in this case, rather than being loaded into RAM (random access memory), as programs on a personal computer are.

1.2 Characteristic of Embedded System

- **Speed (bytes/sec):** Should be high speed
- **Power (watts):** Low power dissipation
- **Size and weight:** As far as possible small in size and low weight
- **Accuracy (%error):** Must be very accurate
- **Adaptability:** High adaptability and accessibility
- **Reliability:** Must be reliable over a long period of time

1.3 Applications of Embedded Systems

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.

Robotics: industrial robots, machine tools, Robocop soccer robots
Automotive: cars, trucks, trains
Aviation: airplanes, helicopters Home and Building Automation
Aerospace: rockets, satellites
Energy systems: windmills, nuclear plants
Medical systems: prostheses, revalidation machine.

1.4 Introduction to Project

The research work carried out here provided an insight into the development of IoT systems. The research area of the Internet of Things in recent years has experienced growth and development in an interdisciplinary manner. IoT is the inter-networking of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. The traditional fields of embedded system, wireless sensor networks, control system, automation systems are together interconnected to form the IoT. That means the internet of things builds over the revolutionary success of mobile and internet network.

2. Literature Survey

Ovidiu Stan et.al. Says in the paper “Eye-Gaze Tracking Method Driven by Raspberry PI Applicable in Automotive Traffic Safety” that This paper comes as a response to the fact that, lately, more and more accidents are caused by people who fall asleep at the wheel. Eye tracking is one of the most important aspects in driver assistance systems since human eyes hold much in-formation regarding the driver's state, like attention level, gaze and fatigue level. The number of times the subject blinks will be taken into account for identification of the

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subject's drowsiness. Also the direction of where the user is looking will be estimated according to the location of the user's eye gaze. The developed algorithm was implemented on a Raspberry Pi board in order to create a portable system. The main determination of this project is to conceive an active eye tracking based system, which focuses on the drowsiness detection amongst fatigue related deficiencies in driving. Kulkarni S. S. et.al. Says in the paper "Application of raspberry pi based embedded system for real time protection against road accidents due to driver's drowsiness and/or drunk and drive cases" that Present work deals with the application of raspberry pi CPU based sensing system to the detection of driver's lethargy and alcoholism in order to avoid the road accidents. The embedded system consists of 5 mega pixel digital camera, alcohol detection sensor and the buzzer interfaced to the microcontroller [2]. The embedded system is controlled by Raspbian operating system. The system detects real time situation of the driver's vigilance and control over the vehicle. If alcoholic and / or drowsiness tests are positive, it switches on the alarm, (ii) turn off the vehicle's engine via microcontroller based program controlling ignition power source and (iii) sends a SMS to the person close to the driver's location. García et. al. described 'Driver Monitoring Based on Low-Cost 3-D Sensors'. They proposed a solution for driver monitoring and event detection based on 3-D information from a range camera is presented. The system combines 2-D and 3-D techniques to provide head pose estimation and regions-of-interest identification. Based on the captured cloud of 3-D points from the sensor and analysing the 2-D projection, the points corresponding to the head are determined and extracted for further analysis. Later, head pose estimation with three degrees of freedom (Euler angles) is estimated based on the iterative closest points algorithm. Finally, relevant regions of the face are identified and used for further analysis, e.g., event detection and behaviour analysis. The resulting application is a 3-D driver monitoring system based on low-cost sensors. It represents an interesting tool for human factor research studies, allowing automatic study of specific factors and the detection of special event related to the driver, e.g., driver drowsiness, inattention, or head pose

3. Proposed System

The IoT-Based Non-Intrusive Automated Driver Drowsiness Monitoring Framework offers an advanced solution for road safety in logistics and public transport. Utilizing Internet of Things (IoT) technologies, the non-intrusive approach employs machine learning and deep learning to analyze external cues and behavioral patterns. By examining factors like head movements and facial expressions, the framework aims to detect driver drowsiness or distraction effectively. The method's ease of implementation and reduced sensitivity to external disturbances make it practical for real-world deployment, especially in settings with challenges related to constant human contact. With a focus on IoT integration, the framework promises enhanced data collection and communication through connected devices and sensors, improving the overall effectiveness and efficiency of drowsiness monitoring. While detailed insights are available in the complete research paper, [3] this framework represents a significant step in mitigating the risks associated with drowsy driving on a broader scale.
Exponential growth in road accidents demands proactive measures.

- Current solutions often lack real-time monitoring and comprehensive behaviour analysis, leading to preventable accidents.
- Our framework leverages behaviour analysis-based approaches and computer vision techniques.
- Detects and monitors driver behaviour such as drowsiness, sleeping, yawning, and distractions.
- Comprises embedded systems, edge computing, cloud modules, and a mobile app for real time monitoring and evaluation.

4. Block Diagram

The above Figure 1 represents the Block Diagram for Microcontroller**.** An Abstract Depiction of the Proposed System shown in Figure 2.

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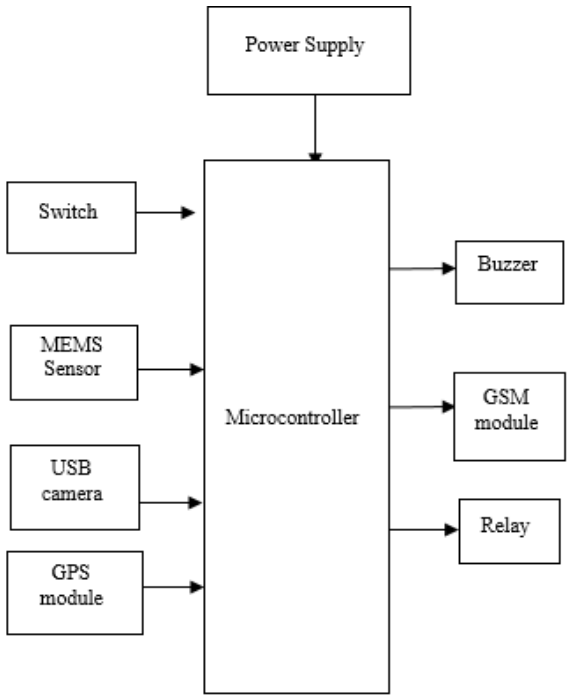

Figure 1 Block Diagram for Microcontroller

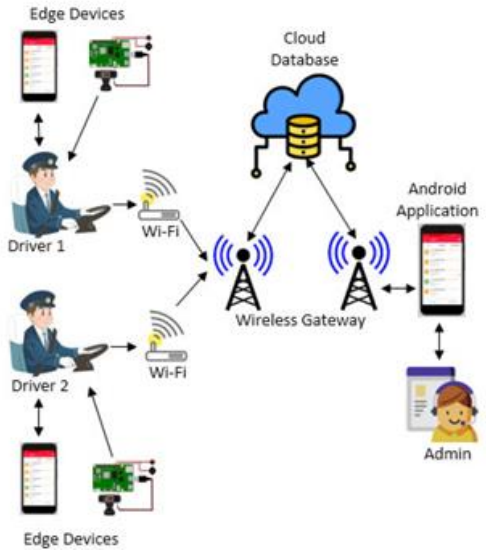

Figure 2 An Abstract Depiction of the Proposed System

The main components of the system are:

- Raspberry pi 4
- Mems sensor
- USB camera
- Switch
- Buzzer
- GPS
- GSM
- ADC module
- Gyro Accelerator Sensor

Raspberry pi 4: The Raspberry Pi is a small, affordable, single-board computer designed for educational purposes and hobbyist projects Here are some key features of the Raspberry Pi 4: Processor, Memory, Connectivity, Ports, Power, Performance, etc. Raspberry Pi 4 Components shown in Figure 3.

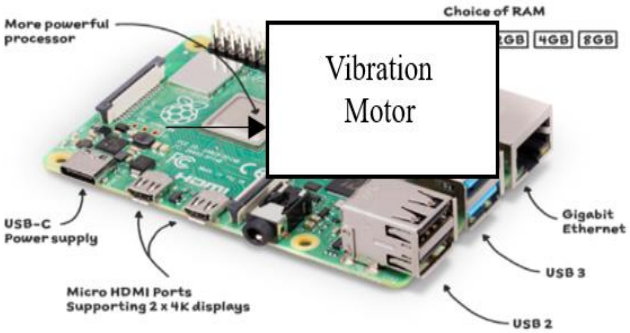

Figure 3 Raspberry Pi 4

Mems Sensor: MEMS sensors are miniature devices that combine mechanical and electrical components to measure physical parameters like acceleration, pressure, or sound with high precision. Mems Sensor shown in Figure 4.

- Miniaturization
- Versatility
- Precision and Sensitivity

Figure 4 Mems Sensor

USB camera: A web camera, commonly referred to as a webcam, is a digital camera device designed

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for capturing video and transmitting it over the internet Webcams capture video for internet use. They're vital for video calls, streaming, and meetings. Often mounted on monitors or built into devices, they enable real-time visual communication. [4] Many now offer HD video and features like autofocus and built-in mics. The USB Camera Model shown in Figure 5.

Figure 5 USB Camera

Switch: A switch is a crucial networking device. It operates at Layer 2 of the OSI model. Its main job is to forward data packets within a LAN based on MAC addresses. The below Figure 6 represents the Switch Component of microcontroller.

Figure 6 Switch

Buzzer: Buzzer is an electronic component that produces sound when an electric current passes through it. It's commonly used in alarms, timers, and notification systems to audibly alert users of specific events or conditions. The Buzzer component shown in Figure 7.

Figure 7 Buzzer

GPS: GPS is a network of 31 satellites enabling ground receivers to determine geographic locations with accuracy ranging from 100 to 10 meters for most devices and within one meter for specialized military gear. GPS network shown in Figure 8. It's widely used in science and now affordable for almost anyone to own a GPS receiver.

Figure 8 GPS

GSM: GSM stands for Global System for Mobile Communication. Developed in 1970 at Bell Laboratories, it's a widely used mobile communication system. GSM is open and digital, operating at various frequency bands for voice and data service. The below Figure 9 represent the GSM.

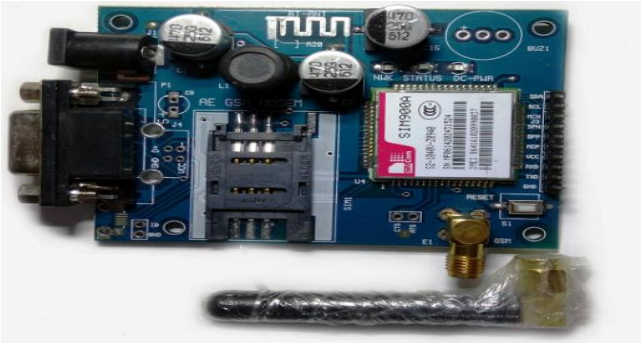

Figure 9 GSM

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ADC Module: An ADC (Analog-to-Digital Converter) module is a component commonly used in electronic systems to convert analog signals into digital data. ADC Module & GPIO Pins Shown in Figure 10 & Figure 11.

Figure 10 ADC Module

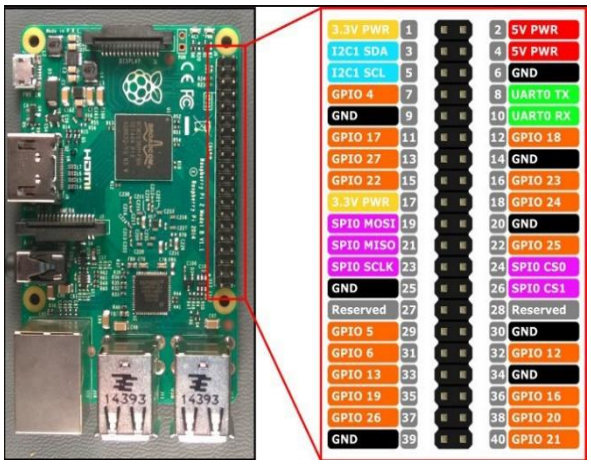

Figure 11 GPIO Pins

Advantages

- Non-Intrusive Nature
- Ease of Implementation
- Reduced Sensitivity to External Disturbances
- IoT Integration
- Applicability to Logistics and Public Transport

Applications

- Logistics and Transportation Industry
- Public Transport Services
- Fleet Management
- Personal Vehicles
- Road Safety Initiatives

Final Project Kit, Eye Aspect Ratio to Detect Open/Closed Eyes, Qualitative Results on Key Sample Images for Eyes Closed Class, Result of Project, Result of Project & GSM Result shown in Figure 12, Figure 13, Figure 14, Figure 15 & Figure 16.

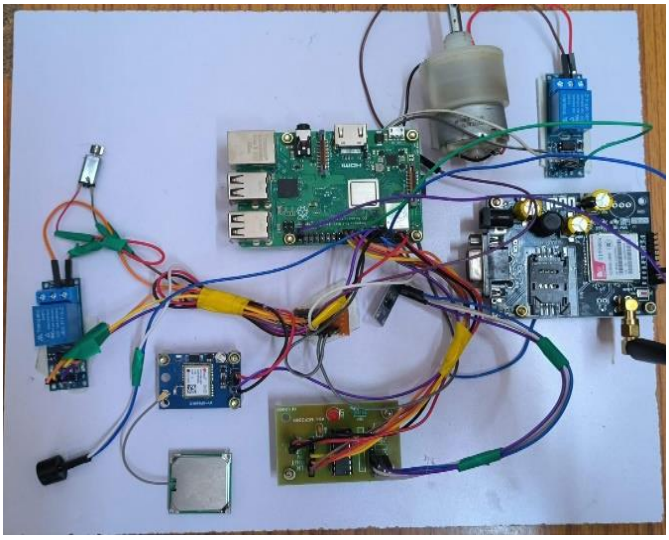

Figure 12 Final Project Kit

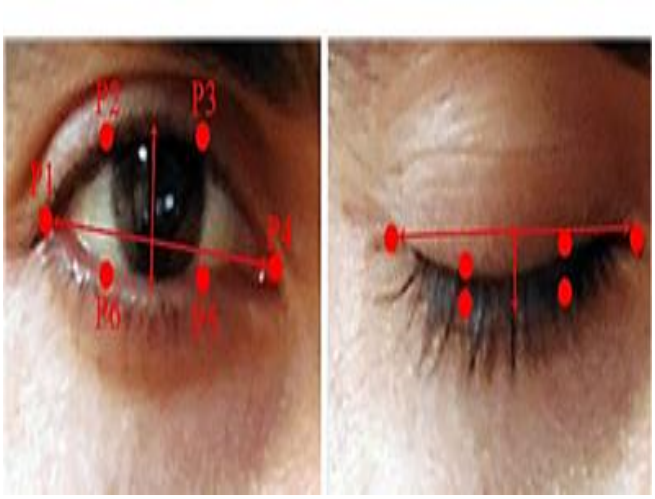

Figure 13 Eye Aspect Ratio to Detect Open/Closed Eyes

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$$EAR = \frac{||P2 - P6|| + ||P3 - P5||}{2||P1 - P4||}$$

$$f(x) = \begin{cases} x, & x > 0.30; \textit{open} \\ x, & x < 0.20 \textit{ and } t > 2\textit{sec}; \textit{close} \end{cases}$$

Figure 14 Qualitative Results on Key Sample Images for Eyes Closed Class

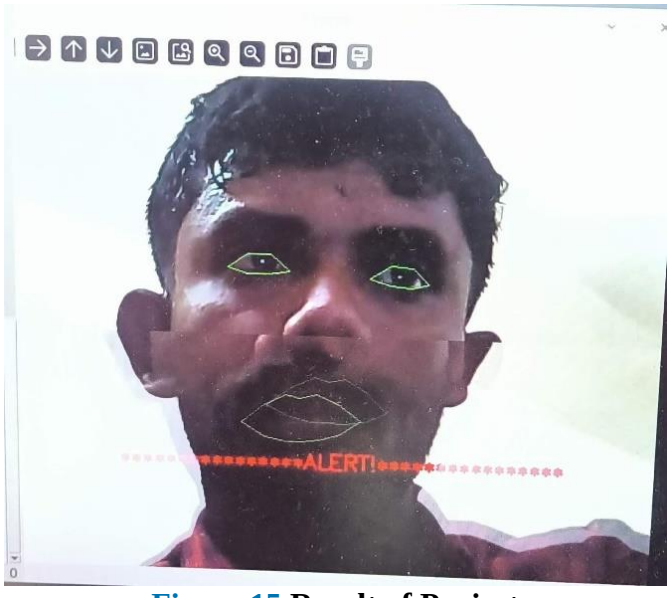

Figure 15 Result of Project

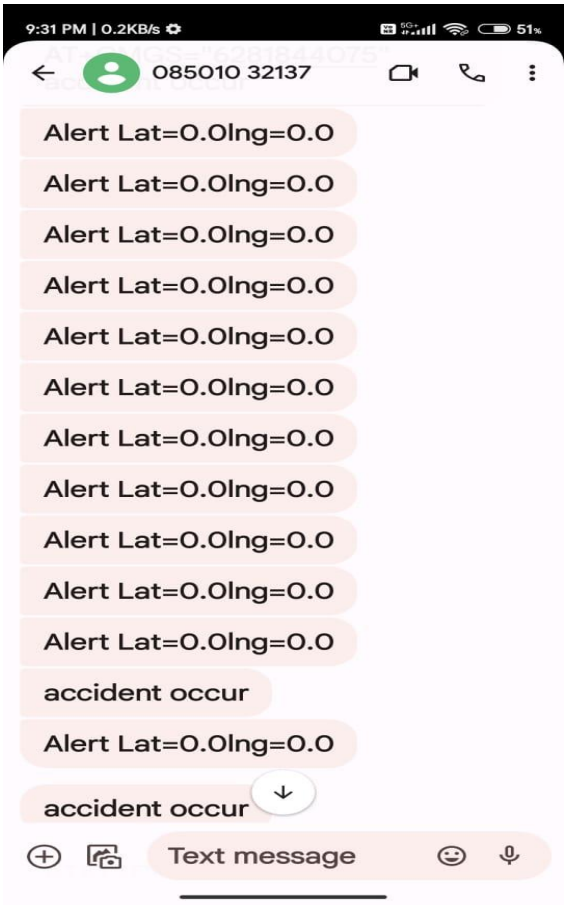

Figure 16 GSM Results

Conclusion

The IoT-Based Automated Driver Drowsiness Monitoring System offers a significant leap forward in road safety, especially in logistics and public transport. Incorporating IoT technologies, it employs non-intrusive methods, utilizing machine learning and deep learning for analysing external cues indicative of driver drowsiness. [5] Its practicality lies in easy implementation and reduced sensitivity to external disturbances, crucial for logistics and public transport scenarios. The integration of IoT enhances effectiveness by leveraging connected devices and sensors for superior data collection. Addressing the global challenge of road accidents, particularly those related to drowsy driving, this framework holds promise for mitigating risks and improving overall road safety.

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