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Design & Development of a Road Safety Device

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***Abstract*—** *Traffic accidents represent a serious threat to public safety because they cause a sizable number of fatalities and injuries each year. The primary causes of these collisions include driver fatigue, high vehicle speed, inattentiveness, and difficulty navigating turns on the road. This study suggests the development and application of a sophisticated road safety device to greatly improve driving safety and lower accident rates to address these problems. The proposed system can recognize traffic signs and promptly notify motorists of impending speed bumps and curves in the route. In addition, it has a function that tracks driver fatigue, reducing one of the major factors contributing to auto accidents. Additionally, the device has accident probability detection built in, which enables preventative actions to be conducted in high-risk scenarios. In addition to providing real-time position tracking, the system automatically notifies neighboring police stations and hospitals in the event of an accident, facilitating emergency response. Neural network-based image processing and an embedded sensor system are the two main technologies used in this system. A system block diagram has been proposed and expected to have low mistake rates in all major features and confirming the system's potential as an affordable way to increase traffic safety.*

I. INTRODUCTION

Road safety is one of the biggest concerns in the globe, especially in Bangladesh, where it is among the worst in the world. A large road network that has grown dramatically to handle the rising number of vehicle traffic traverses the nation. Presently, there are roughly 21,483 kilometers of roads in Bangladesh, comprising 13,659.13 kilometers of zilla roads, 4,280.02 kilometers of regional

highways, and 3,544.06 kilometers of national highways [1]. Even with this vast infrastructure, there are still several problems with road safety. As per the Bangladesh Passengers Welfare Association's (BPWA) 2020 annual report, 4,891 road incidents occurred in the nation, leading to 6,686 fatalities and 8,600 injuries. Interestingly, 43% of these collisions were on national highways, which translates to 18 fatalities every day on average across the country. In Bangladesh, 58,208 car accidents have claimed the lives of 56,987 persons in the last 20 years [2]. The frequency of these incidents is disturbing, but little has been done to prevent them, and funding for road safety research and initiatives is still disproportionately low when it comes to other public health concerns. The system's main objective is to monitor the driver's facial condition and identify any indicators of tiredness through image processing algorithms. When driver sleepiness is detected, the technology reduces the likelihood of accidents by sending a wristband alarm to the driver. This system will help to reduce the road side accident of the country. It can save thousands of lives, if the device is implemented in the vehicles, it will monitor the facial condition of the driver. It also helps the driver to detect the speed breakers and turns of the road. If any unfortunate event occurs on the road, this device will immediately trigger an emergency protocol by sending a SMS of the location of the vehicle using GPS and GSM technology. That's how the device will work in adverse situation.

II. EARLIER RESEARCH

A paper by V. S. K. P. Varma, S. Adarsh and K. I. Ramachandran published a paper in 2018 [3]. They provided a system that uses deep learning techniques to identify and tell the driver about impending un-marked and marked speed bump in real time, as well as offer the distance the car is away from it using stereo-vision approaches. NVIDIA GPU and Stereo labs ZED Stereo camera devices were also utilized. This driver or autonomous mode of the car can manage vehicle speeds to keep them within safe limits so that passengers and the vehicle are not inconvenienced or damaged. In the year 2013, Md. S. Amin, M. B. Ibne Reaz and S. S. Nasir published a paper [4]. Their paper is related to a system for detecting and locating integrated vehicle accidents. Many lives may have been saved if car accident information could have been automatically relayed to an emergency rescue center. An accident detection and locating system that uses accelerometers and GPS data to determine deceleration and data fusion. Integrating using a Kalman filter overcomes the bias, drift, and noise problems of accelerometers, as well as the GPS outage constraint. GSM is used to send the emergency message and the Global Positioning System (GPS) is used to get the exact location of the accident. Their test results demonstrate that the right deceleration is used to identify and locate accidents. The designed technology will be able to overcome GPS/IMU limitations and save important human lives. T. Vesselenyi, S. Moca and A. Rus have published a paper on 2020 about drowsiness detection in drivers using ANN image processing [5]. The paper discusses the feasibility of developing a sleepiness detection system for automobile drivers using three different approaches. Three of these approaches are based on the measurement of EEG (Electroencephalography) and EOG (Electrooculography) data, as well as the categorization of eye state (closed or open) images. The EEG technique monitors brain activity by placing a sensor on a specific region of the scalp, the EOG method follows eye movements by detecting signals from the muscles that operate on the eye, and the eye image analysis method can monitor whether the eye is open or closed. Martins E. Irhebhude, Oladimeji A. Adeyemi, Adeola Kolawole published a paper on speed breakers and the detection of road marking using image processing technology [6]. This work describes an image processing technique for speed breaker detection and recognition, as well as road marking detection and recognition. To recognize traffic signs such as "STOP" markings, an Optical Character Recognition (OCR) method was utilized, and a Hough transform was used to detect line markings, which serves as a preprocessing stage to determine when the suggested technique executes OCR or speed breaker detection. The experimental outcomes show 79 percent of "STOP" signs and 100 percent of speed breakers. The proposed strategy is particularly effective for roads that are suitably painted, regardless of size their dimension.

III. BLOCK DIAGRAM

This project has been developed with five unique features in mind. Included are turn and speed breaker detection, accident detection, drowsiness detection, emergency systems, and alarm systems. The device's main block diagram is shown in figure 1. Where, the Raspberry Pi 4B, the Jetson Nano B101, the Arduino Uno R3, three different types of sensors, and four DC batteries are utilized as a power supply to power up the Jetson Nano, the Arduino Uno, Arduino Pro Micro, Arduino Nano and the Raspberry Pi.

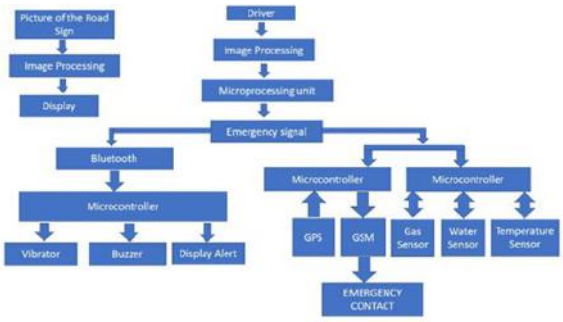

Fig.1: Block Diagram of the device

Visual data is recorded with the help of two camera modules. The Raspberry Pi 4B serves as the main processing unit of the drowsiness detection system. Jetson Nano B101, which is one of the project's major processing units, is used to detect road turns as well as speed breakers. A buzzer, a vibrator, Bluetooth, GPS and GSM module, a smoke sensor, a temperature sensor, a night vision camera, a LCD display are used in this device.

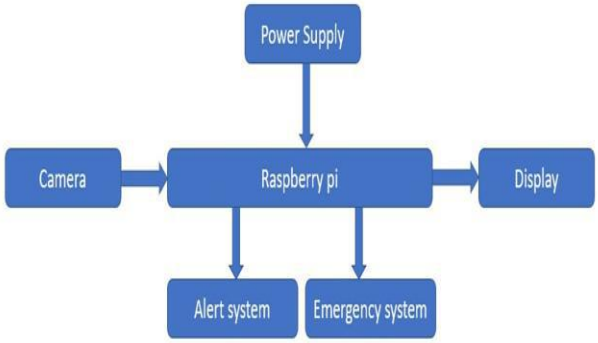

Fig.2: Block diagram of the drowsiness detection system

The drowsiness detection system runs on a Raspberry Pi 4B. This system's main aim is to detect drowsiness in the driver. In figure 2, it can be seen that the following primary processing unit are two integrated microcontroller subsections, Arduino alert and Arduino emergency. A DC power supply powers the processor. The Raspberry Pi module has an advanced camera module that monitors the driver's status and transmits data to the processor. If the main processing unit detects a driver feeling drowsy while driving, an alert signal is delivered to the Arduino. This project's alert section will attempt to warn the driver to drive the vehicle into the road with full awareness. Also, an alert message will be generated on the display. After this action, if the camera module again detects the drowsiness condition of the driver, it will again send a signal to the Arduino alert subsection. Furthermore, if the camera module detects the driver's drowsiness condition more than three times, the processor will immediately send data to the Arduino emergency subsection to run the emergency system.

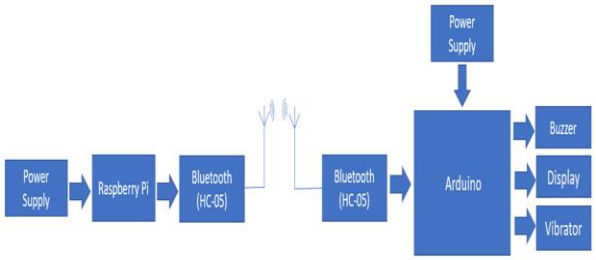

Fig.3: Block Diagram of Alert System

The alert system is one of the crucial parts of the proposed road safety system. Figure 3 shows the Raspberry Pi 4B serves as the system's primary microprocessor. It detects the driver's drowsiness using the camera module and alerts the driver with buzzer and vibrator along with showing an alert message on the wristband's display.

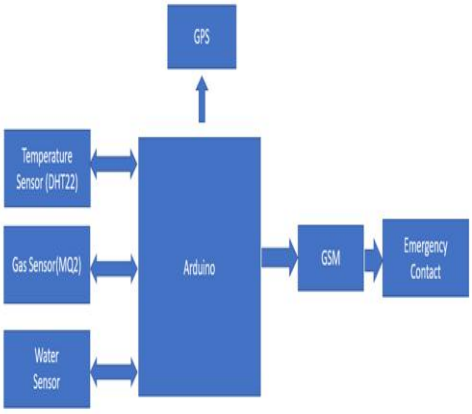

Fig.4: Block Diagram of Accident Detection System

An accident detection system is depicted in the figure 5. Four distinct types of sensors are employed in this system for various functions. Sensors including temperature, gas, water, are used to detect the probability of accident. If any sensor value exceeds the threshold, it will send a signal to the Arduino Uno. Using the GSM and GPS module, the Arduino Uno can send a text message to neighboring police and hospitals, as well as the emergency contact, informing them of its location. The Emergency System works as an essential part of this project. After generating the alert signal three times, the emergency system gets triggered. The

emergency system operates in four steps. After an emergency is caused, Raspberry Pi will send a signal to Arduino Uno.

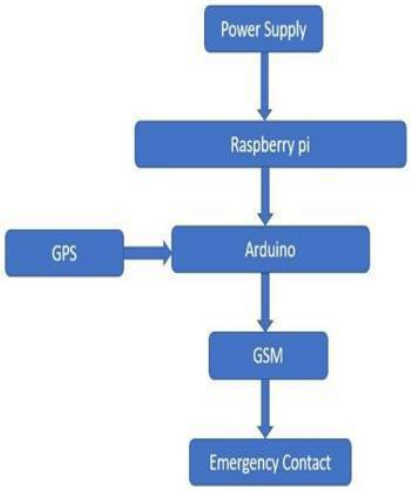

Fig.5: Block Diagram of Emergency System

The Emergency System works as an essential part of this project. After generating the alert signal three times, the emergency system gets triggered. The emergency system operates in four steps. After an emergency is caused, Raspberry Pi will send a signal to Arduino Uno. Arduino Uno will detect the real-time position via the GPS module. GSM module will then take the real-time position from Arduino Uno to the nearest hospital and police station via text message. This is how the emergency system of this project works.

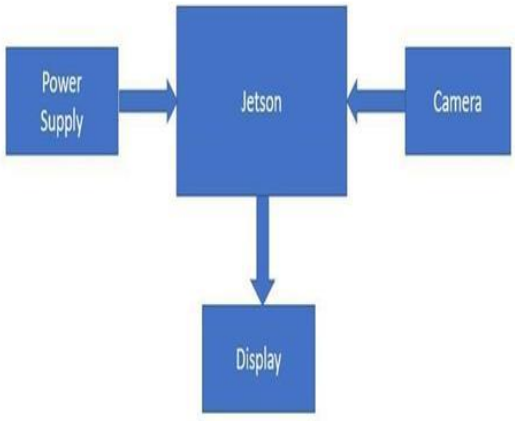

Fig.6: Block Diagram of Road Turns and Speed Breakers Detection System

Road turns and speed breaker detection are major parts of the system. Figure 6 indicates the image processing technology of the proposed system. Jetson Nano B101 is used as the processing unit. This device continuously monitors the road turns and speed breakers of the road through a camera. A display is used to show the road turns and speed breakers of the road. Whenever Jetson detects a road sign or a speed breaker on the road, it will show it one the display inside the vehicle to notify the driver.

IV. MODELING

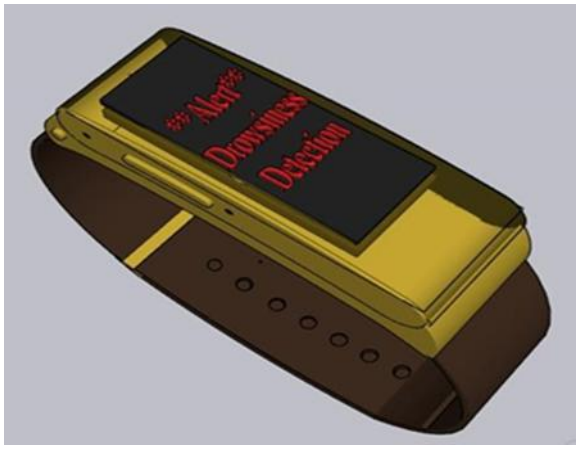

Fig.7: 3D Modeling of Wristband

Fig.8: Display and Camera in Solid works and SketchUp

Figure 7 and 8 are designed with Solid works and SketchUp for the modeling purpose. Here the wristband is designed using SketchUp and LCD display, camera modules are designed using Solid works.

V. FUTURE IMPROVEMENT

Provide scopes for the future where the project's limitations can be fixed. Future research may involve turning the experimental block diagram into a mass production model and prototype, requiring for enhancements to its overall functionality. In below, some of the future developments are given :

1. Inclusion of a wireless high resolution zooming camera.

2. A Vibration feature can be introduced in the driver seat.

VI. CONCLUSION

In this present era, technology is developing day by day. In consistence with that alt the nations are also developing and more and more bridges are constructing in order to develop the transport system [8]. Developed technology has made our lives easier and more comfortable. The transport system is an important sector of a country's economy. A developed transport system will help to improve the communication sector as well as the economy of the country. The roads and highways in our country are not perfectly safe. When compared to the similar situation from the previous year, in 2020, the number of accidents increased by more than 25%. In January of this year, in 2021, at least 484 people have died and 673 were wounded in 427 traffic accidents across the country. According to the Road Safety Foundation, the accident rate jumped to 25.58 percent and the fatality rate increased to 8.76 percent when compared to the same period the previous year (RSF) [7]. As a result, a safe road can save countless lives. To keep this goal in mind, researchers had proposed a block diagram based road safety gadget that has the potential to save thousands of lives on the roads and highways.

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