Development of Microcontroller Based Technology for Automatic Safety Control of Vehicle Braking System

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Abstract - The Detection of a Drowsiness-based braking system is an innovative technology that aims to improve the safety of drivers and passengers by monitoring their eye movements and using that data to apply the brakes in case of an emergency. This system consists of an eye blink sensor mounted on the vehicle's dashboard or steering wheel, a microcontroller unit that processes the sensor data and a braking system that applies the brakes when necessary.The eye blink sensor used in this system works by detecting the eyelids' closure and measuring the blink's duration. The sensor sends this information to the microcontroller, which analyzes it to determine whether the driver is drowsy, distracted, or inattentive. If the microcontroller determines that the driver is not alert, it sends a signal to the braking system to apply the brakes, thereby preventing a potential accident.This technology is particularly useful for long-distance drivers, who may become fatigued after hours of driving. The system can also detect distractions such as mobile phone usage or eating while driving, which are common causes of accidents. The Drowsiness of the driver-based braking system is an important advancement in automotive safety technology, as it can potentially save lives and prevent injuries caused by accidents due to driver fatigue or distraction.

Keywords - Drowsiness, Eyeblink Sensor, Braking System, Microcontroller.

I. INTRODUCTION

Vehicle accidents can occur for a variety of causes, one of which is drowsiness (the feeling of being sleepy). Driving while fatigued is a factor in about 30% of collisions. You can tell if a motorist is sleepy by watching how they react. An IR sensor can be used to identify the driver's eye blinks. The driver's eyes are being monitored by the IR camera. An IR sensor will detect ocular closure if the eyes are closed for a specific amount of time. The IR sensor sends information about the eye blinks to the Arduino Board, which controls the gadget. Therefore, the likelihood of a driver becoming sleepy behind the wheel is decreased. The most frequent cause of auto crashes is poor driving. These frequently occur when a motorist is dozing off or under the influence of alcohol. Using an IR sensor, this craft measures and regulates ocular blinking. The infrared waves that reach our eyes are transmitted using an IR transmitter. The reflected infrared photons from an eye are picked up by the IR receiver. When the eye is closed, the IR receiver's output is higher than when it is open. The opposite is true when the eye is closed. To determine whether the eye is shutting or opening, do this. The circuit receives this output to signal the alert. In this endeavor, eye blinking will be used to prevent accidents brought on by being unconscious. The eye blinks here.This particular eye blink sensor is located in a car where anyone loses consciousness and signals through the alert. The eye blinking sensor sends signals to the Arduino, which then relays them to a dc motor that applies the brakes and, after 3 seconds, progressively stops the vehicle.

II. MATERIAL AND METHODS

In the present experimental investigation, the following instruments and methodologies are employed in the different processes as described below:

ESP8266 WIFI Module

An autonomous system of components with an embedded TCP/IP networking stack, the ESP8266 Wi-Fi Module enables any microcontroller to connect to your Wi-Fi network. The ESP8266 can offload all Wi-Fi networking tasks from a

different processor and run a chip of offloading all Wi-Fi networking tasks from a different processors as well running an application. The ESP8266 module is a very affordable chip with a sizable and expanding community. **Fig 1** Shows Photograph of ESP8266 WIFI Module

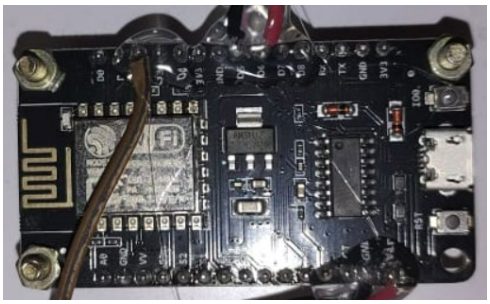

Fig 1. Photograph of ESP8266 WIFI Module

III. PNEUMATIC CYLINDER

By transforming the potential energy of pressurized gas into kinetic energy, pneumatic cylinders apply a force. This is accomplished by the compressed gas's ability to expand on its own without the use of external energy. This ability to expand results from the pressure difference created by the compressed gas's higher pressure than atmospheric pressure. Compressed air can be used to push and pull pneumatic tubes. These cylinders are referred to as double-action cylinders. Some cylinders can only be pneumatically moved in one way. The spring is responsible for the return action. "Single-action cylinders" are cylinders of such a design. A single-action cylinder serves as the expander. The movement of two of the valves from the kit is necessary to turn the cylinder in both ways. According to their name, pneumatic systems use pressurized gases to transfer and regulate power. Since air is a safe, affordable, and easily accessible fluid, the air is frequently used in pneumatic systems as the fluid medium.**Fig 2**ShowsPhotograph of Pneumatic Cylinder.

Fig 2. Photograph of Pneumatic Cylinder.

Solenoid Valve

A solenoid valve is a type of electromechanical valve that canuse with liquid or gas and is regulated by passing electrical current through a coil of wire called a solenoid, which changes the valve's condition. In the case of a two-port valve, the flow is turned on or off; Solenoid valves can have two or more ports. The most commonly used control components in fluidics are solenoid valves.**Fig 3** Shows Photograph of Solenoid Valve.

Fig 3. Photograph of Solenoid Valve.

Relay

A relay is a digitally controlled switch. The current running through the coil of the relay creates a magnetic field, which draws a handle and alters the switch contacts. Because the coil current can be on or off, relays have two switch locations

and are twice-throw switches. Relays allow one circuit to switch to another one that can be entirely distinct from the first. **Fig 4** Shows Photograph of Relay Circuit Board.

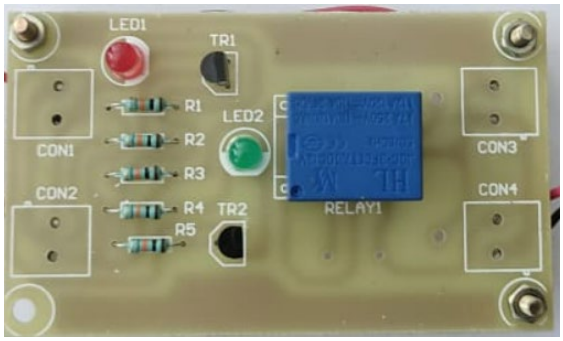

Fig 4. PhotographOf Relay Circuit Board.

DC Motor

A DC (direct current) motor is any type of rotating electrical motor that converts direct current (DC) electrical energy into mechanical energy. The most prevalent kinds depend on the forces generated by induced magnetic fields caused by flowing electricity in the coil. DC motors were the first commonly used motors since they could be fueled by existing direct-current lighting power distribution networks. **Fig 5** Shows Photograph of DC Motor.

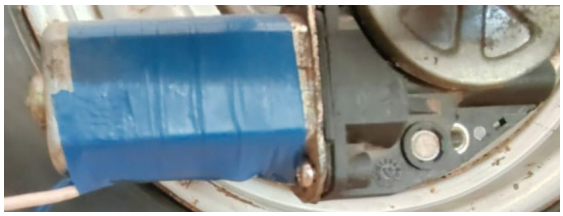

Fig5. Photograph of DC Motor.

SPUR Gear

Spur gears are the most basic and widely used form of gear. Their typical form is cylindrical or circular. The teeth extend radially, and the leading ends of the teeth are parallel to the plane of revolution in these straight-cut gears. These gears will only mesh properly if they are mounted on horizontal shafts. The torque ratio can be calculated by analyzing the force exerted by one gear's teeth on another gear's tooth. Consider two teeth in contact at a location on the line connecting the two gears' shaft axis. The impact will have a radial as well as a circular component. **Fig 6** Shows Photograph Of Spur Gear.

Fig 6. PhotographOf Spur Gear.

Eye Blink Sensor Module

The CNY 70 IR emitter is used in this case. It is a reflective sensor with an infrared transmitter and a phototransistor housed in a lead container that filters visible light. For optimal efficiency, the IR emitter and sensor should be in a straight line. The transmitter sends IR beams into the driver's vision. There will be high production for closed eyes and minimal output for open eyes, depending on whether the eye is closed or open. When the IR emitter sends the beams to the receiver, it conducts because the non-inverting input voltage is less than the inverting input voltage. Now that the comparator's output is GND, the output is sent to the microprocessor.**Fig 7** Shows Photograph of Eye Blink Sensor.

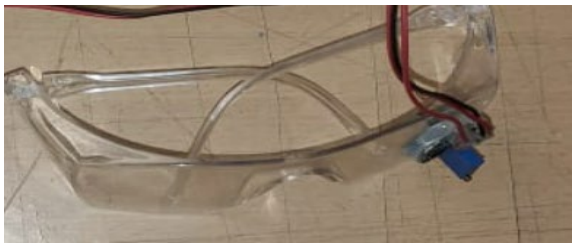

Fig 7. Photograph of Eye Blink Sensor.

Block Diagram of Proposed Method

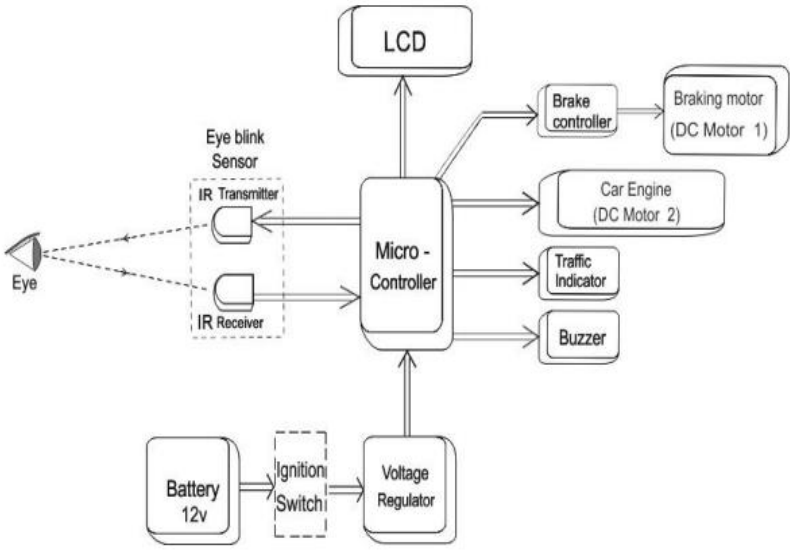

Fig 8. Block Diagram of Proposed Method.

This Safety control system consists of three divided parts there is an eyeblink-detecting part, a Microcontroller part and a Braking Part.The eyeblink sensor part contains the eyeblink sensor and buzzer fitted with the ESP8266 Wi-Fi Module which acts as eye detecting part which detects the driver's eye blink rate which makes the buzzer go on and it made the power supply onto the relay which makes the automatic braking system to applies the brake. The next part is the Microcontroller part which contains the Arduino board, relay, battery for power supply for the circuit and also the motor for the WIFI module for tracking location and also sending signals for applying automatic braking and other part is the braking part which contains the solenoid valve, motor fitted with the tyre, pneumatic cylinder. When the driver worse the eyeblink sensor kit while driving and he supposed to close his eyes for more than 3 seconds then the first buzzer will start to alarm the driver by producing the sound and same fraction of the time this sensor will send a signal to the microcontroller through means of wifi module which made power supply to the relay and the relay switches on to the solenoidvalve which makes pneumatic cylinder to make brake to the stop the motor which controls the vehicle step by step using the stepper motor in the fraction of the time. This WIFI signaling process can also be tracked with the mobile application called BlynkIoT which can able to track the location with the help of a GPS module fitted with the Arduino circuit board here we can also track the timing of the eyeblink rate in the mobile application. This Prototype model can be developed and fitted in Heavy-duty vehicles where drivers used to drive long distances throughout the night time or daytime. This type of sending eyelids frames to the microcontroller is done in a fraction of a second. The frame of the driver's eye is captured every 3 seconds by the eyeblink sensor.These materials are connected with a common wire. The Arduino board is dumped with a C programming language for detecting the eyeblink and emitting the signals.**Fig 8** Shows Block Diagram of Proposed Method.**Fig 9** Shows Photograph of Experimental Setup of Drowsiness Detection and Automatic Braking System.**Fig 10** Shows Photograph of Controlling Unit Circuit.**Fig 11** Shows Photograph of Eye Blinks Capturing an Alarming Circuit.

Fig 9.Photograph Of Experimental Setup ofDrowsiness Detection andAutomatic Braking System.

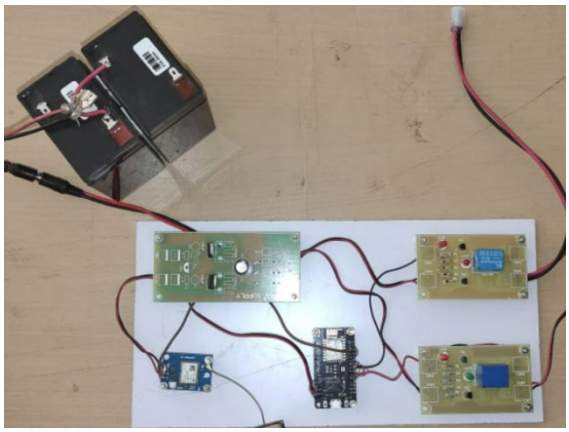

Fig 10. Photograph Of Controlling Unit Circuit.

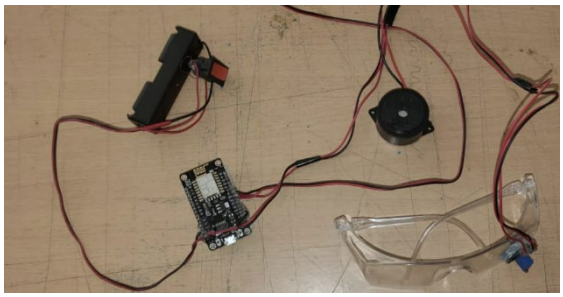

Fig 11.Photograph Of Eye Blinks Capturing an Alarming Circuit.

IV. RESULTS AND DISCUSSION

In this experiment conduct, the eyeblink sensor detects drowsiness using some coordinates as it is called the landmark frames of eyes. These frames are used to detect theface. These frames are captured by the eyeblink sensor and it is graphed by values of six coordinates of the eyes(p1,p2,p3,p4,p5,p6). Here drowsiness was detected by the Eye Aspect Ratio which is used to detect the opening and closure of eyes based on the EAR ratio. When the EAR ratio is greater than the threshold EAR then the eye is considered as open and when it is a letter then it is eyes are closed. Then it sends an output signal to the microcontroller for the actions to be done. It is found that the Vertical coordinates of the face landmark i.e. P1 and P4 had a large impact on determining the closing and opening of the eyes of the Euclidean distance is large then the distance of the coordinates is quite large otherwise it will be less than standard or it will be zero. Graph () shows the EAR ratio for every frame for every 3 seconds. EAR is calculated by the below-given formula.**Fig 12** Shows Photograph Of Coordinates Of Eye.

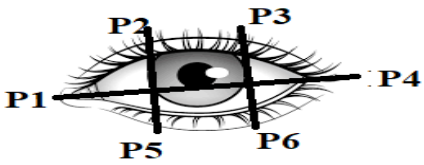

Fig 12.Photograph Of Coordinates Of Eye.

$$EAR= \frac{|(p2-p6)|+|(p3-p5)|}{|2(p1-p4)|}$$

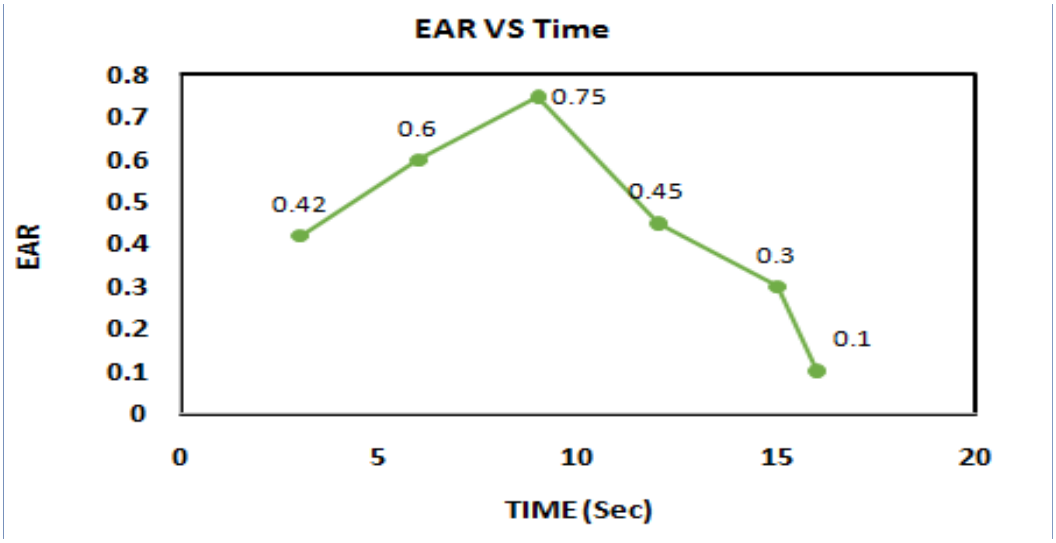

Fig 13. Graph chart of EAR Vs Time.

Fig 13 shows that the experiment EAR ratio increased andin the 18-second EAR ratio fall below 0.2 which is the Standard Threshold EAR ratio. As the EAR ratio is below the threshold frequency it will send the output signal to the module which will get into the braking and alarming system of the vehicle.

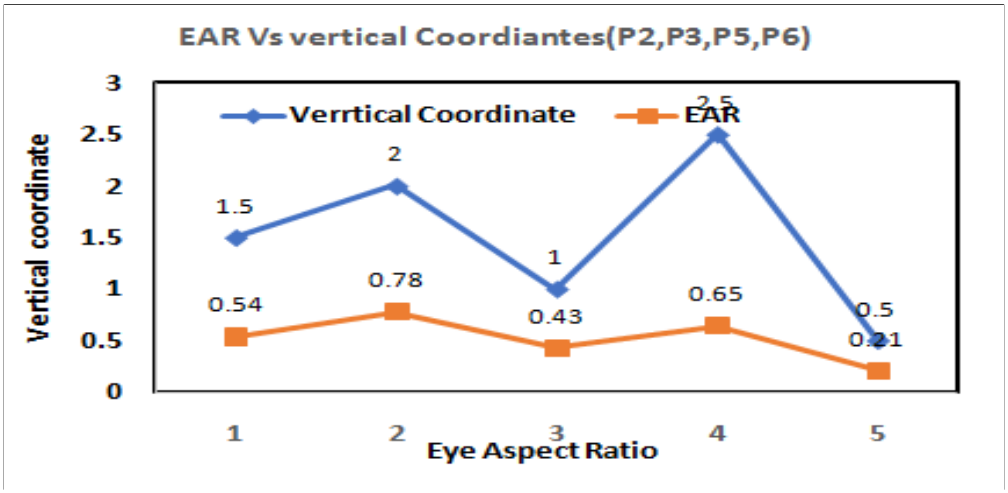

Fig 14. Graph Of Vertical Coordinates Of Eye Face Mark And Eye Aspect Ratio.

In the graph **Fig 14** we can observe that an increase in vertical coordinates causes an increase in the EAR ratio whichis used to detect the blinking of the eye. Vertical coordinates of the eye are related to the eyelids of the eye which

expand and contract when opening and closing the eye. This vertical coordinate had an impact on the EAR ratio when the Horizontal coordinate had a zero impact.

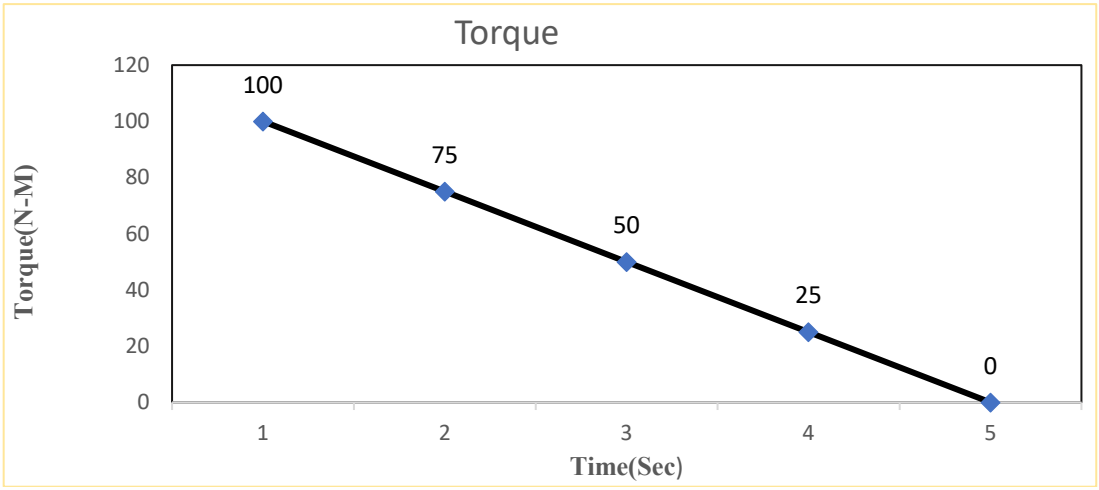

Fig 15. Graph Chart of Torque of motor vs Braking Time.

According to an experiment done When the eyeblink sensor detects the drowsiness of the driver and sends the signal to the signal to the microcontroller. It made the braking system stop the vehicle gradually within 5 secs. The above graph shows the time related to the torque in case of braking the vehicle the torque of a vehicle is considered to be zero as it is in the rest state as shown in the graph of **Fig 15**.From this graph, we can understand that when the drowsiness of the driver is detected, The pneumatic cylinder using a solenoid valve gradually decreases the torque of the vehicle tire in the vehicle experiment setup. This happens in a second of 5 without the sudden application of the brake.When the torque of the Motor gets reduced, then the speed of the vehicle also gets reduced. In this experiment, speed gets reduced for the respective approached minimum distance of 5 metersas shown in **Fig15**.

V. CONCLUSION

The eye blink sensor-based braking system is an innovative technology that has the potential to improve road safety and prevent accidents caused by driver fatigue or distraction. The system uses an eye blink sensor to detect driver fatigue or distraction and automatically applies the brakes in case of an emergency.**Fig 16** Shows Graph of Experimental Speed Vs Speed.

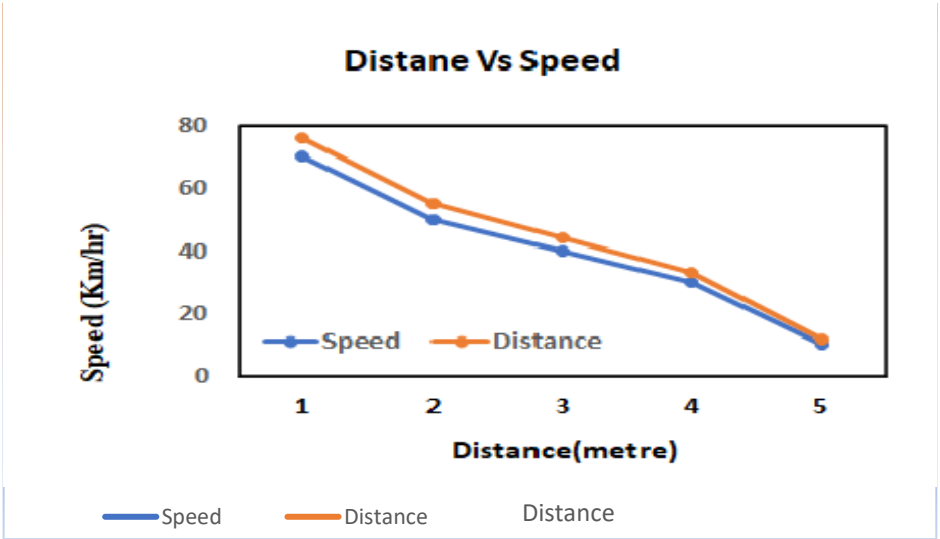

Fig 16. Graph of Experimental Speed Vs Speed.

As we see in the above chart, it represents the comparison of the Distance and Time when the eyeblink sensor senses the eyeblink and braking applicable to the following distance and speed. When the Speed gets reduced the torque of the motor is reduced. The vehicle wants to be braked by reduction of the speed step to step in a certain distance of 5 meters.

In the above, we can understand that the experimental setup of the braking system stops the vehicle by reducing the speed gradually at a certain minimum distance. The technology has several advantages, including improved safety, ease of installation, non-invasiveness, real-time monitoring, reduced stress, and cost-effectiveness. However, there are also potential disadvantages to consider, such as false positives, limited effectiveness, privacy concerns, reliance on technology, and calibration requirements.The eye blink sensor-based braking system has applications in various industries, including the automotive industry, transportation industry, emergency response vehicles, military vehicles, and heavy machinery.Further research and development in this field could lead to more advanced and effective safety features for drivers and passengers.

References

[1]. Srinivasa Chari.V1, Dr.venkatesh P.R2, Dr.Prasanna Rao N.S3, Adil Ahmed S ,"Automatic Pneumatic Bumper And Break Actuation Before Collision", International Research Journal Of Engineering And Technology Irjet Volume: 02 Issue: 04, Pp1015-1023,2015.

[2]. D.Eng. Soo Kim, "Fabrication Of Auto Braking System Using Sensor", International Journal Of Control And Automation, Vol-2, And No1, March, 2009.

[3]. T. Wada, S. Doi, and S. Hiraoka, "A deceleration control method of automobile for collision avoidance based on driver's perceptual risk," 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems, Oct. 2009, doi: 10.1109/iros.2009.5354640.

[4]. D. N. Lee, "A Theory of Visual Control of Braking Based on Information about Time-to-Collision," Perception, vol. 5, no. 4, pp. 437–459, Dec. 1976, doi: 10.1068/p050437.

[5]. J. T. Wang, "An Extendable and Retractable Bumper" 7. Jadhav N. D., Gilmore S.M., Guttulate R.S., Gaikwad A.S., Prof.Fegade S.G. "Automatic Braking with Pneumatic Bumper System" IJSART Volume 1 Issue 5, Pp,2015.

[6]. Katara S.R., Cadlag S.C., Mane P.V., Pawar G.V., Profondes B.C., "Automatic Braking With Pneumatic Bumper System", IJEET, Volume 3, Issue 2,2015.

[7]. Erik, Lotta Jakobsson, Henrik Lind, Magdalena Lineman, "Collision Warning with Auto Brake - A Real-Life Safety Perspective", Volvo Car Corporation Sweden Paper Number 07-0450.

[8]. M. G. Gebreslassie et al., "Evidence-based energy conservation potentials and policy implications in the textile and garment industries of Ethiopia," Energy Efficiency, vol. 15, no. 6, Aug. 2022, doi: 10.1007/s12053-022-10047-8.

[9]. Clay Gabler, Kristofer Kusano, "Research predicts warning, the automatic braking system on autos will help save lives," Virginia Tech Institute, Blackburn, 2012.

[10]. Donald, Kenneth RAgent, Rizenbergs, Traffic accidents, Day versus Night, Research Report 545, Bureau of Highways, Department of Transport, Commonwealth, Transportation Research Board, 1980.

[11]. Eung, "Fabrication of Auto Braking System for Pre-Crash safety," Pusan University of Foreign Studies, Busan, Korea I.J.C.A, 2009.

[12]. Groer C, Simmons I, Couper G, Massie P, Sith B, "Automatic Emergency Braking System, Technical requirements, benefits," Published project Report PPR 227, 2008.

[13]. Dong Guo, T. Fraichard, Ming Xie, and C. Laugier, "Colormodeling by spherical influence field in sensing driving environment," Proceedings of the IEEE Intelligent Vehicles Symposium 2000 (Cat. No.00TH8511), doi: 10.1109/ivs.2000.898350.

[14]. M. Lindman and E. Tivesten, "A Method for Estimating the Benefit of Autonomous Braking Systems Using Traffic Accident Data," SAE Technical Paper Series, Apr. 2006, doi: 10.4271/2006-01-0473.

[15]. Ogawa, Kenji, and Mitsuo Simitian, "A drowsiness detection system‖," Mitsubishi Electric Advance: pg13-16, 1997.

[16]. Yeo, Jung-hack. "Driver's drowsiness detection method of drowsy driving warning system‖, U.S. Patent No. 6,243,015. Pg:55-70, 5 June 2001.

[17]. M. J. Flores, J. M. Armingol, and A. de la Escalera, "Real-time drowsiness detection system for an intelligent vehicle," 2008 IEEE Intelligent Vehicles Symposium, Jun. 2008, doi: 10.1109/ivs.2008.4621125.

[18]. "Research on vehicle-based driver status/performance monitoring: Development, validation, and refinement of algorithms for detection of driver drowsiness," PsycEXTRA Dataset. American Psychological Association (APA), 1994. doi: 10.1037/e526682009-001.

[19]. Ji Hyun Yang, Zhi-Hong Mao, L. Tijerina, T. Pilutti, J. F. Coughlin, and E. Feron, "Detection of Driver Fatigue Caused by Sleep Deprivation," IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, vol. 39, no. 4, pp. 694–705, Jul. 2009, doi: 10.1109/tsmca.2009.2018634.

[20]. L. M. Bergasa, J. Nuevo, M. A. Sotelo, R. Barea, and M. E. Lopez, "Real-Time System for Monitoring Driver Vigilance," IEEE Transactions on Intelligent Transportation Systems, vol. 7, no. 1, pp. 63–77, Mar. 2006, doi: 10.1109/tits.2006.869598.Bernama., et al, ―Real-time system for monitoring driver, Intelligent Transportation Systems, IEEE Transactions on 7.1: pg.63-77, 2006.