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Safety System to Detect Drowsiness of Drivers and Brake Automatically

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Abstract - *The importance of automobile safety has grown by leaps and bounds in the last two decades. Methods to detect and avoid fatal crashes have hence been identified. Drowsy driving is lethal, especially to taxi drivers and drivers of heavy motor vehicles, who cover long routes during nights. These vehicles pose a security threat to the passengers onboard, as well as other vehicles on the road. Our project involves the fabrication of a system which will detect the drowsiness of the driver and if the situation is found to be accident prone, send an electronic signal to the mechanical braking unit which engages the brakes automatically through a pneumatic arrangement. In parallel, the system will alert the driver and also the drivers nearby.*

Key Words: **Drowsiness detection, Raspberry pi, Pneumatic cylinder, Combi-brake, Automobile Engineering**

1. INTRODUCTION

With the increasing popularity of automobiles, the number of road accidents are also increasing rapidly. One major cause of accidents are drowsiness and fatigue of the drivers – especially taxi drivers and drivers of heavy motor vehicles that cover long routes especially during nights. These vehicles pose a security threat to the passengers and the rest of the vehicles on the road.

The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automations. It is therefore important for engineers and technicians to have good knowledge about pneumatic systems, air operated valves and accessories. The project proposes a safety system in which an image processing system involving a webcam and a raspberry pi module detects the drowsiness of the drivers by analyzing the eye blink rate and if the situation is found prone to cause accidents, the system will send an electronic signal to a solenoid valve which operates a pneumatic cylinder which will bring about the braking in automobiles automatically. This can reduce the chances of accidents to a great extent. Simultaneously the system will alert the driver himself and the drivers nearby of the vulnerability of the situation using an alarming system.

1.1 OBJECTIVE

The Fact Sheet published by the AAA Foundation for Traffic Safety [1] lists drowsy driving as one of the major causes for road accidents, and lists the following points:

- 42.4% of drivers have at least one or more days where they get less than six hours of sleep in a typical week.
- The majority of motorists view drowsy driving as a serious or somewhat serious threat to their safety (87.9%) and an unacceptable behaviour (95.2%); yet around 3 in 10 (30.8%) admit to driving when they were so tired that they had a hard time keeping their eyes open at some point in the past month.

It may be concluded that there needs to be a system that can be implemented in most vehicles, which can detect the drowsiness of the driver and bring the vehicle to stop, while making sure that this does not disrupt the regular on-road traffic.

2. METHODOLOGY

Drowsiness detection and automobile braking for automatic vehicles involves two phases of working: detection of drowsiness and subsequent braking. In layman's terms, the working of the project may be summarized thus: a webcam is mounted on the dashboard of the vehicle and is used to monitor the driver continuously. This monitoring is done by the Raspberry Pi computer, which is programmed in Python (V 2.7.9). This system is powered by a 9V battery. Linked to the raspberry Pi system, is a 5V relay, which acts as a switch. The 9V power supply is stepped down to 5V by the use of a 7805 voltage regulator. The Raspberry Pi system detects whether the eyes are closed for more than a particular amount of time – so as to avoid the detection of blinking – and if this condition turns true, sends signals to the buzzer, the LEDs and the relay. Buzzer sounds the alarm for alerting the driver himself and the LED system is used to warn the drivers of other vehicles in the proximity. The signal from the raspberry pi module results in the switching action of the relay – which in turn actuates the solenoid valve. Now the mechanical elements are brought into play. The solenoid valve is connected to the pneumatic cylinder, which gets its input from the compressor.

The signal actuates the solenoid valve which pushes the piston in the pneumatic cylinder outwards. This piston engages the brake pedal automatically. The brake pedal is thereby pushed down. The automobile is thus brought to a stop. The cylinder resets after a short interval, the duration of which is programmed in the Raspberry Pi system. The brake is thereby reset. The combi-brake system is introduced into the existing brake pedal model for coupling

the pneumatic cylinder and the brake pedal. This is done so that pneumatic cylinder piston does not interrupt the normal braking by the driver.

The project may thus be broadly divided into 2 sections:

(i) Electronic System for Drowsiness detection

(ii) Mechanical System for Automobile Braking

2.1 ELECTRONIC SYSTEM FOR DROWSINESS DETECTION

The components of the electronic system include:

a) Webcam

b) Raspberry Pi module

c) Alarming System (buzzers and LEDs)

d) 7805 IC (voltage regulator)

e) Relay

a) Web Cam

A webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When captured by the computer, the video stream may be saved, viewed or sent on to other networks via the internet. When sent to a remote location, the video stream may be saved, viewed or on sent there. In the project, the web camera is used to take pictures of the driver continuously and send it to the Raspberry Pi processor.

b) Raspberry Pi

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. Several generations of Raspberry Pi have been released. All models feature a Broadcom system on a chip with an integrated ARM compatible central processing unit and an on-chip graphics processing unit.

Fig -1: Raspberry Pi

c) Warning System / Alarming System

The warning system aims to alert the driver himself and others nearby of the dangerous situation prevailing. The alarming system is driven by the signal sent out by the raspberry pi module. The system consists of an alarm and LEDs. The alarm sounds when the signal from raspberry pi is received and thus alerting the driver himself to be cautious and take effective measures to prevent hazards. The LEDs are used to alert the nearby drivers of the situation. This would help them to take necessary precautions which would avoid accidents to a great extent.

d) 7805 IC (Voltage Regulator)

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink. 78XX is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost.

e) Relay

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, say, a fan or an electric bulb.

A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. The output section consists of contactors which connect or disconnect mechanically. By using proper combination of contactors, the electrical circuit can be switched on and off.

PART NAME	SPECIFICATIONS
Raspberry pi	Model B - 1GB RAM - 1.2GHz CPU
Battery	9 V
Relay	5V
Camera	1080P, 2MP
7805 Regulator	5 V Output

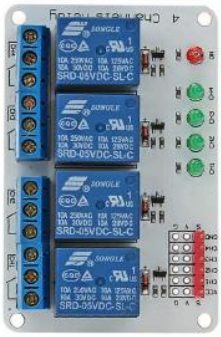

Fig-2: 5V Relay

2.2 MECHANICAL SYSTEM FOR AUTOMOBILE BRAKING

The key components of the mechanical system are:

a) Solenoid Valve

b) Pneumatic Cylinder

c) Air Compressor

d) Brake Pedal

e) Combi-brake arrangement

a) Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.

Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Suiting the requirements of the project, a 5/2 solenoid valve is used, having 5 ports and 2 states. In the said 5 ports, two are used as output ports, connected to the ends of the pneumatic cylinder, controlling its actuation, i.e. controlling the piston movement. One port on the opposite side is used as the input port, receiving compressed air from the compressor. The other two ports act as the exhaust for the exit of compressed air and are hence fitted with silencers.

Fig-3: 5/2 Solenoid Valve

b) Pneumatic Cylinder

Pneumatic cylinders (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Single-acting cylinders (SAC) use the pressure imparted by compressed air to create a driving force in one direction (usually out), and a spring to return to the "home" position. Double-acting cylinders (DAC) use the force of air to move in both extend and retract strokes. They have two ports to allow air in, one for outstroke and one for in stroke. A double acting cylinder is used in the project.

c) Air Compressor

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its engineered upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

A minimum pressure of 2 bar was maintained in the compressor. PU pipes were used to link the compressor to the pneumatic cylinder.

d) Brake Pedal Assembly

Initially the brake pedal was welded onto a stable frame in such a manner that the brake pedal can be pushed without any hindrances. The assembly was done so as to closely resemble the actual situation in an automobile. Frictional brakes are most common and can be divided broadly into "shoe" or "pad" brakes, using an explicit wear surface, and hydrodynamic brakes, such as parachutes, which use friction in a working fluid and do not explicitly wear. When the brake pedal of a modern vehicle with hydraulic brakes is pushed against the master cylinder, ultimately a piston pushes the brake pad against the brake disc which slows the wheel down. On the brake drum it is similar as the cylinder pushes the brake shoes against the drum which also slows down the wheel.

Fig-4: Brake pedal assembly

e) Combi-Brake System

The combi-brake system, actively used in two-wheelers now, was introduced into the Indian market by Honda in 2009 through Honda Activa. Combined Braking System (CBS) means that the brake will act on front and rear wheel together every time the brakes are applied. This technology is designed for 2 Wheelers (Scooters and Bikes). Combined Braking system helps in achieving easier operation while braking. When the rear brake lever is pressed, both front and rear brakes are applied simultaneously. This reduces the braking distance and provides stability to the vehicle which otherwise would have skid in case of sudden application of brakes causing injuries to the rider.

This system was studied and adapted to the needs of the project. Inspired by the existing model under use, it was used to couple the pneumatic cylinder and the brake pedal. A free slot was cut, which enabled the engaging of brake pedal under normal application without getting interrupted by the pneumatic cylinder, and also engaging of the brake pedal by the pneumatic action of the cylinder.

Fig-5: Combi-Brake System

The components constituting the mechanical braking system are:

PART NAME	SPECIFICATIONS
Pneumatic Cylinder	40mm/80mm
Solenoid Valve	5/2 (0.15-0.8 MPa)
Air Compressor	Max Pressure 8 bar
Silencer	X2 Nos.
Flow Control Valve	1/8”
P U Pipe	6mm dia

3. WORKING OF THE SYSTEM

3.1 WORKING OF ELECTRONIC SYSTEM

The webcam is mounted on the dashboard of the vehicle at a suitable distance so that the face and eye blink detection is possible. For practical application, night vision cameras can be used so that eye detection is possible during night times too and lighting inside the automobile will not affect the detection process. The images captured live by the webcam is continuously fed to the raspberry pi processor. The raspberry pi module is programmed in python language and it analyses the blink rate using length of the iris as the parameter.

The processor produces output values corresponding to the input image of the eye obtained. The processor is programmed in such a way that if the output value obtained is corresponding to that of the closed state, the processor rechecks the condition so as to avoid the condition of normal blinking. This is done by providing suitable delay time. If the new output obtained is same as that obtained previously, i.e., that corresponding to the closed condition, the situation is interpreted as that the driver is drowsy and is dangerous for him to continue his driving. In this situation, the output signal of the processor, which was initially preset to high, will become low. This change in the output signal of the raspberry pi processor turns on the relay. The relay used here is the low voltage relay. Hence the output was initially preset to high and when the output from the raspberry pi module becomes low, the relay turns on. The turning on of the relay causes the signal to reach the alarming system and the solenoid valve.

The alarming system consists of a buzzer and LED system. The buzzer unit is used to produce alarming sounds so that the driver becomes aware of the situation and become cautious. The alarming buzzer will be turned off only if the driver opens his eyes. The LEDs are used to alert the nearby drivers of the situation inbound. They too should be aware of the situation and should be cautious so that they can take necessary actions. This will avoid the possibility of the accidents occurring to a great extent. Further, additional equipment can be incorporated onto the system for better effectiveness of alarm.

The battery used for the system is a 12V / 9V battery. The raspberry pi module and the relay operates under 5V. Hence, there is a necessity to reduce the voltage to 5V and to avoid any possible voltage fluctuations. Hence, the voltage regulator 7805 IC is used in the system so as to perform the mentioned function. The voltage regulator 7805 receives high voltage as the input and output obtained will be 5V. The advantage of using a voltage regulator is that only a single battery is required to function all the equipment. The battery used will be that having the maximum rating which is required operate the highest rated component. Subsequent components may be operated at low voltages and these low voltages can be obtained by using the suitable voltage regulators. This avoids the use of multiple batteries. As the system functions in an automobile, the 12V battery of the automobile is sufficient enough to run all the components of the system with the proper usage of the regulators.

Switching on the relay circuit also results in output signal reaching the solenoid valve.

This signal actuates the solenoid valve and mechanical braking system comes into action. This is explained in the subsequent section. A 5V relay can be used for the purpose. On the output from the raspberry pi module reaching the relay, it switches on and completes the circuit containing the solenoid valve and a 12V battery. The solenoid will be actuated by a 12V signal. But it is essential that it is actuated only when the driver is detected as being drowsy. This is achieved by the usage of relay in the circuit. When the driver is detected as being drowsy, the output signal of the processor changes from high to low and this causes the switching action of the relay causing the completion of the solenoid circuitry. This actuates the solenoid valve and the required mechanical action is achieved.

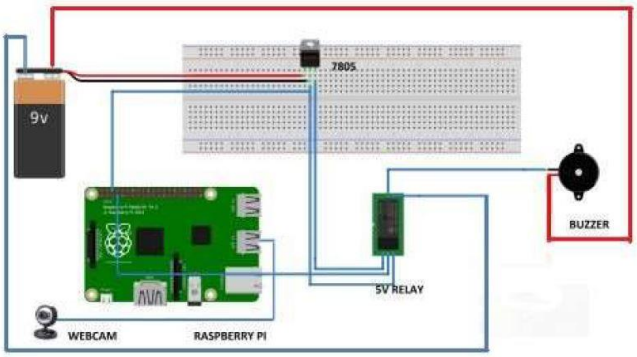

Fig-6: Electrical circuit

3.2 WORKING OF MECHANICAL SYSTEM

The braking is achieved using a pneumatic circuit. Air compressor is used to compress the air and this compressed air is fed to the pneumatic cylinder through a solenoid valve. On idle position, i.e., under normal condition, the compressed air passes through the solenoid valve, reaches the pneumatic cylinder and enters it in such a way that the piston is pushed inwards. In this position the pneumatic system is not engaged and the driver is active.

On the actuation of the solenoid valve by the signal from the raspberry pi module, the solenoid valve switches and the air enter the pneumatic cylinder in such a way that the piston is pushed outwards and this causes the engagement of brakes automatically.

During this time, the air already present in the cylinder is exhausted through the solenoid valve exhaust port. Silencer is attached to the exhaust port so as to avoid the noise produced during the exhaust process. Once the system is re-initialized, i.e., when the driver becomes active, the solenoid is reset to initial condition and the compressed air enters the pneumatic cylinder and pushes the piston rod inwards. During this process, the air already present inside the cylinder is exhausted through the other exhaust port, which is also fitted with the silencer and the pneumatic braking is disengaged.

The use of 5/2 solenoid valve enables the system to work efficiently. 5/2 indicates the presence of 5 ports and 2 states. Out of the 5 ports, 1 is used for the inlet port, 2 for the outlet and 2 for the exhaust purpose. The 2 in 5/2 indicates the two states in which the solenoid can function.

A double acting cylinder is used as the air from the compressor need not be wasted and the air from the compressor is always circulated inside the circuitry. A double acting cylinder alternates cycles of pressurized fluid to both sides of the piston and creates extend and retract forces to move the piston rod, permitting more control over the movement.

Air flow control valves are used to regulate the flow rate of the compressed air into the cylinder. This helps to control the speed at which the piston is pushed outwards and inwards. In effect, the speed of engaging and disengaging of the brakes can be controlled.

P U pipes are used to link the various components of the pneumatic circuit. Inspired from the combi-brake mechanism used in scooters, a similar mechanism can be established at the coupling of the piston-brake pedal interface which ensures free movement of the piston and the interruption of the pneumatic cylinder piston with normal braking is avoided. This allows the engagement of normal brake as well as pneumatic brake together, with each of them not affecting the working of the other. The pneumatic connection is made as per the circuit diagram shown below. The pneumatic circuit diagram clearly explains the flow pattern of the compressed air from the compressor, through the solenoid valve into the pneumatic cylinder.

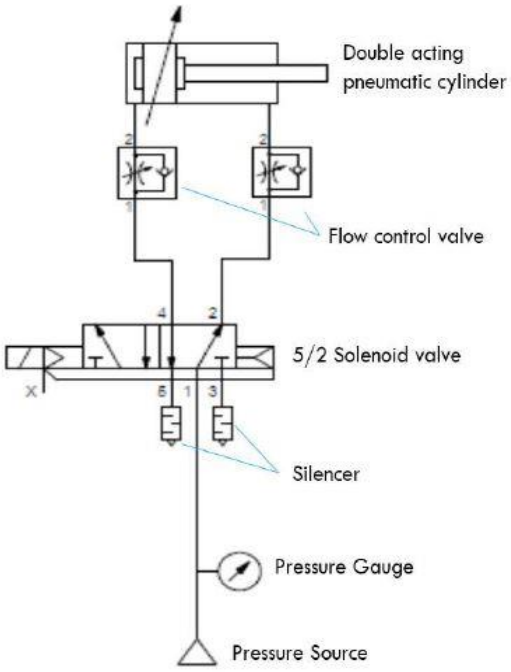

Fig-7: Pneumatic circuit diagram

4. CONCLUSION

Under test conditions, the system was found to work satisfactorily, able to detect the drowsiness of the driver by calculating the length of the iris. This was carried out with

4 different people and each time the detection was found to be good. Mechanically applying the brakes was not an issue as the piston successfully engaged the brake pedal through the Combi-Brake arrangement when the signal was received.

The Combi-Brake arrangement facilitated the manual application of the brake pedal without the interference from the pneumatic cylinder arrangement. After resetting the brakes after 7 seconds, it was seen that if the driver is still asleep, the brakes' action is repeated.

There were slight issues with the processor speed, but this can easily be solved by using a better processor – one of more capability and speed, for example, by using the Beaglebone, instead of Raspberry Pi.

Observed results from the experiment may be summarized as follows:

i. A distance of 0.35m was found to be the optimal distance for drowsiness detection.

ii. A time period of 5 seconds was found to be sufficient for the proper action of brakes in the experiment carried out.

iii. A total time period of 7 seconds was found to be sufficient for the system to successfully reset and carry out actions for the next set of readings.

iv. The Combi-Brake arrangement facilitated the manual application of the brake pedal without interfering with the pneumatic cylinder arrangement. Also, engaging the brake pedal by the pneumatic cylinder through the Combi-Brake system was successful every time.

For obtaining more accuracy in the detection of drowsiness, other advanced techniques may be used to form algorithms, for example, based on steering angle, pedal force, vehicle speed and acceleration as inputs. Currently more researches are taking place in this field.

For the real time application, the project may be installed by modifying the existing model of braking in automatic vehicles – this is by addition of an external, additional provision which includes the pneumatic cylinder and air compressor, or some provision to get compressed air from within the engine. Commercialization would require the use of better versions of the parts under use – including solenoid valves and compressors.

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REFERENCES

[1] AAA Foundation for Traffic Safety – Fact Sheet- April 2018

[2] Eugene Aidman, Carolyn Chudanow, Kayla Johnson, John Reece. (2015) Real-time driver drowsiness feedback improves driver alertness and self-reported driving performance, April 2015 Accident Analysis and Prevention.

[3] Javed Ahmed,Jian-Ping Li,Saeed Ahmed Khan, Riaz Ahmed Shaikh (2016), Eye behaviour based drowsiness Detection System, IEEE Xplore: 20 June 2016.

[4] Jibo He, William Choi, Yan Yang, Junshi Lu, Xiaohui Wu, Kaiping Peng. (2017) Detection of driver drowsiness using wearable devices: A feasibility study of the proximity sensor. February 2017 Applied Ergonomics.

[5] Jose Solaz, Jose Laparra-Hernandez, Daniel Bande, Noelia Rodriguez, Sergio Veleff, Jose Gerpe, Enrique Medina. (2016) Drowsiness detection based on the analysis of breathing rate obtained from real time image recognition, 6th transport Research Arena April 18-21, 2016.

[6] Pia M Forsman, Bryan J Vila, Robert A. Short, Christopher G. Mott, Hans P.A. Van Dongen (2012), Efficient driver drowsiness detection at moderate levels of drowsiness, May 2012 Accident Analysis and Prevention

[7] Tianyi Hong, Huabiao Qin (2008), Drivers drowsiness detection in embedded system, IEEE Xplore: 25 February 2008

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