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Smart Helmets : Vehicular Safety using Wireless Sensors

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***Abstract*—one major challenge in the area of active safety for two wheeler vehicles are smart helmets. The proliferation of two wheeler vehicle road accidents is evident all throughout the world; in India around 1.98 lakh people die annually due to road accidents, according to a report of the National Crime Records Bureau (NCRB). Through our project, we look to mitigate the probability of the deaths caused in two wheeler vehicle accidents. In this project, we proposed a WSN based solution which restricts the driver to wear a helmet while riding a two wheeler vehicle. Current solutions include smart helmets, which are expensive and use high level Artificial Intelligence and heavy infrastructure. However, in our solution, only tiny low cost sensors were deployed, which could then be used to detect the presence of helmet on the rider's head. Communication between the sensors and the vehicle was achieved using Bluetooth connectivity and through a simulator called Arduino. To ensure that the correct helmet is paired, authentication was done using NFC tags. It can also serve as an alternative solution for unsophisticated vehicles, which are not equipped with onboard computers and cannot take advantage of the current Intelligent Transportation System and Services. To illustrate the basic idea of our system, we primarily focus on authenticating the helmet in order to start the vehicle.**

Keywords— Human Safety; Helmet; Arduino; Bluetooth Connectivity; Two Wheeler Vehicle; Road Accidents Component; Pressure Sensor

I. INTRODUCTION

Invention of automobiles by mankind was one of the greatest commercial inventions in the past century, which has contributed to the nation's growth widely. Amongst these inventions, one such invention is "two wheeler vehicles". However, we cannot ignore the number of casualties due to these automobiles, in which tens of thousands of people lose their lives or suffer life changing accidents. Causalities in traffic accidents are mainly caused by collision of vehicles, and the loss of life is due to the lack of safety gears. This paper does not suggest how to avoid road accidents, but a model which makes it mandatory for the two wheeler vehicle rider to wear the safety gear (helmet) while riding. This might help in avoiding the loss of life after experiencing a concussion in an accident. Our model consists of a helmet which comprises of a pressure sensor on the inner side of the helmet, and a Bluetooth module attached to an Arduino like microprocessor. On the two wheeler vehicle vehicle, another onboard Arduino module is attached with a Bluetooth module.

Once the helmet is worn by the rider, the pressure sensor senses a specific pressure and sends the data via the Bluetooth module on the helmet to the onboard module on the two wheeler vehicle. The data received from the helmet is computed and on the basis of these computations, the engine of the two wheeler vehicle can be started. If the pressure sensor fails to send the adequate data to the module, the engine of the two wheeler vehicle would not start.

II. LITERATURE SURVEY

A. Arduino Uno

Arduino is an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. It is a tool that makes the computers to sense and control the physical world. Taking inputs from a variety of switches or sensors, controlling of variety of lights, motors, and other physical outputs can be achieved which can be used to develop interactive objects. Projects of Arduino can be communicating with software running on the computer (e.g. Processing, Max MSP, and Flash) or can be stand-alone. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. In this research work Arduino UNO has been utilized. It has 14 digital I/O and 6 Analog I/O pins. It works on +5volts DC, 10 bit analog to digital converter and 14kb ROM. Fig.2 shows the image of an Arduino UNO controller. Table 1 shows the specifications of the microcontroller. [3][5][6]

1. Digital Input / Output
   Digital input / output works with binary values 0 and 1, in some sources referred to as Low and High value. Logical 0 corresponds to 0 V and logical 1 corresponds to 5 V. Some older versions of Arduino (for instance one of the Pro or Mini Pro versions) have logical 1 corresponding to 3.3 V.

2. Analog input
   Analog input of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [5]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V

3. Analog output
   Analog output of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [5]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V.

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4. Specification [5]:

- Microcontroller: ATmega328P
- Input Voltage (*recommended*): 7-12V
- Operating Voltage: 5V
- EEPROM: 1KB
- Input Voltage (limit): 6-20V
- PWM Digital I/O Pins: 6
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Weight: 25g
- Analog Input Pins: 6
- DC Current per I/O Pin: 20mA
- Length: 68.6 mm
- DC Current for 3.3v Pin: 50mA
- SRAM: 2KB
- Flash Memory: 32KB (ATmega328P)
- Clock Speed: 16 MHz
- Width: 53.4 mm

B. Bluetooth HC-05 Module

This Bluetooth device is a trans-receiver and works as TTL. This Bluetooth module can send and receive data simultaneously. It is a 3.3V and 5V module and can be used in master mode as well as in slave mode.

This module consists of 6 pins. The six pins are GND, VCC, RX, TX, KEY, and STACK. The GND stands for the ground pin and gets connected to the GND pin slot on the Arduino. VCC pin powers the module with 5V. RX stands for the receiver pin. TX stands for transmitter pin. KEY pin is a special pin which is used when the module is programmed and gets connected with the 3.3V slot on the Arduino. STACK pin is used when the Bluetooth module needs to get connected to multiple modules one by one. [3] The Reset button can be used to reset all the setting of this module.

This module can operate in 2 modes:

Mode-1: In this mode the module acts like a slave that waits for connection from other modules. It is also called as the Slave mode.

Mode-2: In this mode the module acts like a master and establishes the connection with any other module with which it wants to get connected. It is also called as the Master mode.

Fig.1. HC-05 Bluetooth Module

C. Pressure Sensor

Force Pressure Sensor is used in the model. This sensor is used to sense the force pressure in new mobile communication model introduce by APPLE Inc. in their latest device the I Phone 6S and I Phone 6S Plus.

This is a small force sensitive resistor which has a 0.16" (4 mm) diameter active sensing area. This FSR will vary its resistance depending on how much pressure is being applied to the sensing area. The harder the force, the lower the resistance [4]. When no pressure is being applied to the FSR, its resistance will be larger than 1Mê. When full pressure is applied the resistance would be 2.5kê. Two pins extend from the bottom of the sensor with 0.1" pitch making the bread board friendly. These sensors are simple to set up and great for sensing pressure, but they aren't incredibly accurate. [7] Dimensions: Overall length: 1.75" Overall width: 0.28" Sensing area: 0.3".

Fig. 2. Force Pressure Sensor

III. PROBLEM STATEMENT

To develop problem solving abilities for Vehicular Safety and to implement intelligent safety system for two wheeler vehicle vehicle in order to identify and authenticate the presence of helmet on Riders head. This model will make sure the riders wear helmet mandatorily while riding a Two wheeler vehicle.

IV. MOTIVATION

The innovations like automobiles have profited the nation in many ways, but also affected the society in negative sense as well. As per the National Crime Records Bureau in India, till date there have been reports for 1.9 lac deaths caused in Two wheeler vehicle accidents per year.[4] With vast technology available to us in today's scenario we are still not able to protect human lives. The proposed model will enable us to avoid the above figures recorded by the NCRB and also reduce the deaths caused due to Two wheeler vehicle accidents.

The reliable technology like Bluetooth communication plays an important role in this design, as it is used to send the data measured by the force pressure sensors, which in return enables the engine of the two wheeler vehicle to start.

V. ARCHITECTURE

Shown below are the two blocks, each represents a model. First model is deployed on the two wheeler that is a motorbike and that model is wired to the kill switch of the motor bike. Now the other model is deployed on the safety gear that is the helmet. First model is powered by the Two Wheeler battery and the second model uses portable battery like power.

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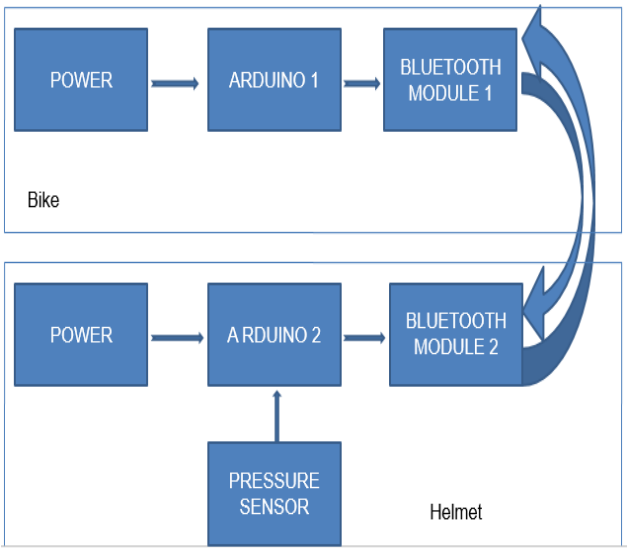

Fig. 3. Architecture

VI. MATHEMATICAL MODEL

Let S be the sample set,
S = {X, Y, I, F, DD, NDD, success, failure}
Where,
X = {X1, X2, ...,Xn} where X is the set of all inputs
Y = {Y1, Y2, ……, Yn} where Y is the set of all outputs
I = initial state
F = final state
DD = Deterministic Data
NDD = Non-Deterministic Data
DD: {Helmet, Sensor nodes, Bluetooth connection}
NDD: {Types of Data sent by the sensors, working of the two wheeler}
I = helmet with sensor
X = {X1, X2}
X1 = Input from the sensor placed in the helmet to Arduino
Y = Bike starts
F = Function used to match the value of sensors with pre-defined condition.
Success = Bike starts
Failure = Authentication invalid, sensors not detected, Bluetooth connectivity issue

The State Transition diagram supporting our mathematical model is shown below:

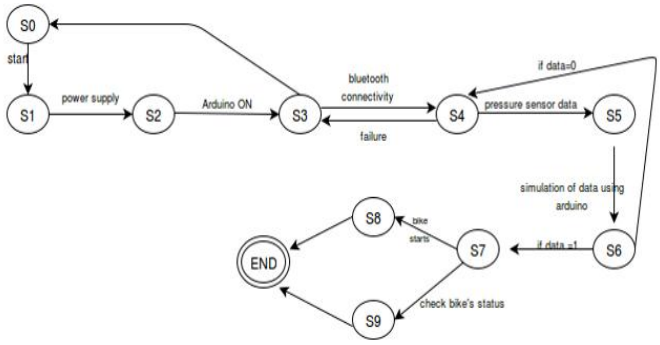

Fig. 4. State Transition Diagram

VII. FUTURE SCOPE

1. Authentication using NFC. The Bluetooth pairing would be done using NFC tags, this will enable the rider to pair any helmet with the second model deployed on it to the model on the two wheeler.
2. We can implement the hands free system on our model, enabling the rider to use very basic mobile phone wirelessly.
3. Implementation of indicators on the helmet. We would like to add indicators on the helmet that will work in sync with the indicators of two wheeler

VIII. CONCLUSION

A majority of victims of road traffic injuries are men in the age group of 12-44 years and belong to the poorer sections of the society. Also, a vast majority of those killed and injured are pedestrians, motorcyclists and pillions riders, and bicyclists. 70 percent of the people riding two wheelers in India avoid wearing helmets while riding, which causes accidental deaths. So, we have proposed a model which restricts riders to wear helmets while riding.

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