Voice Controlled Wiper for Smart Helmets

Santhosha Rao

Abstract: Intelligent transportation system is one of the major focus in today's era. Several sensor integrated devices and unmanned autonomous vehicles, not only enhance the comfort of drivers but also help in safe driving. Specifically, for motorcyclists, helmets embedded with sensors are lifesaving gadgets. Researchers have focused on developing low power low cost smart helmets to prevent road accidents. However, the existing smart helmets are not season friendly. This paper proposes an extension for smart helmets that can assist riders to ride the motorcycle with great ease during heavy rains. The hardware unit consists of wiper integrated to helmet which turns ON and OFF based on the voice commands issued by the motorcyclists.

Keyword : Alexa Echo Input, NodeMCU, servo motor, sinric.

I. INTRODUCTION

Technological advancements and proliferation of Internet of Things (IoT) is transforming every device into smart. This has increased our ease of living with minimal cost. Intelligent Transportation System, building smart cities and smart healthcare devices are perfect epitome in this regard. India, the country enriched with its greenery witness's diverse and extreme climate conditions throughout the year. However, heavy rainfall in monsoon season hinders the people to commute from one place to another. At times, it leads to fatalities and huge traffic jam. According to the survey from Ministry of Transportation, approximately 17 deaths occur every hour by road accidents. It is daunting task to ride on motorcycle during rainy season. So, this paper proposes a voice recognition module extension to the smart helmets that can be used to turn ON and OFF the wiper mounted on the windshield. Wearing such a smart helmet not only improves the visibility of streets, but also ensures safety of the motorcyclists. For the voice recognition, a generic voice recognition module or popular Amazon Alexa Echo Input module could be used. The paper considers both the design approaches. NodeMCU ESP8266 is used as the microcontroller and servo motor attached to it is used to drive the wiper. In case of Amazon Alexa based voice recognition module, rider's Android mobile is configured as Wireless Access point to enable the wireless communication between Alexa and NodeMCU. It is also used to access Alexa skills from the Amazon cloud.

II. RELATED WORKS

Michele Magno et.al [1] introduced a smart helmet which consists of low power sensors and Bluetooth integration module. The authors propose dual power back up to increase the durability of the hardware unit. This serves as an excellent safety critical intelligent gadget for motorcycle riders.

Authors in [2] propose a helmet that could sense the driver's head movement and control the headlight of the bike. Head-up display unit as described in this paper eliminates driver's distraction while checking the dashboard. Further, to assist the navigation of riders, Helmet Mount Display is implemented. According to the authors, the helmet is also integrated with an additional feature to send the emergency notifications using GSM module.

With the increasing number of senior citizens riding two wheelers, a hazard warning helmet is introduced by Yu-Hsiu Hung et.al [3] specifically for the scenario where the scooter users might attempt to pass through double parked vehicles. Ultrasonic sensors are mounted on the helmet and LEDs are lit to provide visibility to some extent. The sensors report to the Arduino Uno microcontroller which in turn alerts the motorcyclist. The main motive of this paper is to assist senior citizens who are using two wheelers by sensing the presence of obstacles from the area which is not visible for the rider directly. This set up is validated through experiment and authors convey that their proposed approach has enhanced the comfort and convenience of riders.

Helmet is used by underground mining laborers for safety purpose. It is essential to make these helmets smart enough for real time environment monitoring. Mayank sharma et.al [4] have attempted to throw light in this direction. According to their proposal, smart helmets are embedded with a wireless sensor network. These sensors monitor the environment for various parameters like harmful gases and alerts the person when there is a life threatening condition in the environment. The hardware of such a safety gadget includes temperature and humidity sensors, methane gas sensor and Zigbee module to transmit the signals wirelessly. It is definitely a cost effective low power solution. However, if these are season friendly it would further elevate the benefits.

Another motor cycle driving assistance approach is proposed by Muthiah M et.al [5]. This paper proposes a novel model to increase the visibility of the riders during heavy rain or snowfall. The helmet is to be integrated with accelerometers which senses the direction of movement of the rider automatically. Based on the direction of motion, the intensity of the headlight is monitored in the direction of movement. Arduino board is used as controller and RF transmitter module is used to send the signals. In addition to the headlight circuit, there is a buzzer to alert the rider about any emergency conditions. This approach necessitates the accelerometer module to accurately detect minor head movements of the rider and sensibly send the trigger signals.

There are several research works to proactively respond to the emergency situations like accidents and severe fatalities. One such method is discussed in paper [6]. Detection of accident or emergency situation is done using pressure sensors integrated with Arduino board. The navigation system automatically accesses

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the location and alters the concerned personnel using GSM module and voice calling facility. However, this approach may lead to higher false positives and false negative accident identification system.

Alternatively, a better approach is proposed by Sreenithy Chandran et.al [7]. According to this, an accelerometer senses the variation in speed of the bike and then GPS module is activated based on the situation. WiFi enabled module and cloud enabled infrastructure leads to dependency on the internet availability and also compromises the power backup of the overall circuit set up. As a result, solar panel backup might be needed to energize the circuit.

The authors in [8] design a smart helmet system such that motor cycle would not start without the rider wearing the helmet. The helmet is connected to vehicle key ignition system which will be electronically controlled. The smart helmet has a proximity sensor fitted inside it, which will act as a ON/OFF switch for ignition. Nevertheless, with wireless connection, the helmet sensor circuit will be connected to the vehicle ignition system.

Aditi Varade et.al [9] also design a helmet which makes the rider compulsorily wear the helmet. If the person meets with an accident, then a message along with the location would be sent to the ambulance or family member.

Based on all the above discussed literature, it is evident that no significant contribution is made to develop a season friendly smart helmet. This research gap has been identified and a solution is proposed in this paper using low power voice recognition module and wiper. This module could be used as an extension to the existing smart helmet technologies reported in the literature.

III. SYSTEM MODEL USING GENERIC VOICE RECOGNITION MODULE

The system model is depicted in Fig. 1. It consists of a NodeMCU microcontroller interfaced to a voice recognition module and servo motor. NodeMCU is an open source LUA based firmware developed for ESP8266 WiFi chip. The ESP8266 is a low-cost WiFi chip developed by Espressif Systems with TCP/IP protocol. It has Arduino like analog and digital pins on its board. It supports serial communication protocols such as UART, I2C, SPI using which it can be connected to serial devices like LCDs, OLEDs, sensors etc. It can be programmed using Arduino IDE. The voice recognition module is used to record and detect the voice. Whenever the words uttered by the user matches with prerecorded voice data, the module sends corresponding codes serially to the NodeMCU. Based on the codes received from the voice recognition module, the NodeMCU can turn ON and OFF the servo motor.

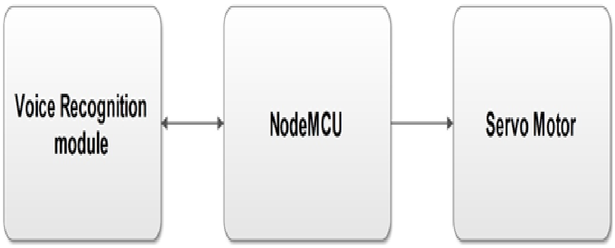

Fig. 1.System model using generic voice recognition module

The first and foremost requirement is the configuration of the voice recognition module. The module is capable of receiving and responding to the configuration commands through serial port interface. This module can store 15 pieces of voice instructions. The maximum length of the voice command that can be recorded using this module is 1300 ms. Those 15 pieces are divided into 3 groups, with 5 in one group. The voice instructions should be recorded group by group. The intended voice group should be imported by using a serial command before recognizing the voice instructions within the group.

In order to record the voice, the voice recognition board is to be connected to a windows computer using a USB to serial adapter module as shown in the Fig. 2. The Accessport serial tool is installed in windows computer to serially send the commands to the module.

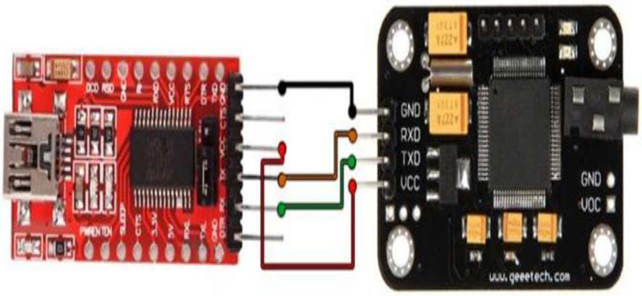

Fig. 2.USB to serial adapter connection to configure the voice recognition module through Windows computer

The snapshot of the Accessport serial tool is depicted in Fig. 3. The first voice command can be given whenever the START message is displayed in the GUI of the serial tool. After this, for the two subsequent AGAIN messages, the same voice command should be repeated. If the voice commands match, the FINISHED ONE message is displayed. This is the indication that the first message is recorded successfully. Using the same method, the subsequent 4 voice commands of the group can be recorded. After the successful recording of all the messages, GROUP1 FINISHED message is displayed.

After successfully recording the voice commands, the module should be configured in compact mode to recognize the voice. This can be activated by sending command bytes 0xAA and 0x37 serially to the module. The recorded group1can be imported by sending the command bytes 0xAA and 0x21 serially. At this time, if the spoken command matches with any one of the stored voice commands, the module returns the corresponding code byte serially. i.e. if the command matches with the first stored voice command, then 0x11 is returned. If the command matches with the second stored command, then 0x12 is returned and so on.

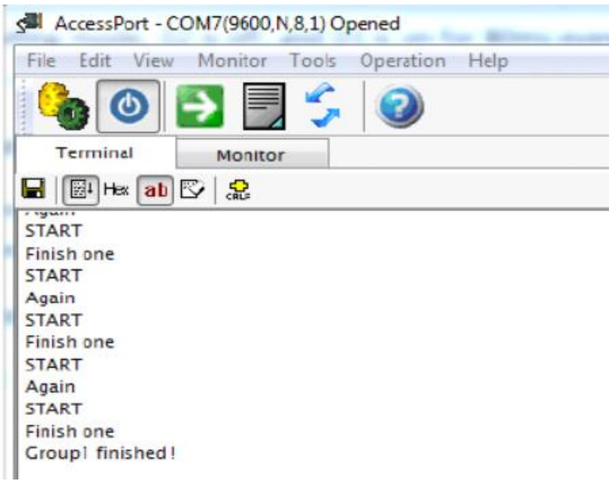

Fig. 3.Snapshot of the Accessport serial tool

The voice recognition module requires 5 volts supply voltage whereas NodeMCU requires 3.3 volts. This is the reason why TxD and RxD lines of these modules cannot be directly connected. A voltage level shifter is used to mitigate the problem of incompatible voltage levels. The TxD line of the voice recognition module is connected to the RxD line of the nodeMCU through a level shifter which converts 5 volts signal to 3.3 volts and the TxD line of the NodeMCU is connected to RxD line of the voice recognition module which converts 3.3 volts signal to 5 volts signal. The connection between NodeMCU and voice recognition module is depicted in Fig. 4. A servo motor is basically used to precisely control angular rotation and its angular rotation is controlled by applying a PWM waveform to it using PWM capable GPIO pin of NodeMCU.

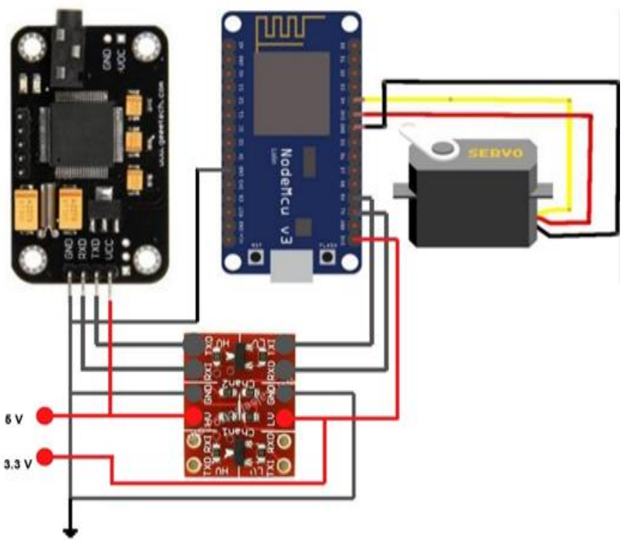

Fig. 4. Connection between NodeMCU, Voice recognition module and servo motor

IV. SYSTEM MODEL USING AMAZON ALEXA ECHO INPUT

As depicted in the Fig. 5, the smart helmet is designed using Amazon Alexa Echo Input, NodeMCU and Servo Motor. The Android mobile phone of the motorcyclist configured as Wireless Access Point facilitates the communication between Alexa and NodeMCU devices. Amazon Alexa Echo Input is initially configured using Amazon Alexa Application installed in the mobile. The application also helps in accessing the necessary skills from the Alexa Cloud.

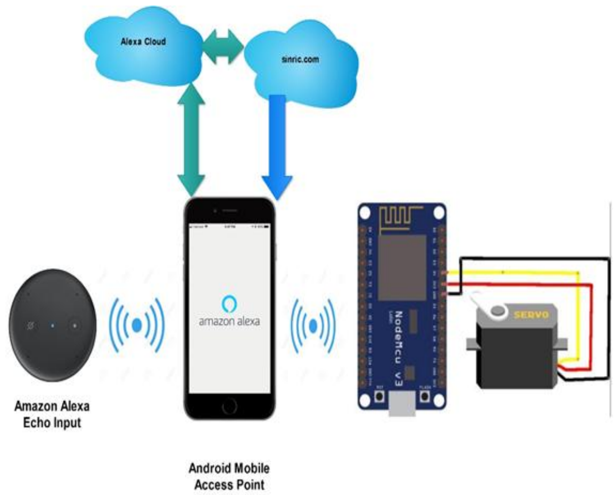

Fig. 5.Communication beween Alexa Echo Input and NodeMCU

The voice command "Viper ON" would turn the Viper ON by generating the PWM waveform on the GPIO pin connected to the servo motor and the voice command "Viper OFF" would turn the Viper OFF by sending logic LOW. To facilitate this communication between Alexa Echo Input and NodeMCU devices, it requires an Amazon skill known as sinric. This skill can be used by creating an account in the website sinric.com. After logging into the account, a new smart home device can be created by adding Add Smart Home Device button. A unique API key is also generated for this newly added device.

The sinric code from Github [10] is to be installed in NodeMCU to control the sinric device connected to it through Alexa voice commands. To run this code in Arduino IDE before downloading into NodeMCU, two more libraries namely deviceWebSocketsClient.h and ArduinoJson.h library are also installed. The API key obtained earlier is used as the deviceId in the turnON() and turnOff() functions as shown below:

```
void turnOn(String deviceId)
{
  if (deviceId == "xxxxxxxxxx") // Device ID
  {
   digitalWrite(device1,HIGH);
  }
void turnOff(String deviceId)
{
  if (deviceId == "xxxxxxxxxx") // Device ID
  {
    digitalWrite(device1, LOW);
  }
```

After successfully downloading the sinric code to NodeMCU, the sinric skill is enabled in Alexa application and Alexa is asked to discover the devices. The connected device and its STATUS can be seen in Fig. 6 and Fig. 7 respectively.

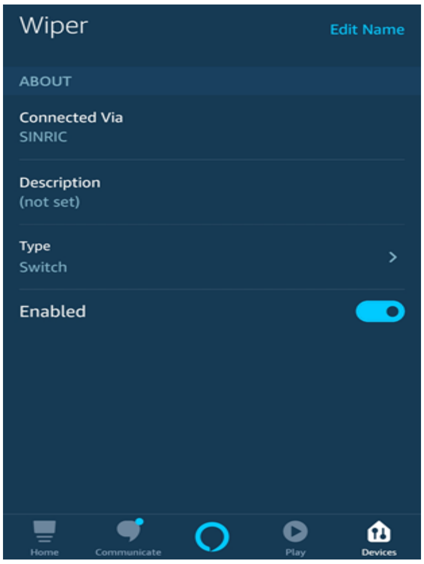

Fig. 6.Wiper connection to Alexa through sinric

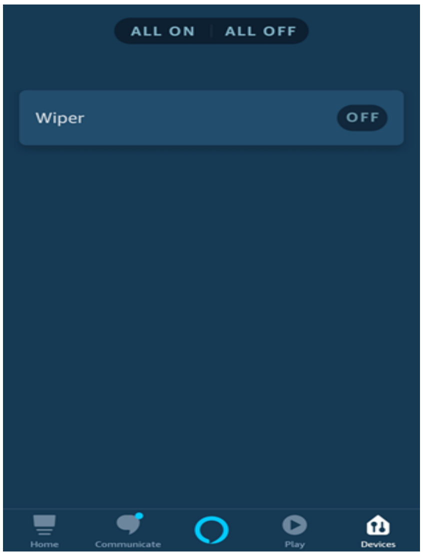

Fig. 7. Status of the Wiper based on the voice command

V. RESULTS AND DISCUSSION

The system designed using generic voice recognition module is very inexpensive and easy to deploy. It is also found to be speaker dependent most of the time. i.e. the person who recorded the voice should be the target user of the system. Also, the system is less responsive in noisy environments. The reason for this is attributed to the poor quality microphone of the voice recognition module. Use of good quality microphone could solve the problem. Though the system designed using Amazon Alexa Echo Input is slightly more expensive, its speaker independence and responsiveness in the noisy environment makes it a suitable choice for the design.

VI. CONCLUSION AND FUTURE SCOPE

The paper proposes a voice controlled wiper extension to the smart helmets to make it smarter and season friendly. The system design using a generic voice recognition module and Amazon Alexa Echo Input are proposed. The proposed system could be combined with existing smart helmet technologies reported in the literature. Though the system design is currently limited to wiper, the features such as voice controlled air conditioner within the helmet, voice controlled helmet mounted indicators, voice controlled navigation etc. can be integrated with the additional modules connected to the NodeMCU.

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Santhosha Rao is currently working as Associate Professor in the Department of Information and Communication Technology, Manipal Institute of Technology, MAHE, Manipal, India. His research areas are Cross Layer Design, Energy Constrained Wireless Networks, Internet of Things. He has around 20 years of teaching experience.

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