Implementation of Smart Helmet using IoT and NLP

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Abstract: Presented paper discusses the project flow and stepwise implementation of the smart helmet system using the technologies like IoT and NLP. Peripheral sensors such as; vibration sensor, alcohol sensor, RFID are used to incorporate functionalities like accident detection, and drink & drive avoidance, also to make sure user carries the helmet in every bike ride. Python v3.8.1 is used as coding language for programming the voice assistant and navigation module. Java has been used as a means for designing server-client API's. Interfacing of circuits is done using Embedded C and predefined NLP libraries are used to enforce VUI.

Index Terms **- IoT (Internet-of-things), NLP (Natural Language Processing), VUI (Voice-user-interface), Embedded C, JAVA, Python v3.8.1, vibration sensor, alcohol sensor, RFID.**

I. INTRODUCTION

Today's fast paced and exploring era, lot of people are relying on mobile devices for many tasks such as calling, message reading, navigation etc. It has been seen that over the years people are getting attracted towards the fad of journeying to distant places on bikes, and they are completely relied on mobile devices, major purpose being navigation. The biggest catch with using mobile or similar devices during driving is that, to look at the directions or to receive calls, texts, etc., the rider must stop their bike and look at the device and then continue riding. Sometimes they don't even bother stopping and check their mobile device while riding the bike, which in many cases causes distraction and accidents. With the ever-growing danger of distracted driving related incidents, it became clear that we need a solution to this problem of distraction and time wastage, we needed a solution that might help us use our mobile functions effectively, be less distracting and also will not require the rider to stop to check their device every time. Taking account of above problems, our goal was to increase safety for motorcyclists and prevent dangerous accidents, while still maintaining a good user experience. Whenever the safety of motorcyclists come into picture, the first thing that pops up in the mind is a "Helmet". A protective shell that is meant to protect our head from potential injuries in any unfortunate incident. Many a times people find it tedious and clumsy to wear a helmet, jeopardizing their safety. Hence, came the idea of combining

Mobile applications with the Helmet to have a hassle-free mobile system on voice command that will not cause any distractions and along with it will also propagate the use of helmet. The Internet of Things (IoT) will give associate degree infrastructure that integrates the services with situational responses, and conjointly permits mutual communication between devices and individuals over a network. Thus, we came up with this plan of IoT based helmet that ensures the safety of the rider while riding.

II. RELATED WORK

In the method of literature survey, we tend to have found a heap of sensible helmets with completely different approaches and with different methodologies. C. J. Behr et al [1] had planned a sensible helmet for mining trade so as to spot dangerous event detection and air quality. this technique will establish the concentration level of the harmful gases like CO, SO2, NO2, associate degreed material by utilization electro chemical device and additionally detects the removal of Helmet by utilization an IR device. It additionally identifies associate degree incident once miners square measure affected by associate degree object in contradiction to their head with a high force extraordinary a price of a thousand by utilization the pinnacle Injury Criteria. associate degree measuring device was accustomed calculate the acceleration of the head once hit and the HIC was calculated in software package.

Elizabeth et al [2] had developed a sensible helmet device for sleuthing and reportage bike accidents. sensible helmet system includes of numerous sensors, and it establish the accident by evaluating uneven or irregular variations obtained from device system, and a trigger can be sent to electronic device Duty from the microcontroller. Electronic device Duty can then trigger a decision to the phone range registered by the driver. If the driver will not respond to it for an amount of five minutes once the 1st decision is initiated, then the emergency contacts can be sophisticated with the details regarding the accident. The emergency contacts can be alerted through text message, e-mail, and phone decision till they acknowledge the incident. In real time, this system assures a reliable and fast delivery of knowledge about the accident. Rashmi Vashisth et al [3] had planned a strategy that uses Piezo electrical buzzer in order to establish over rushing bike and it additionally equipped with a feature known as speed electric circuit, that restricts the ordinance of the bike. It additionally includes a feature that prevents the drunk associate degree drive situations of the rider known as ALCHO-LOCK and a measuring device to establish accidents; upon sleuthing accidents it mechanically sends a message to involved person. A fog device has been used in this system in order to improve the visibility for the rider in case of fog or air pollution. It additionally options automatic deduction of needed or required quantity from the riders registered virtual pocketbook in wireless to helps the rider to prevent and do the payment. Selvathi et al [4] had designed a system that mechanically detects if the rider is carrying a helmet and additionally checks whether or not the rider has consumed alcohol before beginning the ride. The relay connected to the engine can activate if and providing each the conditions square measure met. The Microcontroller within the system controls the functioning of relay and therefore the ignition. this technique additionally identifies the bike accident at any place and alerts the involved person regarding the accident. Archana D et al [5] had planned a system that cannot enable driver to begin the engine while not carrying the helmet. once rider wore the helmet, helmet is fast and engine can be switched ON. This system additionally establishes the approaching vehicle's speed on each sides of the bike whereas riding by utilization supersonic device and alert the rider by generating vibrations in bike's bar. Sayan Tapadar et al [6] had planned a strategy for sensible helmet that will notice whether or not rider is carrying the helmet or not, and notice whether or not the person has over-consumed alcohol and will additionally detects regarding the accident. This system gathers the information generated from the measuring device associate degreed pressure sensors and therefore the same are sent to cloud server via an on-line application programming interface (API) to train a support vector machine (SVM). SVM will facilitate in sleuthing accident exactly thus in the future enough information can be gathered and analyzed to offer a lot of accuracy regarding event detection. The planned system (smart helmet) will be connected to any sensible phone via Bluetooth in order to communicate with the on-line API, by utilization the sensible phone web association.

III. TECHNOLOGIES USED

3.1 Hardware Components

The proposed system contains easily available, cost effective, yet durable hardware components for its efficient working. The system comprises of hardware such as Raspberry Pi, Microcontroller, Alcohol Sensor, Vibration Sensor, RFID Sensor. Many of the hardware components are recommended alternatives for the components used in the existing system.

3.1.1 Raspberry Pi

Raspberry Pi can be seen as small pocket-sized computer that can be plugged into any display device together with all the peripherals such as standard mouse, keyboard etc. Raspberry Pi, in the proposed system is used as a platform for integrating the VUI module and sensor module.

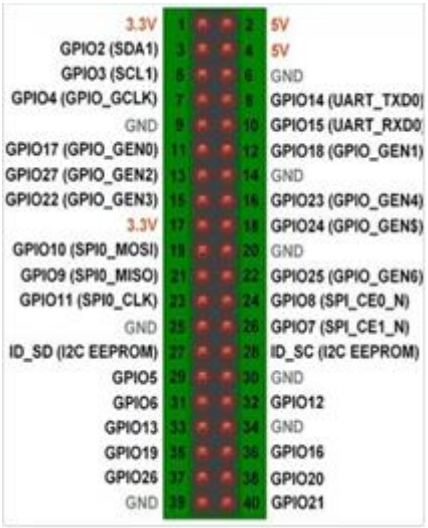


Fig. Raspberry Pi pin diagram

3.1.2 Microcontroller ATMega32A

ATmega32A is a low power Microchip having high performance 8-bit AVR RISC based microcontroller having self-programming 32KB flash memory. It features 2KB SRAM, 1KB EEPROM 8 channel 10-bit A/D converter and JTAG interface for on-chip-debug.

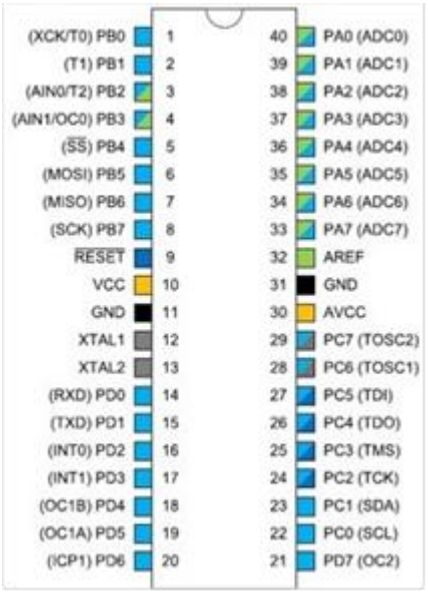


Fig. Atmega32A Microcontroller pin diagram

3.1.3 SW-420 Vibration Sensor

Sensors having a keen ability to detect vibration or tilt in any system and record the readings hence acquired are called Vibration Sensors. A threshold frequency will be specified for the sensor which will work as a benchmark for distinguishing between collision scenario and accidental trigger of the sensor. If the vibration reading during the collision is greater than the threshold frequency then relay will be triggered which will in turn trigger the alarm/buzzer to alert the bystanders.

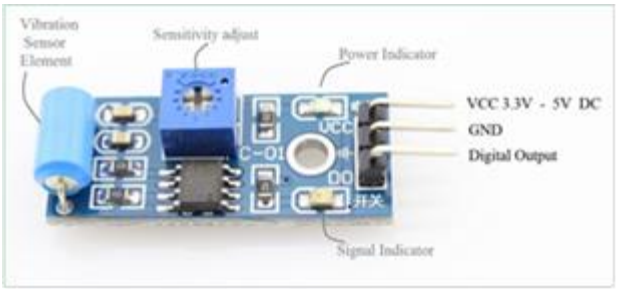


Fig. SW-420 Vibration Sensor

3.1.4 MQ3 Alcohol Sensor

Alcohol sensor is a sensor which is capable of detecting gas leakage. Due to its affinity of detecting various gaseous substances it is suitable for detecting alcohol in a human system which is detected through the breath of the user. In the proposed system, alcohol sensor helps prevent drink and drive to some extent. It is mounted near the mouth piece of the helmet. As soon as the user wears helmet, the earlobe switch will activate alcohol sensor along with RF sensor. It will detect alcohol content in the user's breath, if alcohol is found in high amount, it will relay a signal to RF sensor which will transmit another signal to the RF receiver mounted on the vehicle to break the connection and prohibit the vehicle ignition.

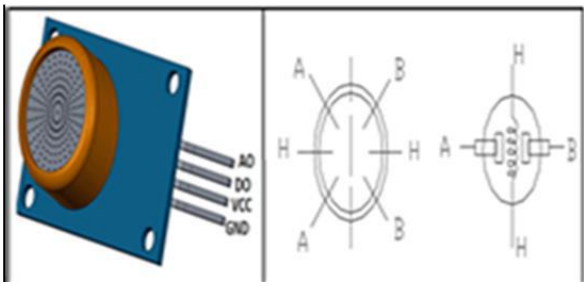


Fig. MQ3 Alcohol Sensor

3.1.5 RFID TLP34 MHz Transmitter and Receiver

RFID Sensors are the sensors which use electromagnetic fields to identify and track tags attached to various objects automatically. In the proposed system, RFID Sensor has the functionality to make or break the connection between the helmet and vehicle unit to allow or prohibit the vehicle ignition depending upon the specific condition fulfilment. For example if the user is not wearing the helmet, the connection will not be established, hence prohibiting the ignition, or if the helmet is worn by the user but alcohol sensor has a positive reading on the alcohol content in the user's breath, then RF breaks the signal with RF transmitter on the vehicle to again prohibit vehicle ignition.

3.2 Software Components

3.2.1 Natural Language Processing (NLP)

Natural Language Processing or NLP in the field of computer science is a branch that is concerned with the human computer interaction via natural language, i.e. to program systems to analyse and process natural language data. To enforce NLP in the proposed system, NLTK (Natural-language-toolkit) library was used.

3.2.2 Webhook

In web development, webhook is a methodology of augmenting or sterilization the behavior of an online page, or internet application, with custom call-backs. These call-backs could also be maintained, modified, and managed by third-party users and developers who might not essentially be related to with the originating web site or application.
The proposed system utilizes webhook to connect two different applications. In case of an event, which may take place due an order or command issued by the user, called as trigger application, it calibrates knowledge from that event and sends it to a webhook URL from the action application to perform the specific action.

3.2.3 Google Distance Matrix API

The Distance Matrix API is said to be a service that gives travel distance and time for a matrix of origins and destinations. Map service makes use of the Google Distance Matrix API that provides travel distance and time for a matrix of origins and destinations to revert a suggested route between the beginning and finish points, as calculated by the Google Maps API. Navigation functionality provided in the proposed system makes use of the Google Distance Matrix API to relay the directions to the user. When the user issues the command to navigate to certain destination, the current location and the destination are passed down as parameters to the GDM API, which are then converted to coordinates as longitude and latitude to calculate the distance between them. The API then compares the best route based on the distance and time thus computed and returns the result in the form of either JSON script or XML format. The result so obtained is then connected to our system using webhook and the directions are dictated in real-time.

3.2.4 Voice Assistant

An intelligent virtual assistant (IVA) or intelligent personal assistant (IPA) could be a computer code agent that may perform tasks or services for a personal supported commands or queries Google Assistant is an entity that extends to help users across various devices like Google Home, Mobile Phone etc. It is common functionality that is now available on every android device. The proposed system utilizes google assistant to establish connectivity between various API. Google Assistant has been used in the system to enforce VUI (Voice-user-interface). The assistant has been integrated with the system and moreover custom wake word has been added to help user access the system easily. 'ALFRED', would be the hot-word that would give access to all the voice activated functionalities provided in the system.

3.2.5 Database Specification

Firebase database provides a cloud-hosted Realtime NoSQL database used for storing and synching the data. Data generated from the database is stored in cloud storage called firebase storage which is powerful, cost effective and simple storage service. Google Doc has also been used to store and access location data.

3.3 Coding Languages

3.3.1 Python 3.8.1

Python is associate degree interpreted, high-level, general programming language. Its language constructs and object-oriented approach aim to assist programmers write clear, logical code for little and large-scale programming modules. In the proposed system, Python has been used to develop the voice assistant module. Python has also been used to support the construct of navigation API.

3.3.2 JAVA

Java is an object-oriented programming language and have virtual machine platform that enables you to make compiled programs that run on nearly each platform. Java has been used in the proposed system for developing various API's such as 'API for Message' etc. Java has also been used for server-client coding to enable messaging functionality.

3.3.3 Embedded C

C language is a widely used system programming language used for software development. Embedded C is an extension to the C language which enables it to be used for developing efficient programs for embedded system. Embedded C has been used in the proposed system for programming and calibrating the peripheral sensors attached to the system.

IV. PROPOSED SYSTEM

The proposed system utilizes the combination of various concepts such as NLP and embedded programming along with the use of various sensors such as alcohol sensor, RFID sensor, vibration sensor, microphone, speaker, buzzer to enhance the natural ability of the helmet of protecting the bike rider. It uses cost efficient, yet robust and easily available components as an alternative for the priced one so that the product could become affordable for everyone.

4.1 Project Flow

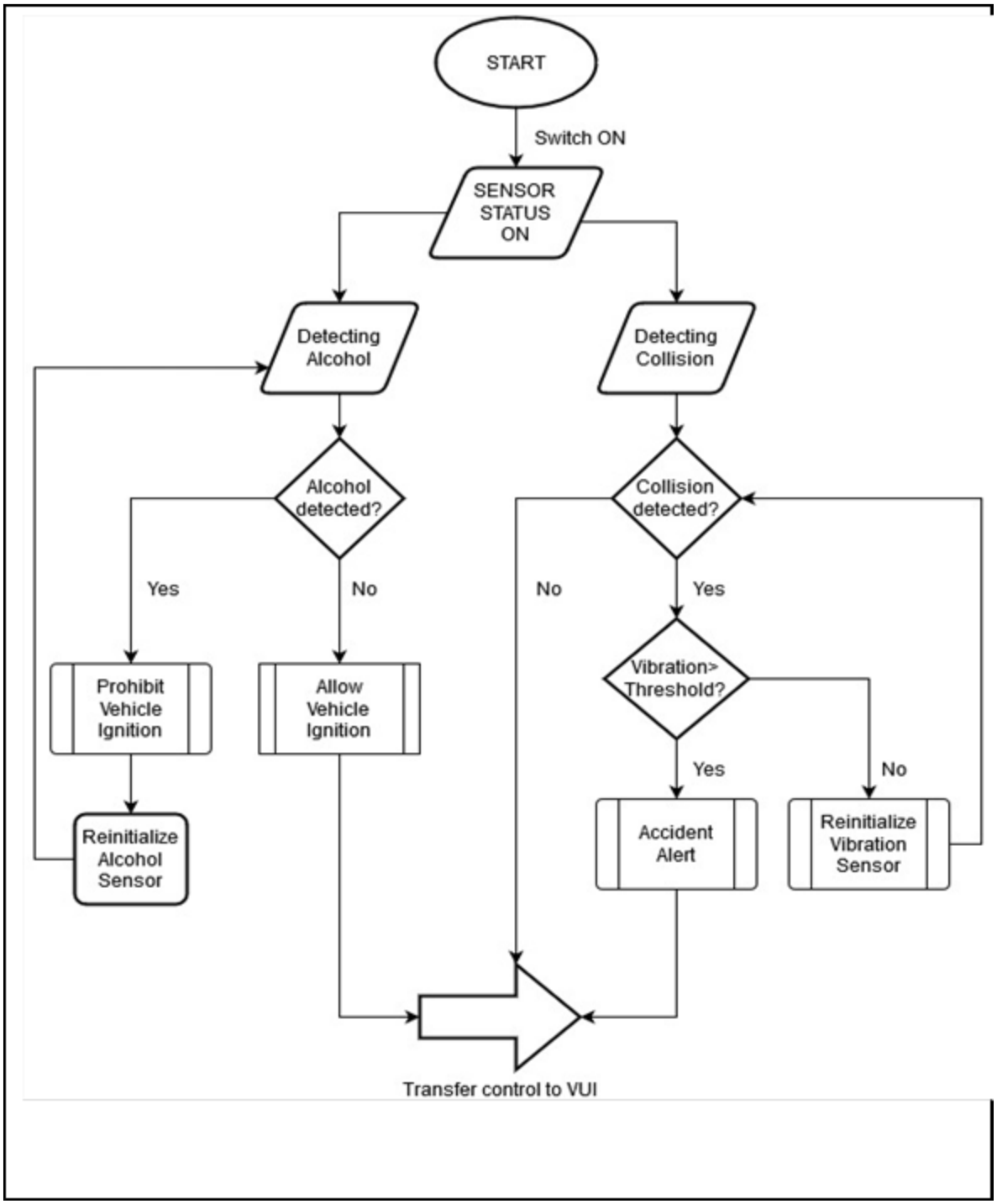
This project contains two module one helmet section and vehicle section. In helmet section, it contains ear lobe (switch), which is mounted at the top of the helmet to initialize or activate RF sensor and alcohol sensor. If alcohol is not detected and switch is on then send a rf data to turn on the ignition in the vehicle (motor on) else relay is off that means ignition off (when alcohol detected display alcohol detected and buzzer on) In the vehicle section if the above two condition are matched only then turn on motor and display helmet worn. Vibration sensor is mounted at the hull of the helmet. If vibration sensor picks up reading higher than the threshold than accident has occurred, then quickly trigger the buzzer to let the bystanders know, and also use the Google Dot matrix API settings to send the current location of the user to the emergency contact specified. The proposed system utilizes NLP for implementing the VUI which gives the wearer the ability to interact with the helmet hands-free and issue voice commands to 'Navigate' to certain destination, 'Send' or 'Read' recent messages or mails, 'Make Call' to the said contact. The user will issue voice commands using the microphone installed at the face rim of the helmet right in-front of the mouth.

The user can call out the custom wake word "ALFRED" to activate the assistant and start issuing voice commands. For example, a statement like; "Alfred, send text message to xxx, I am going to be late", will result in sending a text to contact name/number 'xxx' with content saying 'I am going to be late'.

Raspberry Pi operating system, the 'Raspbian', was used as a coding platform and as a medium to interface and integrate the sensory circuit to the VUI (Voice-user-interface). For sensor coding, pre-generated code templates from the microcontroller home was used for the interfacing of the microcontroller with the peripheral sensors. User can say 'Navigate to xxx', which will instruct the assistant i.e. Alfred to find and dictate directions to the said location, i.e. xxx. Map service makes use of the Google Dot Matrix API that provides travel distance and time for a matrix of origins and destinations to revert a suggested route between the beginning and finish points, as calculated by the Google Maps API.

4.2 Project Description

4.2.1 Flow Chart



(A)

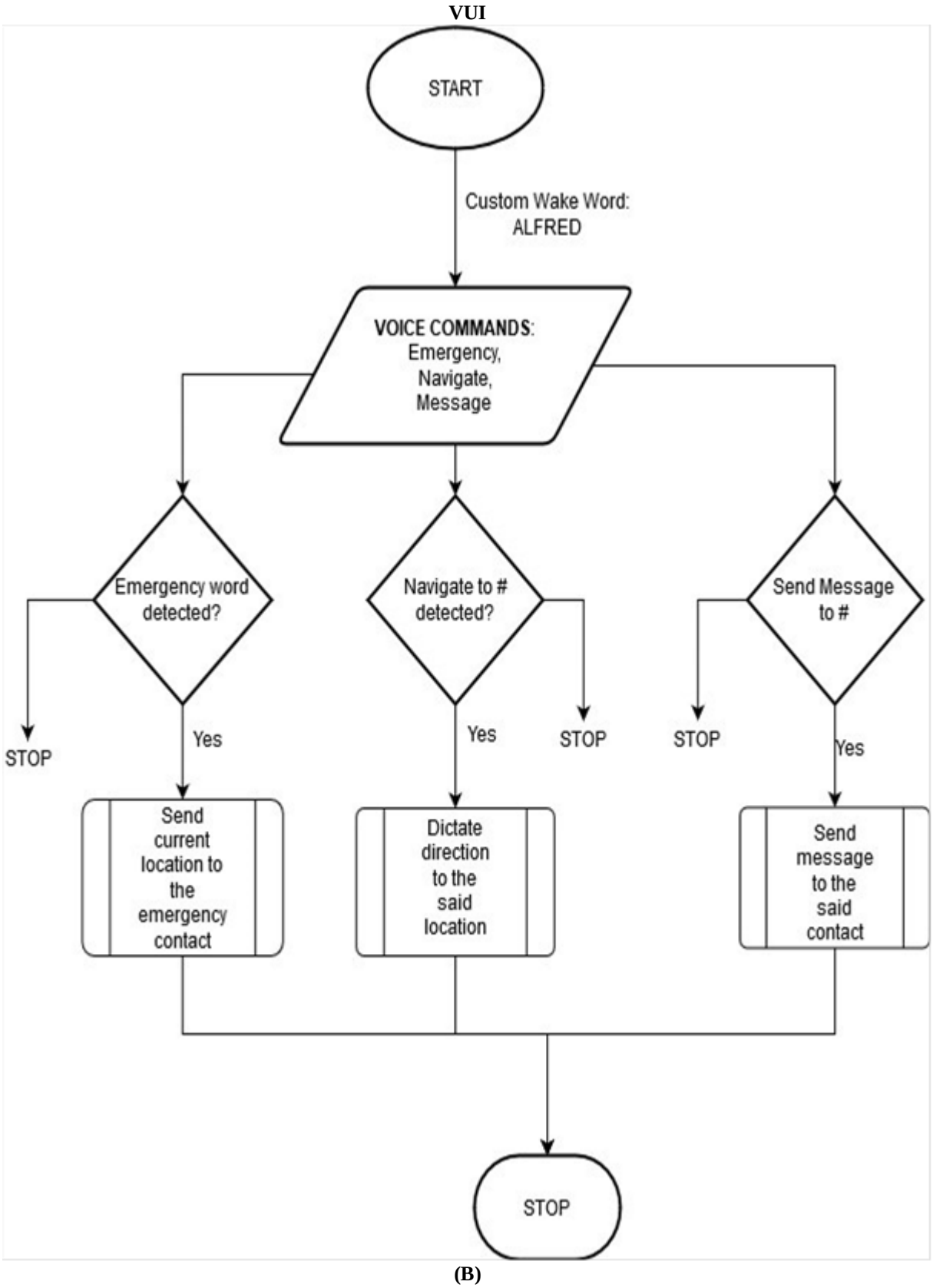


Fig. Flow chart (A) Sensor Unit, (B)Voice Control Unit

4.2.2 Architecture Diagram

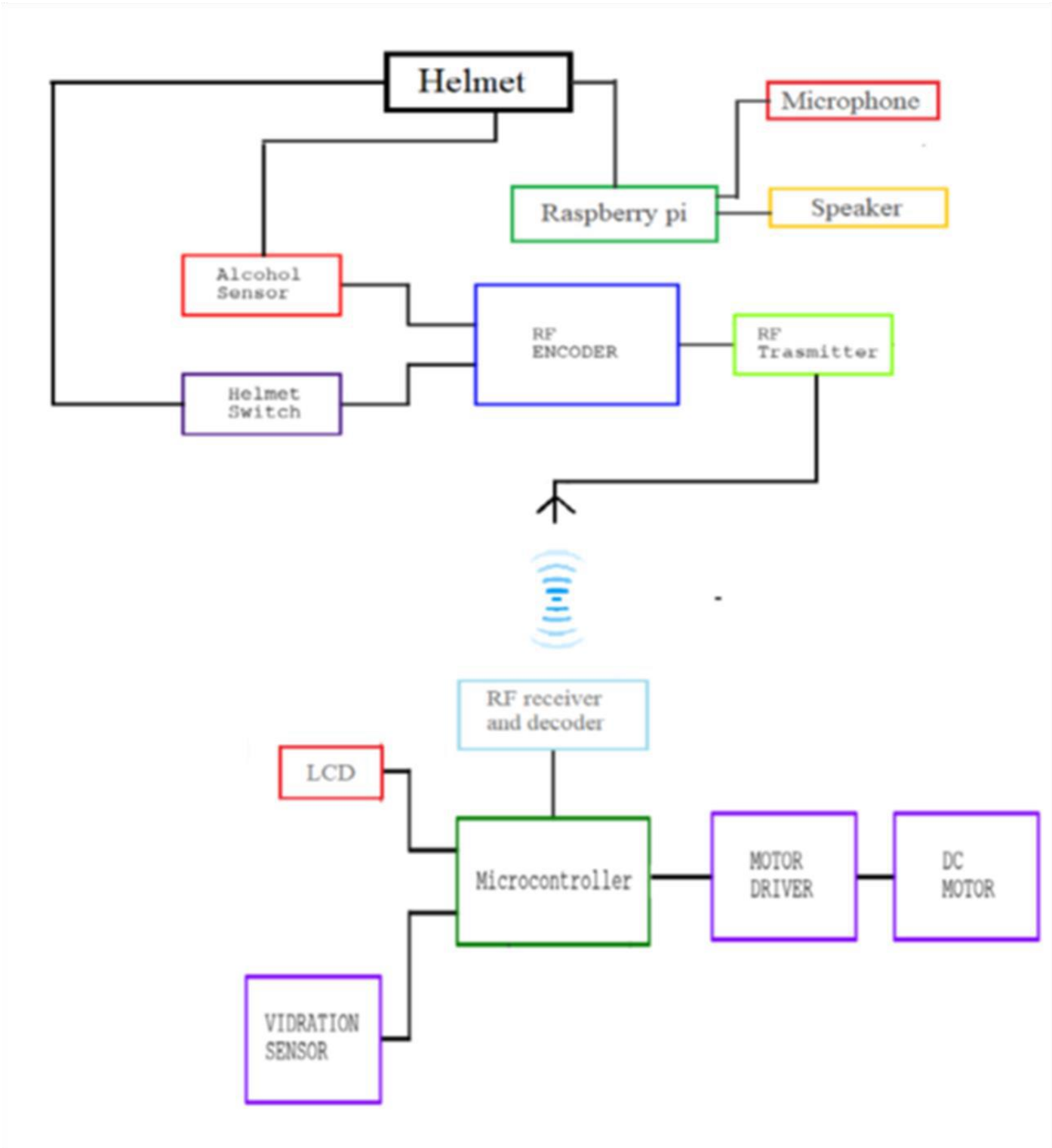


Fig. Architecture Diagram

4.3 Algorithms

4.3.1 Tokenization

```
function RetrieveToken () returns Token

    Parameters:

        Stream which contains the "Source" text to be parsed.

    Returns

        Token

        Create a new Token.
        Set the Type property of Token = End-Of-File.

    else

        Set State = Initial-DFA-State.
        Set Done = False.
        Set Length = 1.

        loop until Done

            if the State accepts a terminal

                Set Accept-State = State.
                Set Accept-Length = Length.

            end if

            Set State = the Target-State property of the Edge.
            Increment the Length.

        else

            if the Accept-State was set

                Create a new Token.
                Set the Parent-Symbol property of Token = symbol in Accept-State.
                Set the Data property of Token = read Length characters from Source.

            else

                Create a new Token.
                Set the Parent-Symbol property of Token = Error.
                Set the Data property of Token = read one character from Source.

            end if

            Set Done = True.

        end if

    next loop

end if

Return the Token.

end function
```

4.3.2 Speech-To-Text

Speech to text is a software technology which is capable of effective audio content recording and transcribing it into written words on a display destination. In the said system, it helps taking audio input from the user which is nothing but the voice commands.

```
#Initialize the recognizer
r = sr.Recognizer()

#generate a list of all audio cards/microphones
mic_list = sr.Microphone.list_microphone_names()

#the following loop aims to set the device ID of the mic that
#we specifically want to use to avoid ambiguity.
for i, microphone_name in enumerate(mic_list):
    if microphone_name == mic_name:
        device_id = i

#use the microphone as source for input. Here, we also specify
#which device ID to specifically look for incase the microphone
#is not working, an error will pop up saying "device_id undefined"
with sr.Microphone(device_index = device_id, sample_rate = sample_rate,
                   chunk_size = chunk_size) as source:
    #wait for a second to let the recognizer adjust the
    #energy threshold based on the surrounding noise level
    r.adjust_for_ambient_noise(source)
    print "Say Something"
    #listens for the user's input
    audio = r.listen(source)

    try:
        text = r.recognize_google(audio)
        print "you said: " + text

    #error occurs when google could not understand what was said

    except sr.UnknownValueError:
        print("Google Speech Recognition could not understand audio")

    except sr.RequestError as e:
        print("Could not request results from Google
                                Speech Recognition service; {0}".format(e))
```

4.3.3 Voice Assistant

An intelligent virtual assistant (IVA) or intelligent personal assistant (IPA) could be a computer code agent that may perform tasks or services for a personal supported commands or queries.

```
def get_audio():

    rObject = sr.Recognizer()
    audio = ''

    with sr.Microphone() as source:
        print("Speak...")

        # recording the audio using speech recognition
        audio = rObject.listen(source, phrase_time_limit = 5)
    print("Stop.") # limit 5 secs

    try:

        text = rObject.recognize_google(audio, language ='en-US')
        print("You : ", text)
        return text

    except:

        assistant_speaks("Could not understand your audio, PLease try again !")
        return 0
```

```
# Driver Code
if __name__ == '__main__':
    assistant_speaks("What's your name, Human?")
    name ='Human'
    name = get_audio()
    assistant_speaks("Hello, " + name + '.')

    while(1):

        assistant_speaks("What can i do for you?")
        text = get_audio().lower()

        if text == 0:
            continue

        if "exit" in str(text) or "bye" in str(text) or "sleep" in str(text):
            assistant_speaks("Ok bye, "+ name+'.')
            break

        # calling process text to process the query
        process_text(text)
```

V. CONCLUSION AND FUTURESCOPE

Hence, in the presented paper, the implementation and design flow of the project has been discussed. The planned helmet ought to accommodate all the required facilities in a compact manner. In parallel, the choice of microcontroller and sensors are being taken care. The planned style can provide a resolution in terms of price effective and updated technology front for all varieties of helmets.

With the assistance of this device, driving would become distraction free. To some extent it can also stop potential accidental situations. The developed style for the helmet reduces difficulties in traffic conditions and intends individuals to use this helmet for safe-driving. It's going to minimize the accident magnitude related to distracted driving by providing all mobile functionalities out there to the user on voice command. By exploitation of this helmet, riders are going to be acutely aware, since they are giving voice commands to manage the essential bike functionalities. This price effective resolution will be integrated with engine ignition. The developed system provides a scope in everyday lives of people and working-class folks that use bikes as means of travel. The aim is to target the motor-bikes and then bi cycle users with lighter version.

FUTURE SCOPE

The sensible helmet is supposed to provide security, safety and luxury journey to the rider. The look of the helmet will show satisfactory results by additional modification in line with normal bioengineering and will work well by harvesting alternative energy sources. In future the functionality of the helmet would be increased by applying AR (augmented reality) technology to provide onscreen navigation. In future the functionality of the helmet would also be increased together with extra options like rider's fatigue detection system, cooling mechanism, phone charging unit and ignition management unit, which are lacking inside the traditional helmet. This would provide a much better safety and security to the rider.

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