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Cloud Incorporated Smart Helmet Integrated with Two-wheeler Communication Setup

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ABSTRACT

This research proposes a Helmet based on IoT (Internet of Things), powered with Arduino Controller and Wi-Fi unit. The novelty includes dual functionality of (i) Seamless interconnection of the system to the Internet and (ii) An interlock which forces the Helmet to be properly secured to the user's head and buckle the chin strap. The research also involves presence of the alcohol sensor MQ-3 in the vehicular setup of the System which when detecting the presence of Alcohol Content in the person's breadth doesn't allow the vehicle to start in spite of the user wearing the helmet. The benefits include: (i) Tracking the vehicle location using the helmet and a Wi-Fi, (ii) Communication with pre-programmed mobile users during an emergency. Easy setup and configuration algorithms and library functions allow users to quickly and easily interface sensing and monitoring devices to the internet. In order to demonstrate the ease and feasibility of deploying internet-connected devices, a completely distributed smart helmet system, comprising of transmitting and receiving systems, is designed. The transmitter section or the helmet section consists of Arduino microcontroller platforms, sensors, whereas the receiver section or the vehicular section also comprises of Arduino microcontroller, Wi-Fi shield. The receiver setup collects and stores data from the wireless transmitters, and uploades the Real-time sensor data to the Xively Cloud Services website,which can be made available for the public viewing through online.

Key words: Xively, Wireless, MQ-3 Sensors, Microcontroller, IoT, Wi-Fi, Arduino, Helmet.

1. INTRODUCTION

Internet of Things (IoT) refer to those objects that have distinct identities and are capable of connecting to the Internet[1]. In IoT, emphasis is given to those devices or "things", which one can least expect to be connected to the Internet like Toasters, Fans, Irrigation pumps other than usual devices like networked computers, mobile phones. Development of Smart Cities also have been led to the usage of IoT[2]. Managing Crowds in Smart Cites is also a concept which uses IoT extensively[3] Here in this research helmets, which like any other objects have been the subject of excessive scrutiny and their importance as an accessory to the two-wheeler users is also emphasized by law. Helmet use also increases with education. Drivers who show a higher awareness of road risks are both more likely to wear a helmet and to speed less. Wearing helmets bring down the severity of head injury by 80% and reduce fatalities by 45%[4].India has emerged as one of the capital of head injuries in road accidents across the world [5].Reports infer that wearing a helmet is the most effective way reducing head injuries and fatalities resulting from motorcycle and bicycle crashes. As per WHO regulations, wearing a helmet has been shown to decrease the risk and severity of injuries as well as the likelihood of death of two-wheeler drivers, horse-riders, Baseball players, polo jockeys, etc, significantly, and also substantially reduce the costs & trauma of post health care associated with such crashes [6].

2. REPORTED WORKS

Reported works in the field of Helmets include, the usage of RF technology to detect crash and notify to the control room [7].Vibration Sensors placed on the Helmet detects the vibrations that are created when

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the helmet hits the ground and the intrinsic microcontroller process it and sends information about location [8].An Intelligent Helmet system that ensures that a bike doesn't start without the user wearing the helmet[9].A helmet system that detects the sobriety of the user using alcohol sensors without which vehicle doesn't start [10].Another novelty known as Saab Alco Key breathe analyser on driver seat is used to check drunken condition of the drivers in cars[11]. But in this case, circuit complexity is high to be implemented in two-wheelers. In another technology involving smart helmets, the signal detected by IR sensor from the earlobe region and an alcohol sensor will be transmitted to the vehicle control circuit. It will not turn ON the vehicle, when the user is without helmet or in drunken condition [12]. From these reported works, one can infer that all these Helmet technologies use either proprietary or non IP-based systems and networks and decouples application layer at all, leading to the term, M2M(Machine to Machine) communication. The differences between IoT and M2M are significant enough to highlight them as follows (refer Fig.1).

Thus IoT encompasses M2M on a larger scale, and is a successor technology of M2M.

2.1. Arduino Platform

Arduino is a complete open-source technology used for building real time embedded systems. It comprises of a printed circuit board (bundled with microcontroller) and a proprietary software, or SDK (Software Development Kit) that runs on the host system, and the the program is downloaded onto the Arduino board. Unlike other developmental boards, the Arduino does require a separate programmer in order to load new code onto the board – It only requires an USB cable. In addition, the

Table 1
Comparison between M2M and IoT

Machine to Machine (M2M)	*Internet of Things (Iot)*
Focus of communication includes protocols like Zigbee, Bluetooth etc...	Focus of communication includes HTTP, CoAP, and Web Sockets etc...
Includes homogeneous devices.	Involves heterogeneous devices.
Special emphasis on embedded hardware only.	Importance given to software programming.
Data is collected on premises storage infrastructure.	Data is managed in Cloud.

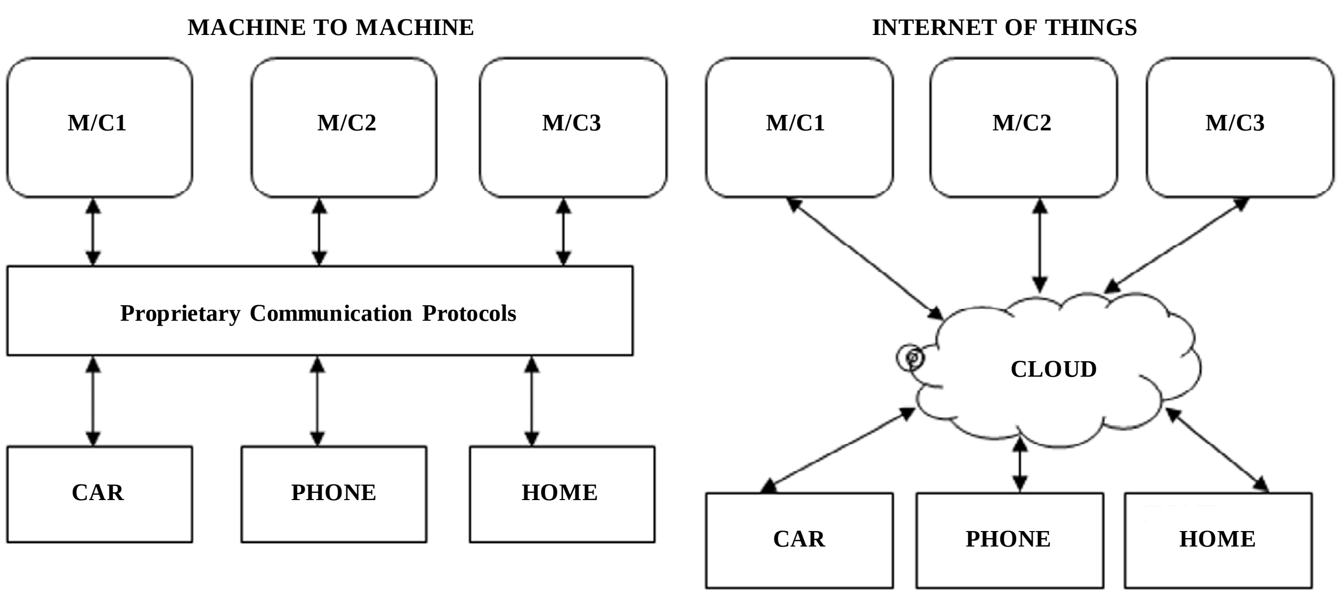

Figure 1: Comparison of M2M and IoT

Arduino SDK also uses a scaled version of C++, making it easier to program. To conclude, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package[13].

3. PROPOSED IOT BASED INTELLIGENT HELMET SYSTEM

The entire system can be divided into two halves:

(a) Helmet System

(b) Vehicular System

(a) Helmet System: In this proposed system, based on IoT, multiple pressure sensors are uniformly mounted in the innermost side of the Helmet and chinstrap, to sense whether the helmet is securely strapped upon the wearer's head. The Smart Helmet based system is then powered ON, and gets self-connected to the internet. By using Wi-Fi based settings of the Smart Phone, the Smart Helmet network is then connected with the phone. The Helmet is then worn and the locking buckle which is located on the chinstrap enables an alarm after receiving signals from all the pressure sensors, and sensing tension in the chinstrap. The alarm or beep sound gets cut, once the Helmet buckle is properly locked. The Helmet system also comprises of an alcohol sensor which works in full conjuncture with the pressure sensor to ensure that the breadth of the user is alcoholic free. The signals from the sensors are displayed and monitored through an App indicating whether Helmet is worn or not and whether the alcohol content in the user is present or not. The status of Helmet worn or not and the user's breadth is alcohol free or not are stored in the database and are constantly retrieved and updated. The power source for the application uses an external and can be charged even with alternate energy sources like the solar panels. Fig.2 shows the conceptual layout of the helmet with location of different sensors across the helmet and chinstrap. The proposed block diagram based on IoT is shown in Fig.3 and also different hardware requirement for the smart helmet is also shown in Table 1.

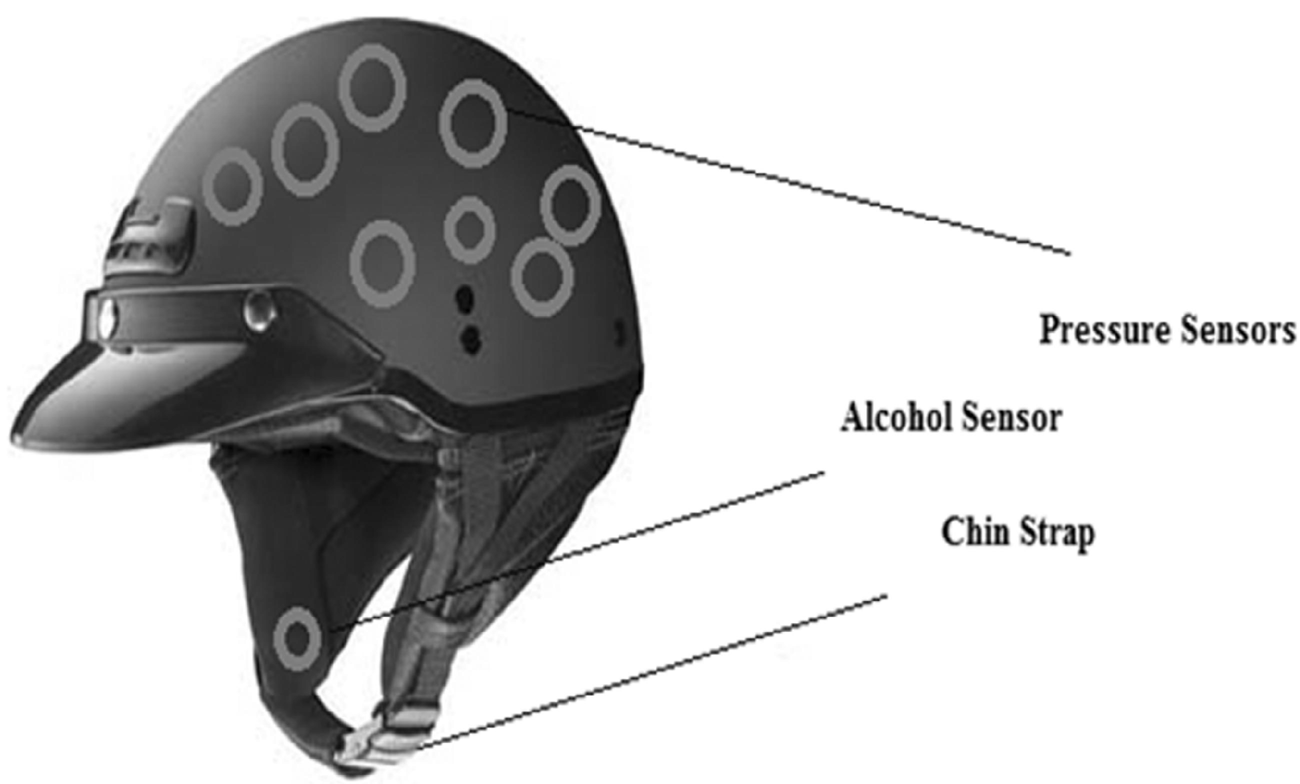

Figure 2: Conceptual Layout of Helmet with Different Sensors.

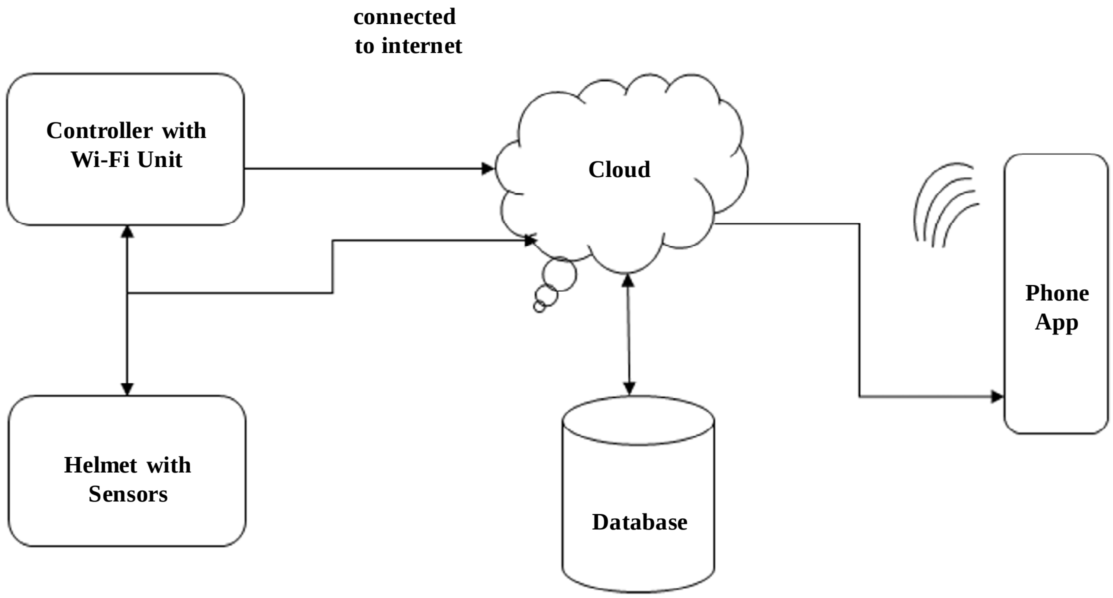

Figure 3: Block diagram of the proposed system (Helmet System) based on IoT.

Table 2
Hardware requirements of the Smart Helmet

Components	Type	Working	Remarks
Pressure sensors	NPA 700	Flexi force alters resistance due to pressure	More sensitive at edges.
Alcohol Sensors	MQ-3	By sensing the Blood Alcohol Content (BAC) in the human breath.	Fast response and High Sensitivity.
Wi-Fi shield Unit	Arduino Wi-Fi shield	Seamless connection of the Arduino board to the internet.	Communication is done through SPI bus.
Driver circuit	Songle SRD Relay	Connects the power supply to the Helmet.	1 channel 5V relay module
ATmega micro-controller	ATmega1280	Connects with the Wi-Fi shield through Master-slave communication	Clock speed:16MHZI/O Pins:54 Flash Memory:128KB

PRESSURE SENSOR NPA-700

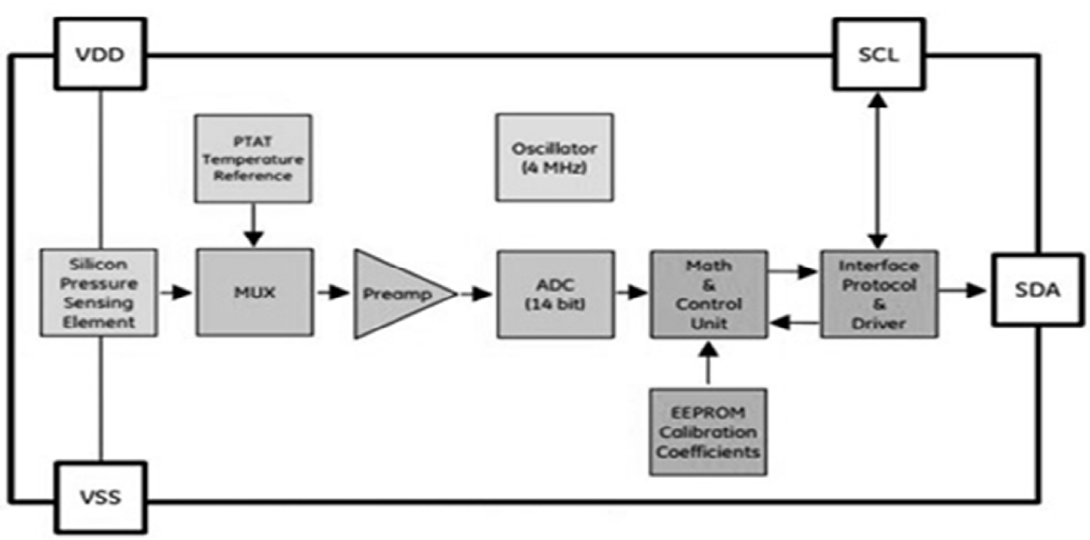

Figure 4: A Schematic showing NPA700 pressure sensor [14].

3.1. Alcohol Sensor Mq-3 And Its Drive Circuit

The sensor used for detecting Blood Alcohol Concentration (BAC) in the user's breadth is the MQ-3 gas sensor.MQ-3 has a high sensitivity to the different concentrations of Alcohol and has good resistance to gasoline and vapour disturbances in the air. It has a simple drive circuit as shown in the Figure.5[15].

3.2. Interconnection Between Arduino and Wi-fi Shield

The above schematic in the Figure.6 shows how an Arduino board and Wi-Fi shield can be connected together.

The Arduino Wi-Fi Shield connects Arduino board to the internet using the 802.11 wireless specification(Wi-Fi). It consists of HDG204 Wireless LAN 802.11b/g System in-Package. An AT32UC3 provides a network (IP) stack capable of both TCP and UDP standards. Arduino board communicates with both the Wi-Fi shield's processor and SD card using the SPI bus (through the ICSP header). This is on digital pins 11, 12, and 13 on the Uno and pins 50, 51, and 52 on the Mega. On both

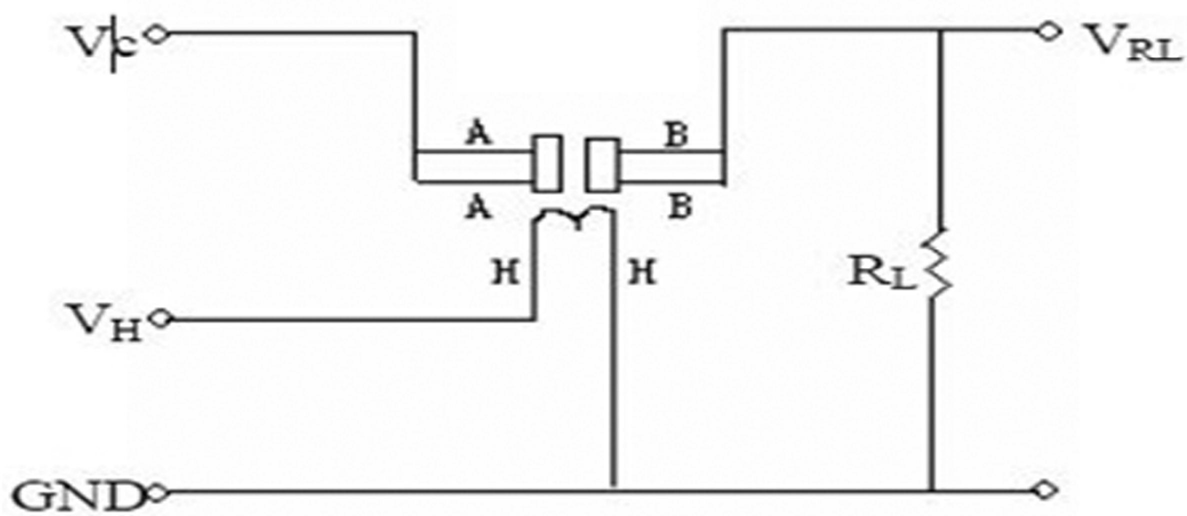

Figure 5: Drive circuit for MQ-3 Alcohol Sensor

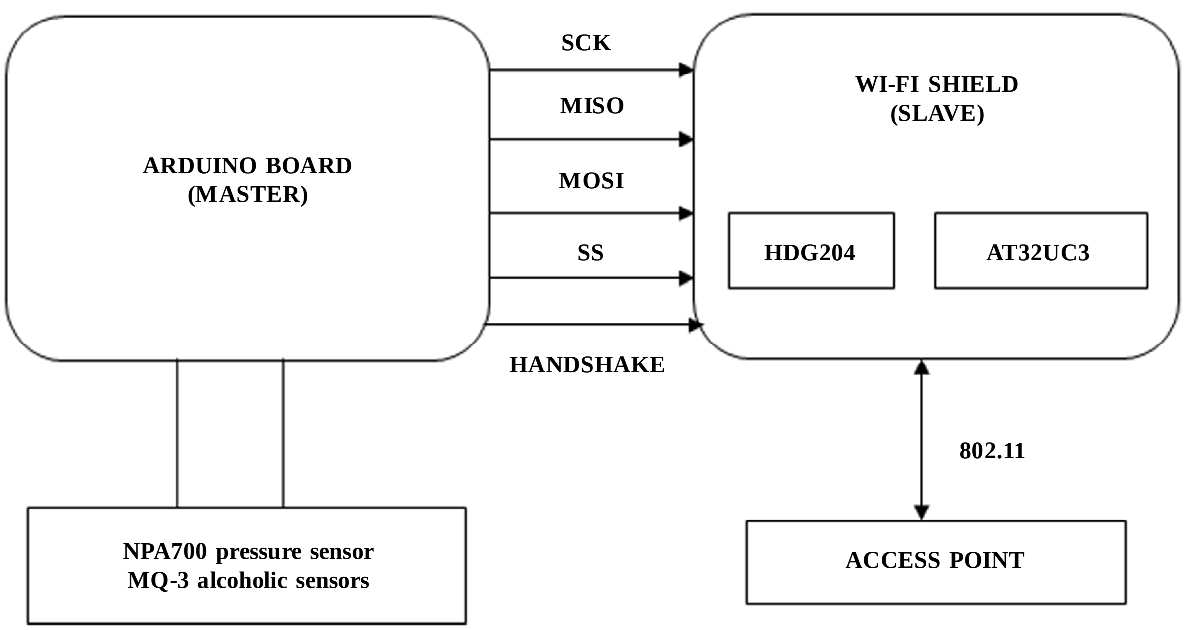

Figure 6: Interconnection between Arduino and Wi-fi Shield.

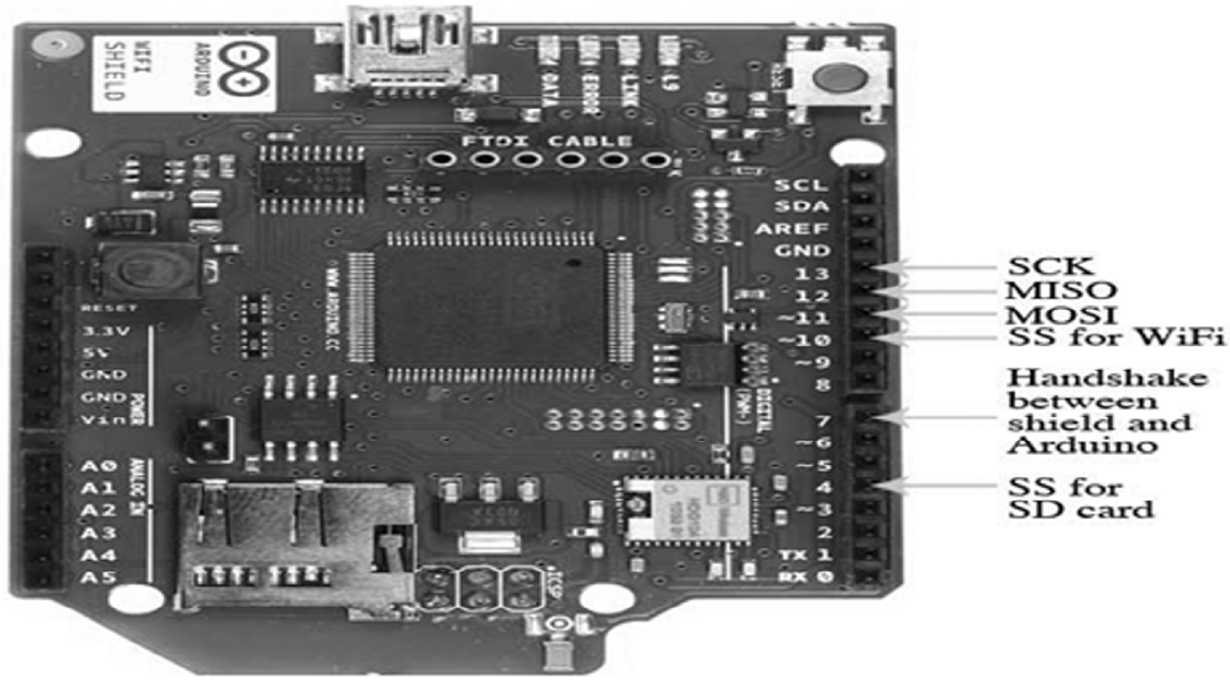

Figure 7: Pin configuration of Arduino Wi-Fi Shield

boards, pin 10 is used to select the HDG204 and pin 4 for the SD card. Digital pin 7 is used as a handshake pin between the Wi-Fi shield and the Arduino. The Wi-Fi shield Pin Configuration is shown in figure.7

3.3. Connection to The Network Using Wi-fi Shield

The Wi-Fi Shield can be connected to the open network as well as secured network. In this research, the shield is connected to WPA2 (Wi-Fi Protected Access) based Personal encrypted networks, for which SSID and password is needed for authentication. When the shield is configured to be used for the first time, it scans for the networks in the close vicinity. The pseudo-code for connecting the network is given in Appendix-I.

3.4. Vehicular System

The Vehicular System of the Smart Helmet comprises of the receiver section that consists of the Arduino microcontroller along with the Wi-Fi module along with the buzzer connected to ignition switch, which

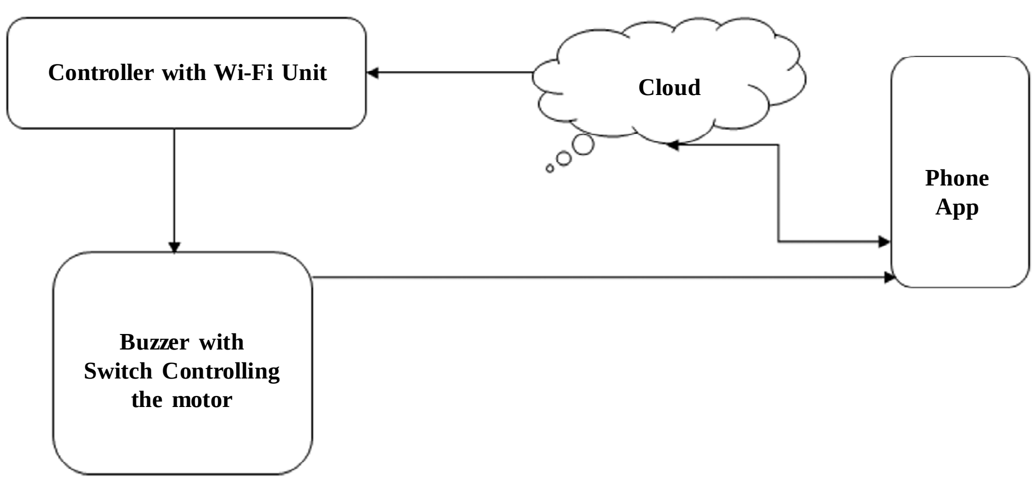

Figure 8: Block diagram of the proposed system (Vehicle System) based on IoT.

gets turned ON only when there is presence of Alcohol in the driver's breadth and irrespective of whether the user is wearing or not wearing the Helmet. This status is automatically indicated to the mobile App indicating the present condition of the two-wheeler user. The Vehicular system of the Smart Helmet is shown in Figure.8.

4. WORKING OF THE PROPOSED IOT BASED SMART HELMET

The flowchart for the complete working of the IoT based Smart Helmet system is shown here.

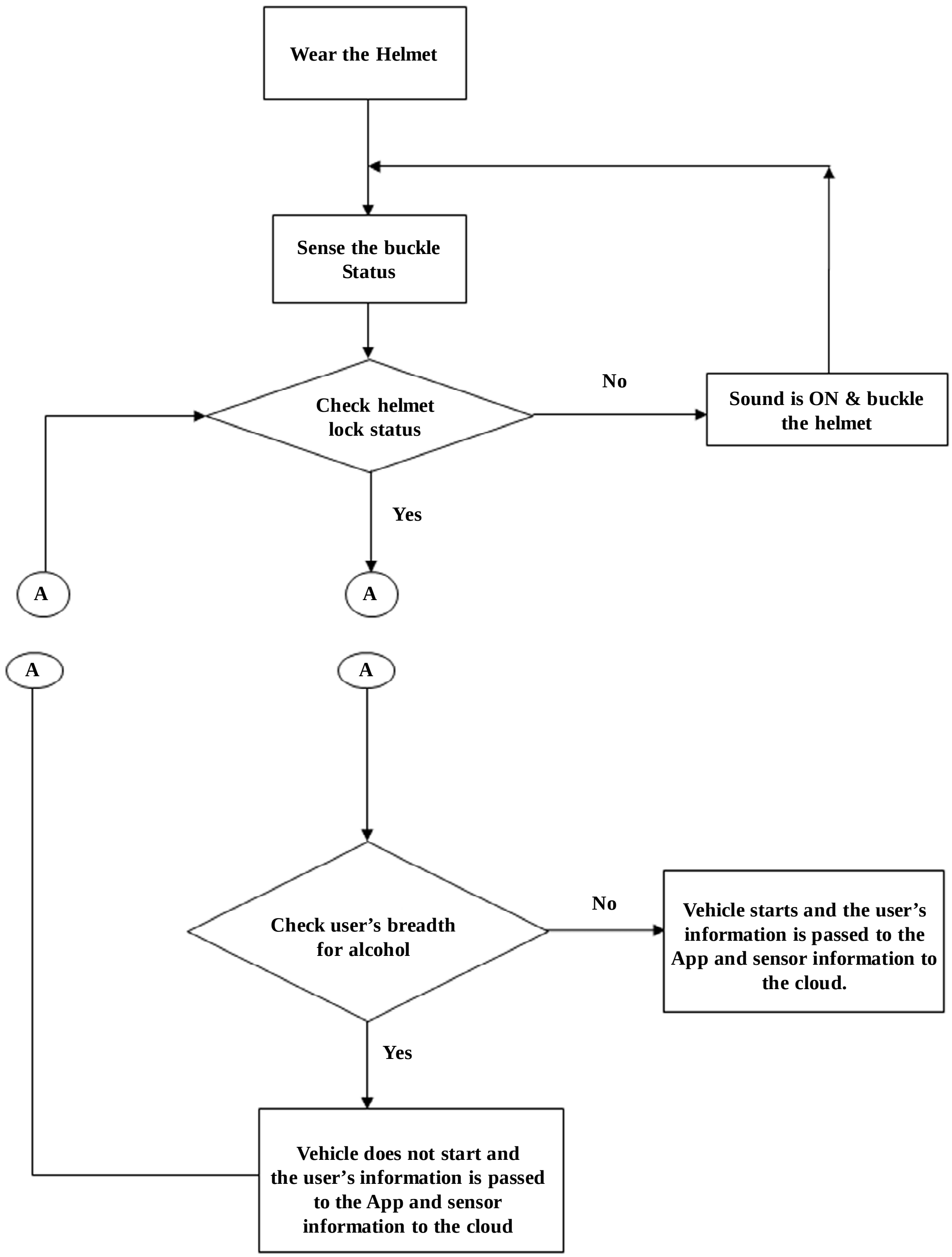

Figure 9: Flow chart for the complete working of the smart helmet system

The above system is an example of the stand-alone mode, where a single user is involved. This system can be further enhanced by adding multiple users and providing interconnectivity amongst them.

5. XIVELY CLOUD SERVICE

Xively is a Paas (Platform as a service) or cloud service developed to monitor environmental parameters in an urban environment and enable internet-access of the data collected [16]. This system comprises of two parts: 1) Internet accessible component (Software); and 2)The data collection and uploading component(Hardware).

In Xively Cloud Services, programmers are given free access by connecting devices and creating data streams and applications. APIs,programming libraries, and applications are provided to simplify programming and enable rapid development and interfacing of devices with the Xively website.

Xively Cloud Services provide a platform for uploading, viewing, and sharing data via the internet. To enable user data to be uploaded and viewed, a web page is created on the Xively website and the user enters information about the incoming data stream, or feed, and data values, or channels. The user then configures the data-collection device using the feed and information to send the real time sensor data to Xively web page.

Steps involved in creating a Xively Account for the Smart Helmet System

- Log on to http://www.xively.com, and create a developer account by providing a unique account name and password.
- Add a new device from the Xively dashboard as shown in figure.10.
- A web page, along with the unique identification number(feed ID) is generated for accessing the web page.
- An API key is generated which identifies the incoming datastream, used by the developer to post data to the proper web page.
- The developer then configures the web page to identify the feeds, which consist of multiple parameters, or channels.
- The web page can be set as public or private access only by the programmer.

Integrating the Xively Service with the Smart Helmet System

- Smart Helmet system is integrated with the Xively Service by programming the developer's datastream information into the helmet system. The information include the feed ID or channel ID, API key, and the datastream channels is incorporated into monitoring device programming.
- Here, using minimal coding, we upload the real time data from the system to the Xively Web site.

The following screenshots gives an comprehensive view of the steps followed in Figs.10, 11, 12 and 13.

From, the above, we can infer that the sensor values change over the course of the day giving real time status. In other words, Xively displays the real values over the internet. The Pseudo code for uploading sensor values over the cloud for the Smart Helmet is given in Appendix-II.

5.1. Screenshots from The App Indicating the Status

The engine motor starts only when the helmet is worn and the breadth of the user is alcohol free and the following status messages are displayed.

Similar to the above, the status indicating the helmet wearing status is set and alcohol content in user's breadth is present will generate the negative status resulting in vehicle not starting at all. Based on this status, many catastrophic incidents can be prevented by this setup.

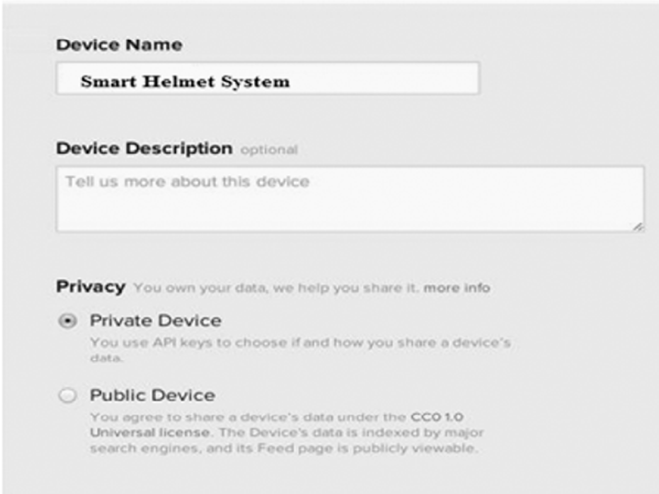

Figure 10: Adding a new device from the Xively.

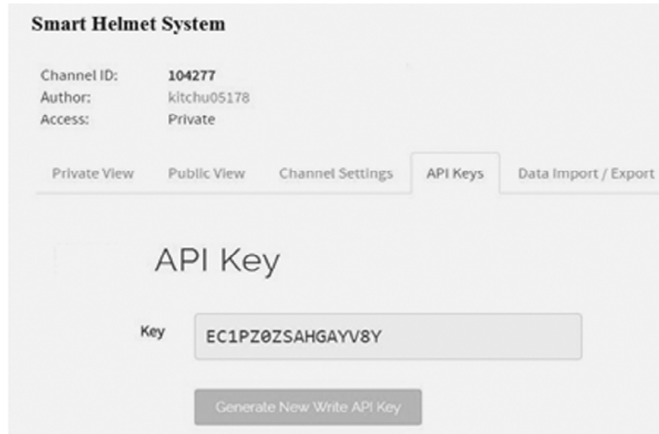

Figure 11: Generation of API Key for Proposed system

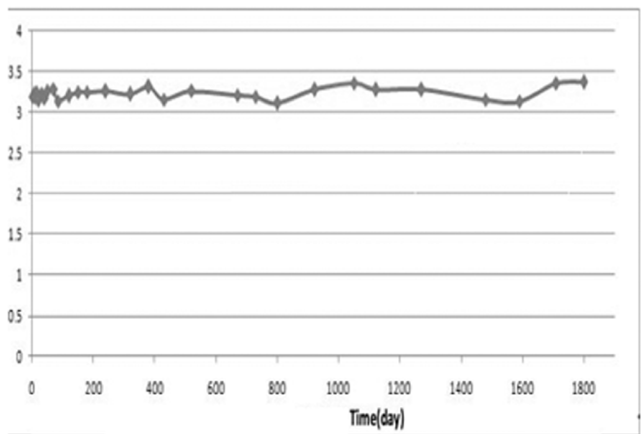

Figure 12: Real time Alcohol Sensor values.

Figure 13: Real time Pressure Sensor values.

HELMET WEARING STATUS	ALCOHOL CONTENT IN USER'S BREADTH
● YES ○ NO	● NO ○ YES

Figure 14: Screen shot indicating the positive status of the vehicle

HELMET WEARING STATUS	ALCOHOL CONTENT IN USER'S BREADTH
○ YES ● NO	○ NO ● YES

Figure 15: Screenshot indicating the negative status of the vehicle

6. CONCLUSION AND FUTURE SCOPE

An IoT based Smart Helmet system has been designed in this research work that not only detects whether helmet is worn but also the presence of alcohol in the user's breadth and this is integrated with the two-wheeler ignition motor, which will not start the vehicle if the user is not wearing a helmet and the breadth is not free from alcohol. The novelty of this research is uploading and analysing the real time sensor values over the Xively Cloud. This setup could act as strong deterrent to the erring drivers by preventing many accidents and saving precious lives. The above research work can further be enhanced by placing advanced sensors that could detect over speeding during the course of travel and bring the vehicle to the halt. The above system can also be enhanced as a Vehicular MANET system with security features, interlinking many users which would help notify each other in case of emergency. Many new enhancements not limited to above can developed with respect to the Smart Helmet system in particular and IoT in general.

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APPENDIX-I

The pseudo-code for connecting the Wi-fi network is given as follows:

```
#include<wifi.h>
Char ssid[]="Smarthelmet";//network SSID name
Char password[]="ecedept123";//network password
void setup()
{
Setbaudrate(value); //initialise baud rate
Display("Attempting to connect to WPA network");
// if not connected stop here
Display("Connected to the Smart Helmet system"); //if connected, print info about connection}
```

APPENDIX-II

The pseudo-code for uploading sensor values over the cloud is given as follows:

```
//header file declaration for xively
//declare global variable datastream;
#intialize xively feed
API_KEY="EC1POZSAHGAYV8Y"
api=xivelyAPIClient(API_KEY);
readPressureSensor()
{
#return pressure sensor readings;
}
readAlcoholSensor()
{
#return alcohol sensor readings;
}
Runcontroller()
{
Pressure=readPressureSensor();
Alcoholcontent=readAlcoholSensor();
Display("Updating xively with pressure sensor values: %s",Pressure);
Display("Updating xively with alcoholsensor values: %s",Alcoholcontent);
Pressure.update();//updating the pressure sensor values;
Alcoholcontent.update();//updating the alcohol sensor values;
}
```