SMART*I* B*OT*

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Abstract— With the ever growing trends in technology it has become essential to develop smart systems in each field which give more output in less involvement of man power. This paper represents one such idea of Smart Fire-fighting Robot which uses the concept of IOT (Internet of Things) to control the Robot wirelessly. It not only overcomes the drawbacks of conventional fire-fighting techniques but also proves better than other technologies introduced till date by enabling the feature of controlling the robot wirelessly using Wi-Fi and ability to monitor the surrounding of robot with the help of visual provided by camera. The main objective of this paper is to detect the fire and extinguish it in places where humans cannot reach easily.

Keywords— Android App - Blynk, Fire-Extinguishing, Robot Design, Water Pump.

1. Introduction

Life is the most priceless gift from the universe. It cannot be substituted or replaced. As generations have passed on, complexity of life has increased to such an extent that populaces are certainly not concerned about the safety processes. In the present day scenario, fire accidents are on the rise due to sheer negligence and hence resulting in the loss of countless lives to which no effective procedures are being undertaken [1]. This paper presents an effective and efficient method to tackle fire accidents. The paper also proposes a robot which is equipped with on-board water supply and a pick and place arm enabling it to remove any obstacles coming in its way. The robot is controlled using Arduino, which performs various operations based on the commands received from the android app "Blynk", which serves as a platform for developing a wireless controller (remote controller). The system is incorporated with an ESP8266 module which is a Wi-Fi module interfaced to Arduino which enables IOT control. This increases the credibility of the system. Also there is a network of sensors which make this robot feel safe-system and also provide a feedback of the surrounding environment using temperature sensor, humidity sensor, and gas sensor [2].

2. Block Diagram

In the block diagram as shown in Fig.1, all the inputs form various sensors, camera and Wi-Fi communication are shown on the left of the controller. The components on the right of the controller are for output devices like motors, pick-n-place arm and water pump [3]. Also power supply unit is provided to all blocks via battery

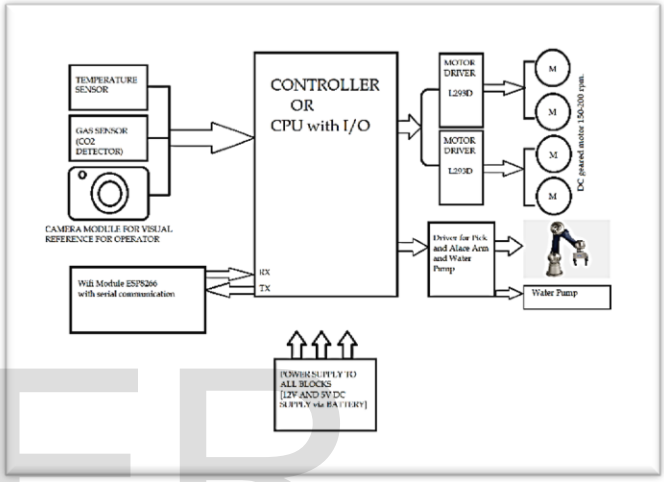

Fig.1 Block Diagram

3. Components Used

- Controller: **NodeMCU**.

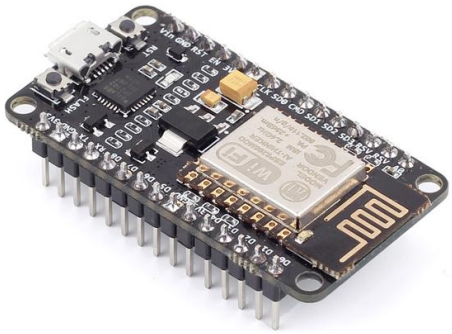

Fig.2 NodeMCU

NodeMCU is a Wi-Fi integrated Arduino board [4] as shown in above Fig.2 and its specifications are shown in Table 1 below.

Table 1. Hardware Specifications

Hardware Paramaters	Peripheral Bus	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/PWM
	Operating Voltage	3.0~3.6V
	Operating Current	Average value: 80mA
	Operating Temperature Range	-40°~125°
	Ambient Temperature Range	Normal temperature
	Package Size	5x5mm

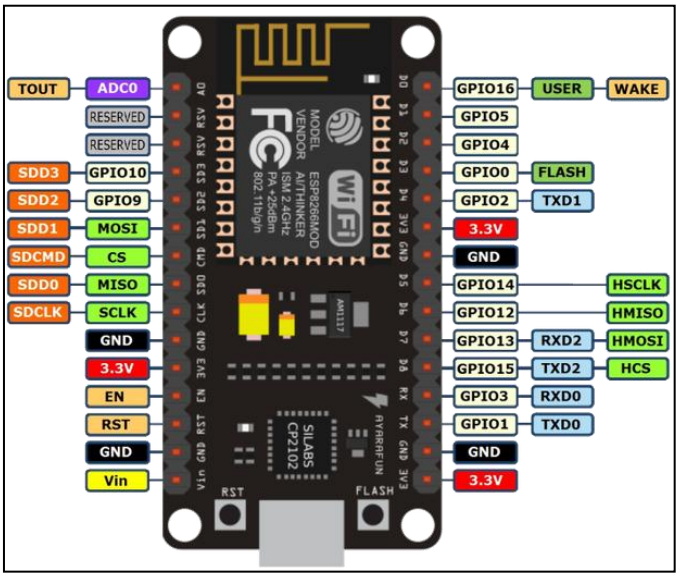

Fig.3 Pinout of NodeMCU

The above figure, Fig.3 shows pinout of NodeMCU. NodeMCU ESP8266 based boards were first introduced with LUA scripting language for programming but since Arduino IDE is most popular among electronic hobbyist for programming the development boards, so this leads to the esp8266 package that needs to be added to Arduino IDE for programming ESP based boards [5]. Since the NodeMCU ESP8266 boards were designed for a different architecture but later on implemented for Arduino IDE, as a result, we needed GPIO pin mapping of NodeMCU pinout that is marked on the board from D0-D8 but while in coding we use the mapped GPIO pin no. so that (note that in latest IDE we can directly write the pins as D0, D1 or so.) Here is the **NodMCU Pinout** of the Pins mapped with their corresponding values of GPIO no. [6]. For example – D7 pin mapped to GPIO pin 13, so in coding, we need to declare the D7 as pin 13.

- Temperature and Humidity Sensor: **Dht11.**

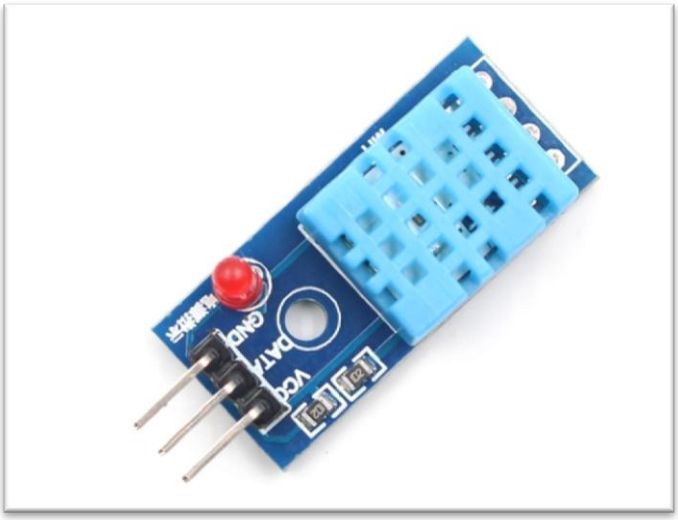

Fig.4 DHT11

The operating voltage and resolution for DHT11 sensor as shown in Fig.4 is as follows [7]:-

i. Operating Voltage: - 3v-5.5v DC
ii. Resolution: - For temperature = 1^0c
For Humidity = 1%RH

- Gas Sensor: **MQ-9**

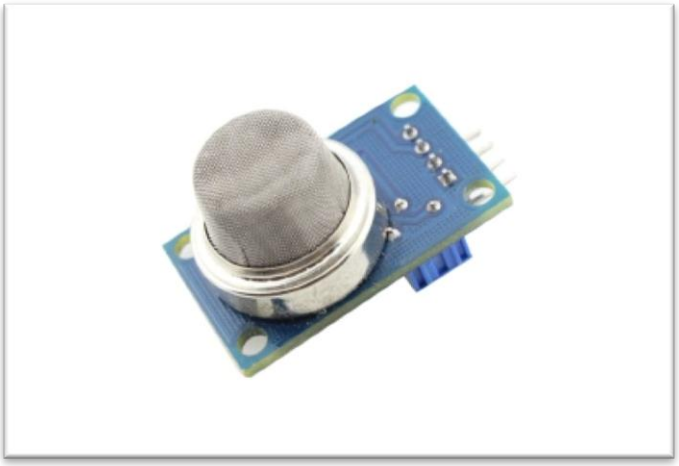

Fig.5 MQ-9

Table 2. Specifications of MQ-9

Model No.			MQ-9
Sensor Type			Semiconductor
Standard Encapsulation			Bakelite
Detection Gas			CO and combustible gas
Concentration			10-1000ppm CO 100-10000ppm combustible gas
Circuit	Loop Voltage	V_C	≤10V DC
	Heater Voltage	V_H	5.0V±0.2V ACorDCHigh 1.5V±0.1V ACorDCLow
	Heater Time	T_L	60±1SHigh90±1SLow
	Load Resistance	R_L	Adjustable
Character	Heater Resistance	R_H	31Ω±3ΩRoom Tem.
	Heater consumption	P_H	≤350mW
	Sensing Resistance	R_S	2KΩ-20KΩ(in 100ppm CO)
	Sensitivity	S	Rs(in air)/Rs(100ppm CO)≥5
	Slope	α	≤0.6(R_{300ppm}/R_{100ppm} CO)
Condition	Tem. Humidity		20±265%±5%RH
	Standard test circuit		Vc:5.0V±0.1V V_HHigh: 5.0V±0.1V V_HLow: 1.5V±0.1V
	Preheat time		Over 48 hours

The Grove - Gas Sensor (MQ9) as shown in Fig.5 is a module which is useful for gas leakage detection (in home and industry). It is suitable for detecting LPG, CO, CH4. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible [8]. The sensitivity of the sensor can be adjusted by using the potentiometer. MQ-9 sensor provides both analog as well as digital readouts. Hence in this project it is connected to the analog pin of NodeMCU. Table 2 shows the specifications of MQ-9 sensor.

- Motor Drivers: **L293D**

Fig.6 L293D Motor Driver

As shown in Fig.6, L293D motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors . The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins [9].

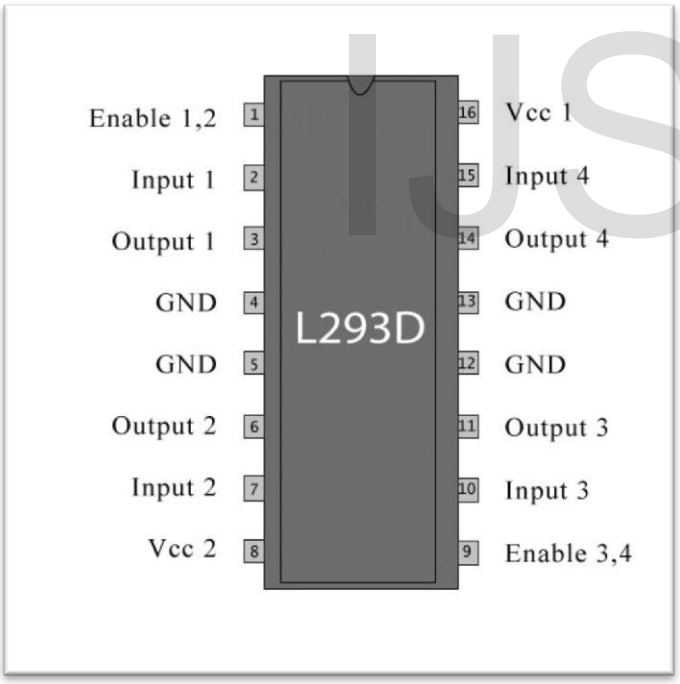

Fig.7 Pinout of L293D

Fig.7 shows the pinout structure of L293D motor driver IC.

Table 3. Pin Description of L293D

Pin No	Function	Name
1	Enable pin for Motor 1; active high	Enable 1,2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	Vcc 2
9	Enable pin for Motor 2; active high	Enable 3,4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	Vcc 1

Table 3 shows the pin decription of L293D motor driver IC. It is a 16 pin IC.

- Characteristics of L293D: -

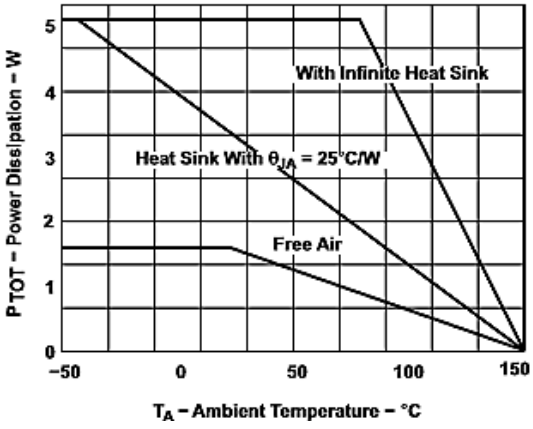

Fig.8 Characteristics graph of L293D

The above characteristics graph shown in Fig.8 is taken from the data sheet of L293D provided by Texas Instruments [10]. It is a graph of power dissipation Vs ambient temperature of L293D motor driver.

- Motors: **12V DC Geared Motors 200 RPM**

Fig.9 12V DC Geared Motor

Fig.9 shows 12V DC geared motor. It's specifications are as follows:-

i. RPM: 300 at 12V.
ii. Voltage: 4V to 12V.
iii. Stall torque: 23Kg-cm at stall current of 8.4A@12V.
iv. Shaft diameter: 8mm.
v. Shaft length: 17.5mm.
vi. Gear assembly: Spur.
vii. Brush type: Carbon.
viii. Motor weight: 280gms.

- Water Pump: **3V DC**

Fig.10 Submersible Water Pump

Fig.10 shows submersible 3V DC water pump. Water canon is also used for extinguishing. Its features are as follows:-

i. Works between 3V to 6V and water submersible.
ii. Can be used in water or any other free flowing liquids - Coke / Pepsi anyone [11].
iii. Red wire indicates positive and black (or white) is for the negative terminal of your power source.
iv. Long lasting and sturdy plastic body

- Robotic Arm: **Pick-N-Place Arm**

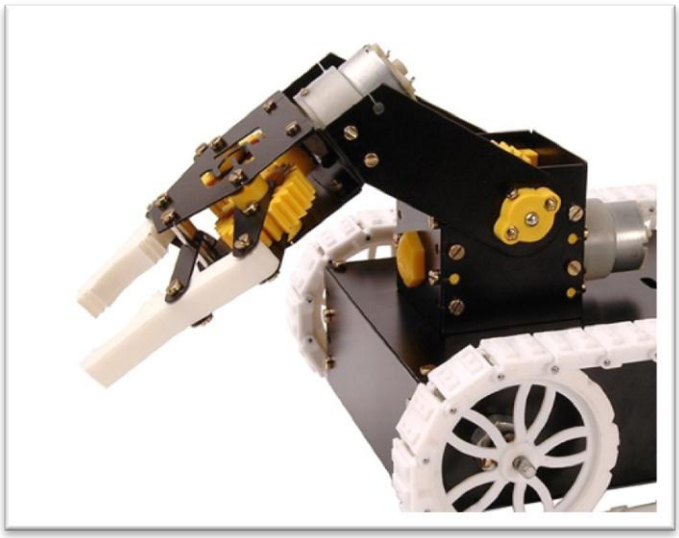

Fig.11 Robotic Arm Mounted on to the Robot Chassis

The above Fig.11 shows robotic arm mounted on to the Robot Chassis.

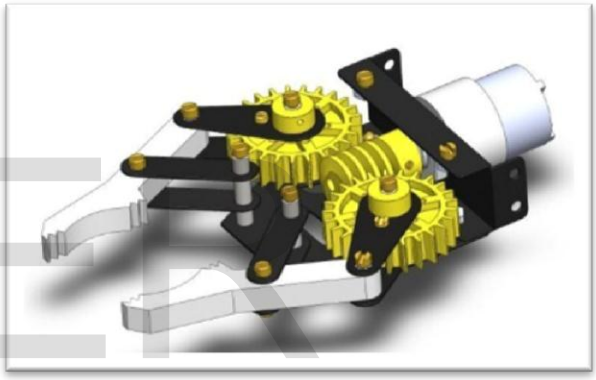

Fig.12 Schematic of Gripper

Fig.12 shows schematic structure of gripper of robotic arm which whe have used in our project. The basic function of a pick and place robot as shown in Fig.16 is done by its joints. Joints are analogous to human joints and are used to join the two consecutive rigid bodies in the robot. They can be rotary joint or linear joint. To add a joint to any link of a robot, we need to know about the degrees of freedom and degrees of movement for that body part. Degrees of freedom implement the linear and rotational movement of the body and Degrees of movement imply the number of axis the body can move.

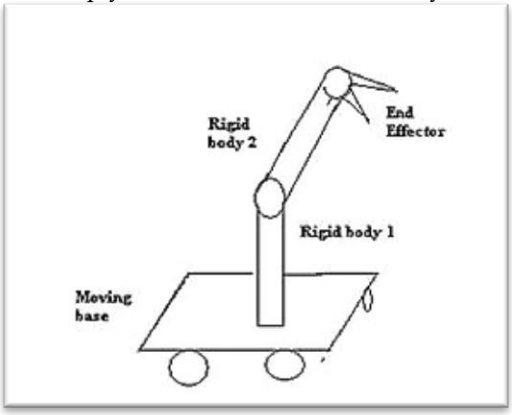

Fig.13 Working of Basic Pick N Place Robot

- **Camera Module**

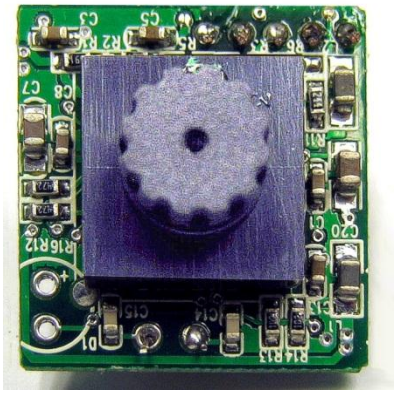

Fig.14 Camera lens

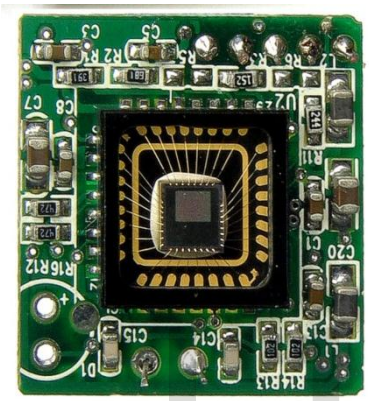

Fig.15 Image sensor

A **camera module** as shown in above figures, Fig.14 and Fig.15 consist of an image sensor integrated with a lens, control electronics, and an interface like CSI, Ethernet or plain raw low-voltage differential signaling.

4. Implementation

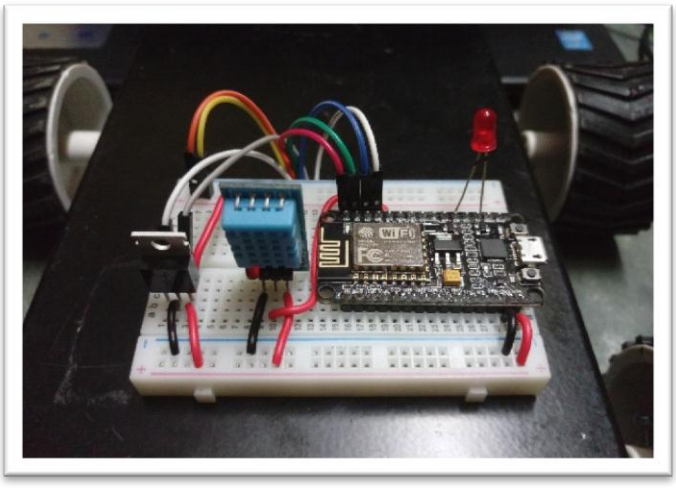

Fig.16a Actual Circuitry Mounted on the Robot

The actual circuitry implementation of robot is shown in above Fig.16a.

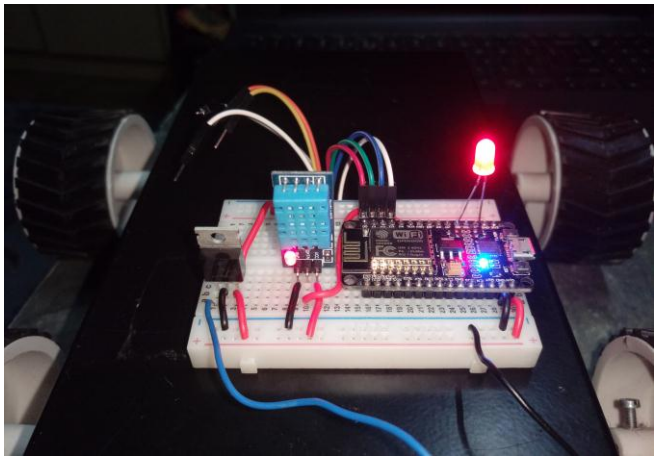

Fig.16b Water Pump ON

The red led glowing in the Fig.16b indicates the water pump is on.

In the above figures, Fig.16a and Fig.16b, we have implemented our hardware part of our project i.e. all sensors, modules, along with connections on the Robot Chassis. Also we observed that the water pump ON indication is represented by LED which glows after successful connection and arduino coding. It indicates that the fire is sensed and water pump is ready to extinguish the fire.

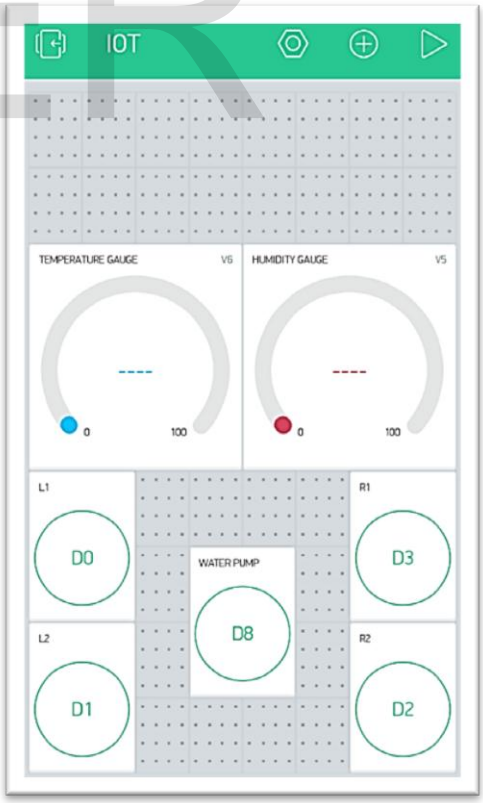

Fig.17 Blynk UI

In the above Fig.17, Android App-Blynk is shown along with the following controls for controlling the robot:-

- **D0-D3:-**Controls for Robotic Vehicle movements.

- **D8: -** Water Pump Control**.**
- **V5: -** Humidity Gauge.
- **V6: -** Temperature Gauge.

In this project we have used virtual pins (V5 and V6) of NodeMCU for Temperature and Humidity monitoring. The DHT-11 sensor is actually connected to the D4 pin of NodeMCU Controller. Since DHT-11 alone senses both temperature as well as humidity, we use virtual pin to separate out both quantities [12].

Working:

The robot we designed works on the instructions received over the Wi-Fi form the Blynk app. For authentication purpose, an authentication token is used. This token is generated by the Blynk App when we initiate the process of designing the controller app as shown in below Fig.18

```
32 // You should get Auth Token in the Blynk App.
33 // Go to the Project Settings (nut icon).
34 char auth[] = "12b4e3e90133439ca9666b3927e8a941";
```

Fig.18 Authentication Token entered in the Arduino program.

```
36 // Your WiFi credentials.
37 // Set password to "" for open networks.
38 char ssid[] = "xxxxxxxxxxx";
39 char pass[] = "xxxxxxxxxxx";
```

Fig.19 Space for Wi-Fi credentials in Arduino Program.

The name of Wi-Fi network (SSID) and the password for that network are to be entered into the fields shown in the Fig.19.

The main use of the token is to validate and allow only the authentic user to use the robot from any remote location. Using the authentication token only the specified robot will be controlled [13].

5. Results and Discussions

```
·lýþh%´E¤□Connecting to karan
[3232] Connected to WiFi
[3232] IP: 192.168.0.4
[3232]
    ___  __          __
   / _ )/ /_ _____  / /__
  / _  / / // / _ \/  '_/
 /____/_/\_, /_//_/_/\_\
        /___/ v0.4.10 on NodeMCU

[5001] Connecting to blynk-cloud.com:8442
[5127] Ready (ping: 0ms).
```

Fig.20 Serial Monitor of Arduino IDE

The above figure, Fig.20 shows that the robot is connected to the local Wi-Fi network and has obtained the IP address.

```
Temp = 32.00 Humi = 33.00
Temp = 32.00 Humi = 33.00
Temp = 37.00 Humi = 30.00
Temp = 37.00 Humi = 30.00
Temp = 32.00 Humi = 33.00
Temp = 32.00 Humi = 33.00
Temp = 32.00 Humi = 42.00
Temp = 32.00 Humi = 42.00
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Temp = 32.00 Humi = 41.00
Temp = 32.00 Humi = 41.00
Temp = 34.00 Humi = 41.00
Temp = 34.00 Humi = 41.00
```

Fig.21 Serial Monitor of Arduino IDE showing readings of temperature and humidity.

The physical quantities sensed by the sensors are transmitted as shown in Fig.21 and are shown on to the Blynk App as shown in Fig.22 which we have configured to receive and transmit information to and fro from the robot over Wi-Fi.

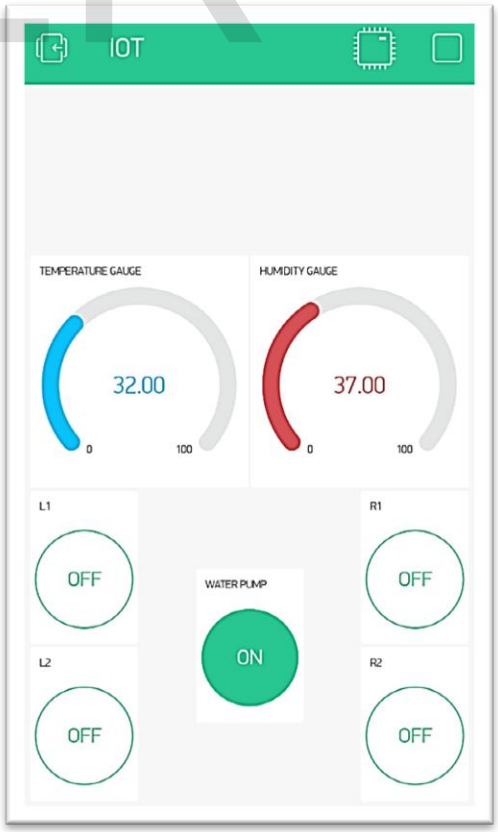

Fig.22 Blynk App Showing the Temperature and Relative Humidity Readings.

6. Conclusion

i. This paper has presented a unique vision of the concept which are used in this particular field.
ii. It aims to promote technology innovation to achieve a reliable and efficient outcome from the various instruments [14].
iii. Thus our Robot detects temperature, smoke and flame at the site where the fire exists.
iv. The movement of this robot vehicle is controlled by the controller as per the commands given by the operator via the internet enabled device (e.g. via the app on android phone).
v. This robot is help full in those areas where natural calamity and bomb explosions can occurs.
vi. If fire is detected with the help of sensors, controller operates the water pump mechanism through driver/relay circuit.
vii. Finally it reduced the efforts of human labour and level of destruction.

7. Future Enhancement

i. Speech processing and AI (Artificial Intelligence) can be integrated into this robot to enable it communicate with user and any person trapped in fire (if any).
ii. Also a 360 degree camera can be interfaced with the bot to provide a view of 360 around the bot.
iii. Improve the pay load i.e. weight carring capacity of the BOT.
iv. Reduce the overall weight to make the BOT more flexible [15].

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