

IoT Development Board for Engineering Applications

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Abstract

Technology developments in engineering applications has made life easier. Nowadays, Internet based computations and control are more popular. Internet of Things (IoT) is the latest improvements in industrial domain. This technology revolution satisfies the industrial requirements and societal needs. In the present scenario, most of society related research are carried out in the IoT domain. In this project, how the different sensors are being connected to the microcontroller and how the real-time data is collected and used as required by the application, have been discussed. It shows the advantages of the graphical view of the data output by which, the changes can be understood easily and in a more convenient way. This paper briefs about the IoT development board and the peripheral components. The methodology for interfacing the sensor and the communication with the cloud has also been detailed.

Keywords: Design board, sensor interfacing, wireless communication, IoT interfacing, cloud communication

1. Introduction

The IoT is the framework in which the sensor, processors and other devices are integrated together for exchanging and processing the data through cloud server. The implementation the IoT for any application depends on its architecture. During the initial stages of research, the IoT had 3 layers, application layer, network layer, perception layer.

- Perception layer: It is the layer in which all the actuators work according to the data, or the information collected by the sensors.

- Network layer: This layer establishes a link between the perception layer and the application layer by providing communication network.
- Application layer: This is the main working layer responsible for the working of the sensors, according to the software provided.

The prototype of IoT allows integrating various objects in a secured connection. All the connected devices can be accessed and controlled using a centralized controller. The entire network supports engineering applications with improved efficiency and accuracy in data processing. In 1982, the smart network devices concepts were started. Kevin Ashton is known for inventing the “Internet of Things” (IoT) which is a system where the internet network is connected to the world around us by different sensors [3]. IoT is able to interact with different devices/objects without human or manual intervention. Some of the basic IoT has a lot of applications in different fields such as the medical healthcare, or the transportation department, and automotive industries. Many new developments along with the IoT, has led to the new developments with different electronic sensors.

2. Literature Survey

IoT is one of the leading emerging technologies that has various techniques in wireless communication, sensor networks and embedded systems. The technology has progressed and the purpose to design a device that can sense the data from the surrounding and exchange the information over the cloud without any manual work is the same. The IoT is used to connect different smaller devices or sensors and establishes a small interface between the device and the people using the Internet as the base to communicate with one another. The ability of the different sensing devices to gather real time from around us through a network is referred as the IoT [1].

Cloud computing is used to store the collected data and analyze them. It makes it easier for the user to access the required particular information based on the application easily. However, IoT devices can be modified on the application based on the requirement, and store large data and process them accordingly, and solve the real time problems.

Some of the common problems faced are the communication problems. The different sensors sometimes face interrupted connectivity which will in turn affect the communication. Also, another problem with the sensors is when the number of sensors increase, the compatibility becomes an issue. Once the data are collected, the next step is to safeguard it,

so security of sensor communication or the channel becomes critical. Due to this, many protocols need to be maintained for the betterment and progress.

3. Development of IoT Board

An IoT development board includes a specific microprocessor, the stripped-down hardware components required to support its use, and few more. Along with the microprocessor, these boards typically include a power supply, an interface that allows components on the board to be programmed, and some basic input and output devices, like buttons and LEDs. Engineers can usually connect a device – a computer, a USB flash drive, or another input object carrying minimal software that can run code.

Development boards provide two specific benefits to engineers prototyping an IoT device:

- They allow them to work with a standard set of circuits and power supplies that would otherwise have to be reassembled for every project; and
- They are stripped down and simple enough that they provide a quick, affordable way to test software and IoT device functionality.

3.1 IoT Evaluation Board

The IoT Evaluation Board containing the different sensors and other components are shown in the figure 1.

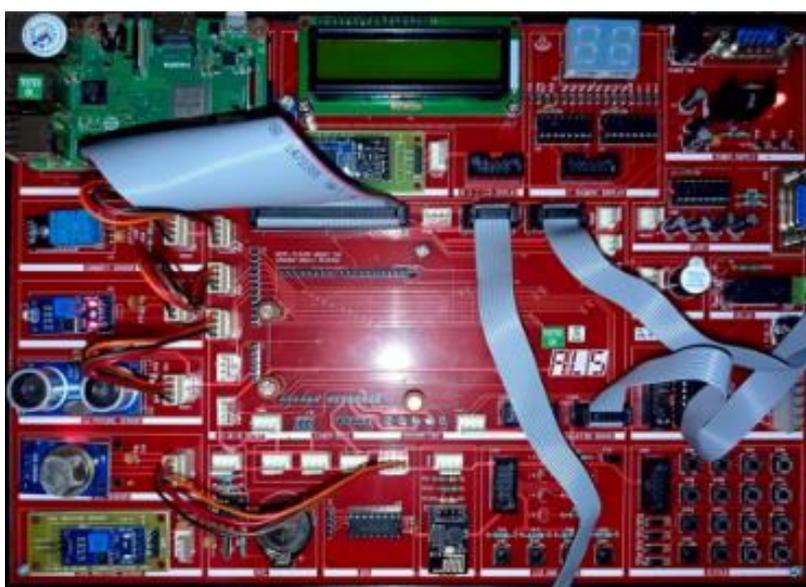


Figure 1. IoT Evaluation Board

IoT development boards could be used to test an automation of some kind such as, a system to water crops on a schedule, or to turn an industrial facility's HVAC system on and off at specific times. Development boards can also be helpful when an IoT engineer needs to ensure functionality in a more extreme environment i.e., when heat or cold, or humidity is potentially hazardous. The boards provide a cheaper way to evaluate risks to equipment and to evaluate whether all systems will function appropriately in real-world conditions before deploying a full complement of devices. The most accurate result is essential to select the type of board that allows the right testing processes and yields.

3.2 Hardware Description

3.2.1 IoT Kit Specification

The initial stage of developing an IoT board has few requirements such as:

- Authentication of users
- Configuration of Controller
- Monitoring the Process Variables
- Diagnostics
- Updating the latest software to avoid malware attacks

The development board has the compatibility with few sensors, so that IoT applications can be developed and tested easily. The component specifications are tabulated in table 1.

Table 1. Specifications of the Components

Components	Specifications
Raspberry Pi 3	64bit CPU, 4USB 2.0 ports, Micro SD port, BCM43438 wireless LAN, 1 GB RAM
Humidity Sensor	Operating voltage: 3.5V to 5.5V, current: 0.3mA, Temperature Range: 0 to 50 degrees
Light Sensor	Range of Voltage: 3.3V to 5V DC, Range of Current: 15mA
Temperature and Humidity Sensor	Temperature range DHT11: 0 to 50 degrees Celsius Humidity Range: 20-80%
Gas Sensor	Range: 300 to 10000ppm (for flammable gas)

3.2.2 Raspberry Pi 3

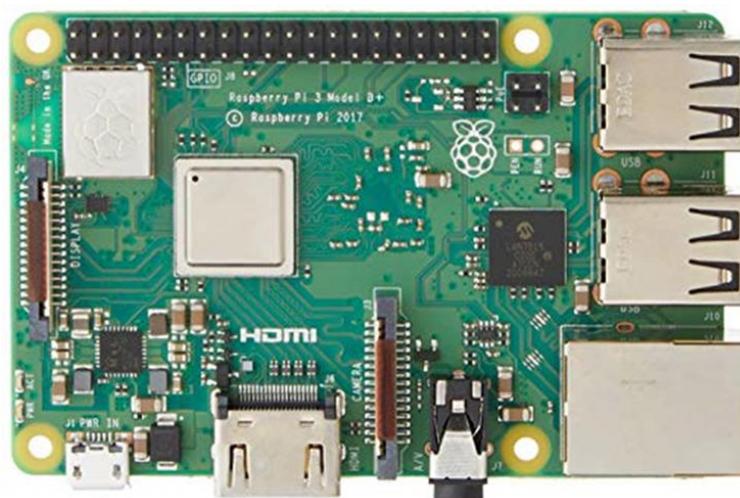


Figure 2. Raspberry Pi 3

Most of the features available in computers are realized by Raspberry Pi. It is a low-cost version of computer, which is compatible with cameras and other interfacing devices. The memory ranges from 256 MB to 1 GB RAM. It has 4 USB ports along with an HDMI port. Its speed ranges from 700 MHz to 1.2 GHz. It supports python programming and OpenCV. Various computing algorithms and real time image processing techniques can also be implemented with fun ways of learning.

3.2.3 Humidity and Temperature Sensor

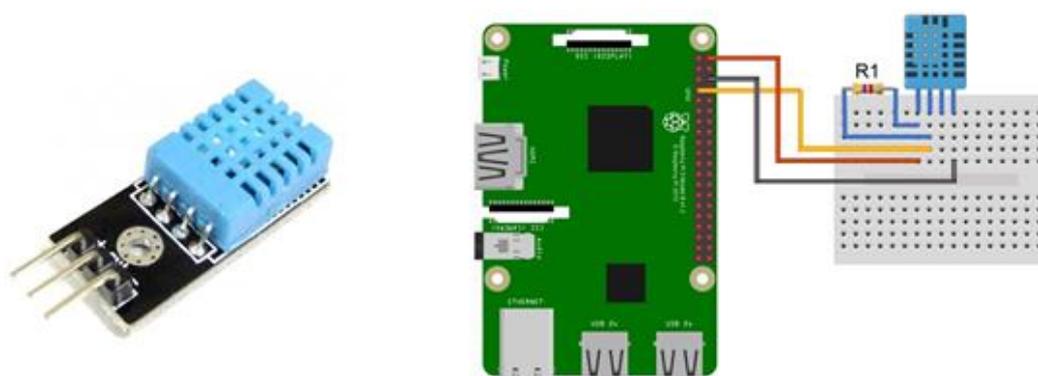


Figure 3. (a) Interfacing Temperature Sensor (b) with Arduino

The temperature and humidity sensor DHT22 is shown in figure 3. The sensor used here is a basic and a low-cost sensor which senses the humidity in the range of 20 to 80% and

the temperature. This humidity sensor is a capacitance -based sensor. Thermistor is used to measure the surrounding temperature. Every two seconds the data can be logged.

3.2.4 Light Sensor

A light sensor is used to measure the light intensity. It is basically a photo resistor which has the property of changing the resistance with respect to change in light intensity. The resistance is inversely proportional to the light intensity. The light sensor used in the evaluation board is shown in figure 4.

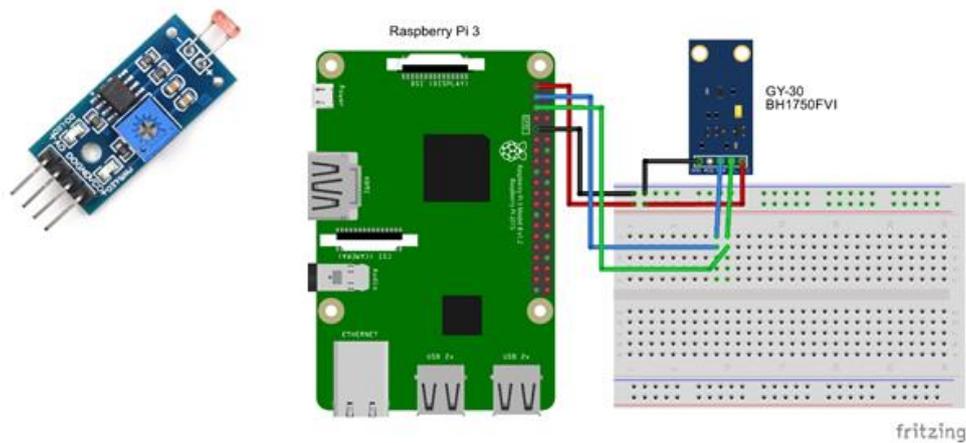


Figure 4. (a) Interfacing Light Sensor (b) with Arduino

3.2.5 Ultrasonic Sensor

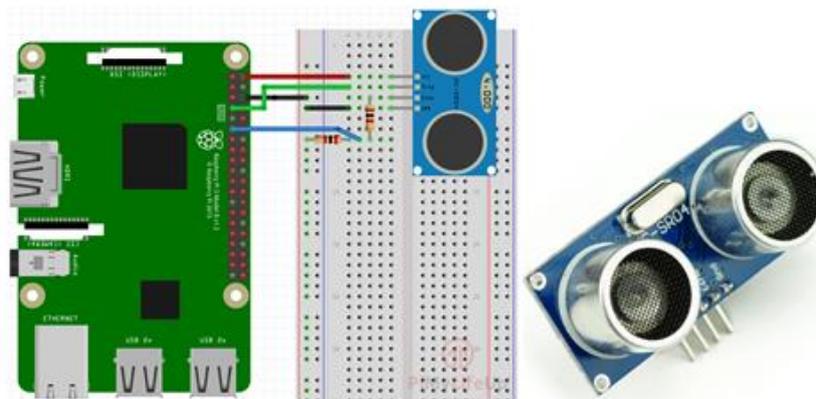


Figure 5. (a) Interfacing Ultrasonic Sensor (b) with Arduino

Ultrasonic sensors are commonly used for distance measurement. Obstacle detections and distance between different objects can also be measured using this sensor. This ultrasonic sensor is made up of a transducer and this transducer is used to transmit and receive the

ultrasonic signals that give back the output about the object's proximity or nearness. The high-frequency sound waves that reflects from boundaries, produce distinct echo patterns which are used to measure the distance. The sensor used in the board is shown in figure 5.

3.2.6 Gas Sensor

Many types of gas sensors are available in the market. Few sensors utilize the effect of specific sensing materials to detect the gaseous components. These materials are normally treated with platinum and have the effect of change in resistance while detecting gasses. The sensor used in the development board is a Metal Oxide Semiconductor (MOS) type Gas Sensor. The Interfacing gas sensor with development is shown in figure 6.

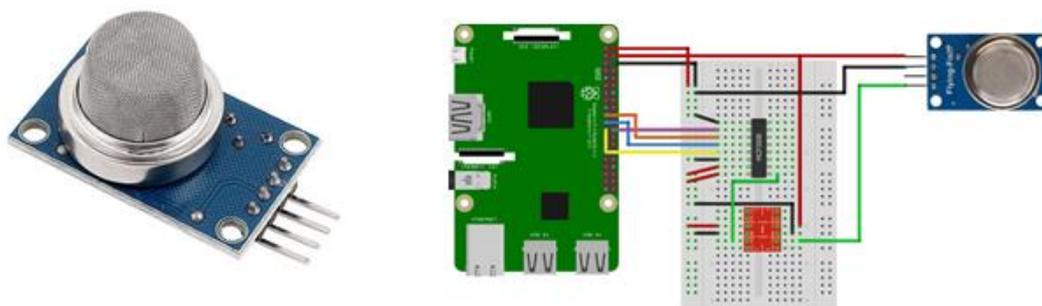


Figure 6. (a) Interfacing Gas Sensor (b) with Arduino

4. Methodology

4.1 Block Diagram

Block Diagram shown in figure 7 depicts the complete structure of the IoT development board. The micro controller is the heart of the application where the program is written and dumped on it. In the given block diagram below, it can be seen that there are four sensors connected to the main processor that is the microcontroller. Raspberry Pi 3 is used in this project and the sensors are Ultrasonic Sensor, Light Sensor, Temperature and Humidity Sensor and a Gas Sensor. The IoT Board can use any kind of microprocessor depending upon the application that is required. The real time data is being monitored in the cloud. Here, the ThinkSpeak Cloud is used, which gives the real time data from the sensor in a graphical way.

Whenever the IoT is used for any related application, it requires network. Since many devices/things (sensors) are connected through the internet, the configuration of the network is required. In this Development Board, the IoT Cloud servers used in here is the ThinkSpeak cloud, and they will use web-based user interface to manage and control the data collected.

The IoT server that collects the real time data is used for monitoring the status of the applications. The data exchanged will be saved in the cloud servers.

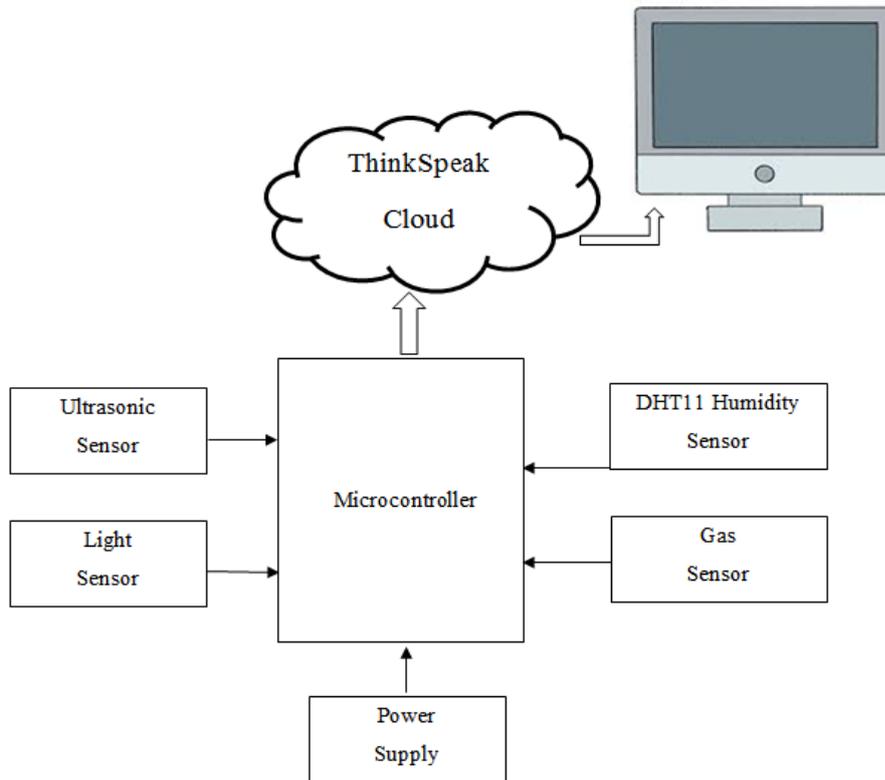


Figure 7. Block Diagram

4.2 Flowchart

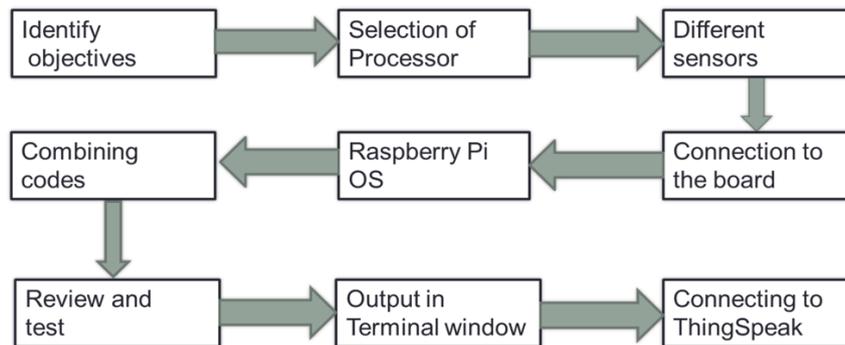


Figure 8. Flow chart

4.3 Working Procedure

An IoT development system with sensors, controllers and other devices can be able to communicative with each other through cloud server. All the data from the sensor are given to the cloud. Once the data reaches the cloud, then the processing of the data is started and

will decide what action is to be performed depending on the application, such as sending an alert or automatically adjusting the sensor without manual interruption.

In the development board used, there are many sensors and other components integrated. It includes raspberry 3, gas sensor, light sensor, buzzer, humidity sensor, ultrasonic sensor, etc. Based on the requirement of the application, the components can be individually interfaced and the desired output can be obtained, or all the components can be interfaced together if required [6].

The next step is to do all the port pin connections using the cables and then to connect the raspberry pi OS. Once the Raspberry pi is booted up to GUI, the keyboard and the mouse are connected to the USB slots.

- A 40 pin FRC cable connects the microcontroller to the rest of the board.
- 4 pin connector wires are used to connect the DHT11 humidity sensor, light sensor, ultrasonic sensor, and gas sensors to the board.
- Using the Thonny IDE, the python code is loaded onto the processor.
- Then the required configurations of language and time zone are changed. It is connected to the Wi-Fi and the date and time are checked. Once all the settings are done, the Terminal window is opened and the following default commands are executed:
 - `sudo apt-get update`
 - `sudo apt-get upgrad`
- Now the programs are written on the Thonny Python IDE and the program is executed in the terminal by the following command:
 - `sudo python<program-name>.py`

The output appears on the terminal window. Now, it can be connected to the ThinkSpeak Cloud for the real time data that is collected. The collected data can be seen graphically or in the form of charts for further analysis.

5. ThinkSpeak Cloud

5.1 Introduction

The software used in the development is ThingSpeak. It helps to communicate with the devices connected through the internet. It is a cloud platform to perform various tasks in IoT applications. In this cloud, all the sensor data are gathered and stored, which can be viewed graphically. All these data are stored in the channels. Each channel that is created will have its own API read and write keys to access the channel. Each channel consists of 8 fields to store the data from the different sensors and can be named accordingly [7]. It also contains 3 location fields and 1 status field which describes the data stored.

5.2 Working of ThinkSpeak Cloud

Figure 9. Login page of ThinkSpeak

Figure 10. Image with unique API read and write key

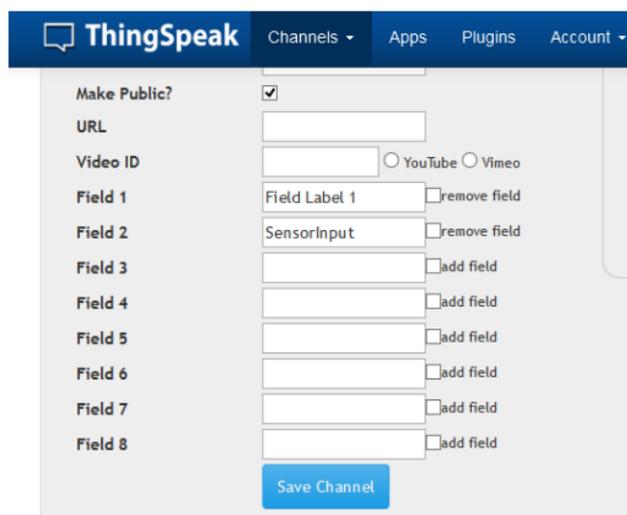


Figure 11. Interface to enter the required different field names

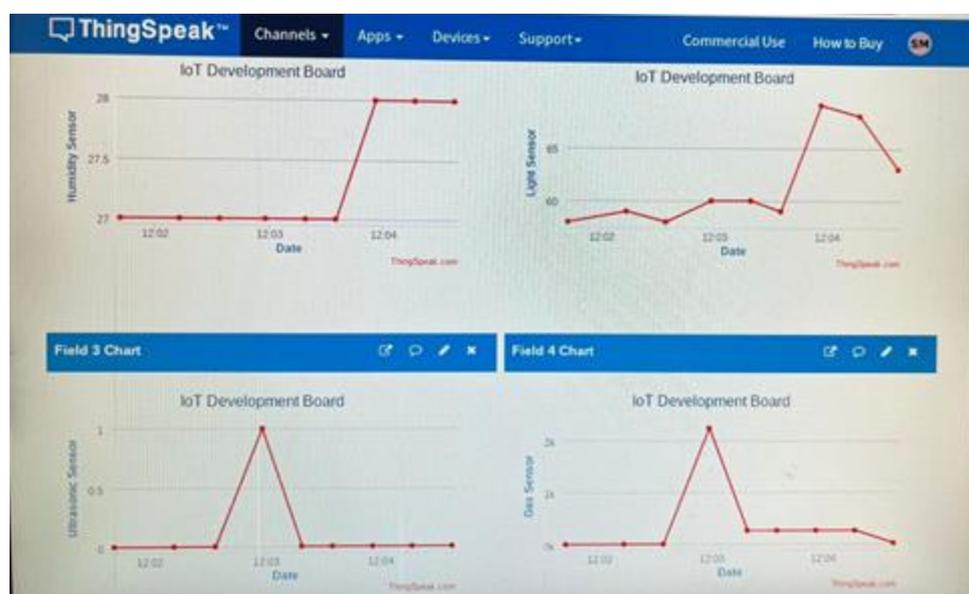


Figure 12. Output from ThinkSpeak Cloud

First, it is signed in into the MathWorks account and a channel is created (figure 9). Once the channel is created, the API keys will be provided which is unique for every individual channel as shown in figure 10. In figure 11, it can be seen that every channel is provided with 8 fields which can be renamed as desired. Since 4 sensors are used, 4 different fields are used and named accordingly.

In the next step, the API keys of the channel is typed in the python code, where the graphical output is obtained. Next, the terminal window is re-visited, and the program for all

the sensors is executed. It is observed that the entire four sensor's output is observed in the ThinkSpeak in a graphical format as shown in figure 12.

6. Applications

Internet is one of the greatest inventions which helps in connecting the people with the computers using the computers and smartphones. The IoT framework described in the previous modules is used in a variety of applications such as:

- Medical Procedures (Medical practitioners to use the collected data with high accuracy for their analysis [9]).
- Smart street light prototype using Ultrasonic and Light sensor.
- Live weather broadcasting using DHT11 and ThinkSpeak Cloud.
- Smart Irrigation prototype using Soil Moisture and DHT11.
- Smart Gas leakage email alerts using Gas sensor and ThinkSpeak alerts.
- Smart Environment monitoring prototype using Gas sensor and with ThinkSpeak alerts.
- Weather display system using DHT11 and LCD display.
- Automatic gate opening and closing system using Mobile app and stepper motor.
- Alarm setting system using RTC, Switches and Buzzer.
- Automatic Fan/AC controlling system using DHT11 and Relay.

7. Conclusion

By studying all the applications of IoT, it can be considered as the most effective emerging digital technology. This will definitely become more useful in the upcoming future applications. Even in the present time, the IoT has a vast application in many fields and its solution have their own advantages. Even though the IoT has a lot of advantages, it does carry few drawbacks which must be taken care of during the implementation. Also, the implementation of the IoT requires a lot of hard work and effort to achieve the required task without facing any problems.

References

- [1] K. Vandikas and V. Tsiatsis, "Performance Evaluation of an IoT Platform," 2014 Eighth International Conference on Next Generation Mobile Apps, Services and Technologies, 2014, pp. 141-146, doi: 10.1109/NGMAST.2014.66.
- [2] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications," IEEE Commun. Surv. Tutorials, vol. 17, no. 4, pp. 2347–2376, 4th Quart. 2015
- [3] L. Atzori, A. Iera, G. Morabito, The Internet of Things: Survey. Computer networks, 2787–2805.
- [4] Graham, M. and Haarstad, H. (2011) Transparency and Development: Ethical Consumption through Web 2.0 and the Internet of Things. Research Article, 7.
- [5] Ruchi Parashar, Abid Khan, Neha, "A SURVEY: THE INTERNET OF THINGS," International Journal of Technical Research and Applications e-ISSN: 2320-8163, Volume 4, Issue 3 (May-June, 2016).
- [6] Somayya Madakam, R. Ramaswamy, Siddharth Tripathi, "Internet of Things (IoT): A Literature Review," Journal of Computer and Communications, 2015, 3, 164-173
- [7] I. Abdul-Rahman and C. A. Graves, "Internet of Things Application Using Tethered MSP430 to Thingspeak Cloud," 2016 IEEE Symposium on Service-Oriented System Engineering (SOSE), 2016, pp. 352-357, doi: 10.1109/SOSE.2016.42.
- [8] Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M., 2013, "Internet of Things (IoT): A vision, architectural elements, and future directions," Future generation computer systems, 29(7), pp. 1645-1660.
- [9] S. Misra, P. Venkata Krishna, Harshit Agarwal, Anshima Gupta and M. S. Obaidat, "An Adaptive Learning Approach for Fault-Tolerant Routing in Internet of Things", 2012 IEEE Wireless Communications and Networking Conference: PHY and Fundamentals, pp.815-819, 2012.