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Research and Development of Smart Internet of Things Based System to Monitor and Prevent House Hold Gas Wastage †

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Abstract: In this paper development of smart Internet of Things (IoT) based system to monitor and prevent the household gas wastage is proposed.An IOT based gas wastage monitoring system has been developed. The system needs to be integrated with the cooker. There are sensors integrated with the system that will find out if the cooker is being used for cooking purpose or not. If it is found that the cooker is not in use there is automated switching off technique in the system to turn off the supply of gas. The system also includes cloud storage feature. With the help of this cloud storage system the use of gas for per day of per user can be monitored. This process will help to detect the misuse of natural gas of per user at the end of the day. The system has been tested and it is working fine. In future more features will be added with this system. This system will help the wastage of natural gas and save the country form reducing the storage of it.

Keywords: Internet of Things; natural gas; cooking; cooker; wastage

1. Introduction

Natural gas is one of the most essential elements of our daily life. Natural gas is used for different areas from households to industrial purposes. It is one of our main fuels for power plants and running vehicles. Households use a significant amount of natural gas as it is a very essential component for cooking. In many countries, most of the households are interested in using natural gas for cooking rather than using electricity or other burner stoves. Also in Bangladesh majority of the households use natural gas for cooking purpose. People have been using it for decades in unorganized way. Majority of the people in Bangladesh are not aware of the critical demand of energy.In our country, the amount of storage of natural gas is inadequate and it is finishing quicker. In Bangladesh, natural gas is used for many purposes. One of the most important uses of natural gas is in the household for cooking purpose.The major issue is that in domestic cooking wastage of gas is very common here. Users sometime forget to stop the cooker after they finished of cooking which causes wastage of natural gas. Users of natural gas in domestic are not very serious about the wastage of gas.They are also not much aware of the consequences of wastage the natural gas. It is very hard for the gas authority companies to monitor this type of wastage of gas and prevent the wastage of it. In this scenarios it is very urgent to monitor and stop the wastage of house hold gas that is used for cooking purpose [1].

Recently, research interest is growing in this area for detecting the gas leakage and prevention, gas wastage monitoring and prevention [2–6]. Different techniques are applied in various articles. A

number of research papers have been published on gas leakage detection techniques [2–4]. In [5] design and implementation of a simple electromechanical system to reduce domestic gas wastage and accidents in South Asia has been presented. Smart ultrasonic device for vitro-ceramic cooker safety control is presented in [6]. However, to the knowledge of the authors of the paper smart Internet of Things (IoT) based system to monitor and prevent house hold gas wattage has been presented. In addition to that in Bangladesh such system is not available. It is very import hat to develop Internet of Things (IoT) based system to monitor and prevent house hold gas wattage. Development of Internet of Things (IoT) based system to monitor and prevent house hold gas wattage has been proposed and discussed in this paper. The system is very user friendly and cost effective. It cost only 10.41 US Dollar which is equivalent to 1383 Bangladeshi Taka.

2. Methodology

In this system the working principle of the whole system is described. Figure 1 shows the block diagram of the whole system showing the function of each section. This system is design through the combination of hardware and software. The main hardware components are Arduino microcontroller, ultrasonic sensors, flame sensor and motor. The software part is cloud based website; see Figure 1. Here in the proposed system, the ultrasonic and flame sensors are used to detect different actions. Ultrasonic sensor detects if there is any cooking pot exists over the household gas burner. Flame sensor is used to detect the presence of fire of the domestic cooker. Arduino UNO microcontroller is the mother components in this system. It is used as a controller unit for every sensors and action of the system. Microcontroller Arduino UNO receives the information from both sensor and process the data based on the data it determines action plan. Servo motor turns the gas supply on/off based on the decision. As mentioned earlier a cloud based feature also included with the system. Using Internet of Things data is stored and display in the website.

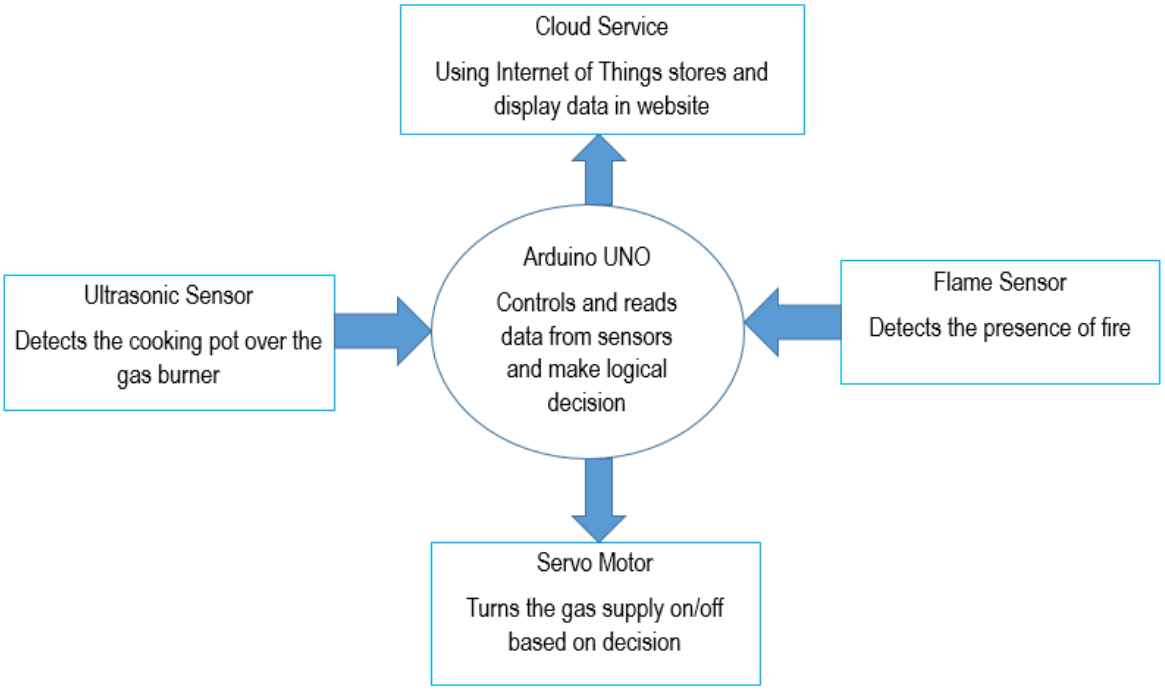

Figure 1. Block diagram of the whole system showing the function of each section.

Figure 2 shows the flow chart of the whole system with more details of the working principle of each section. The IoT based gas monitoring and wastage system has to place on the cooker. The device needs to switch on using the device on power button. Based on the reading of ultrasonic sensor the gas supply will be on or off. If any pot is detected on the cooker the gas supply will be on but if no pot is detected on the cooker the gas supply will be off. After that flame sensor will be on

for the detection of fire and if the pot is off the from the cooker the gas supply will be off and no fire will be on the cooker; see Figure 2 for more details.

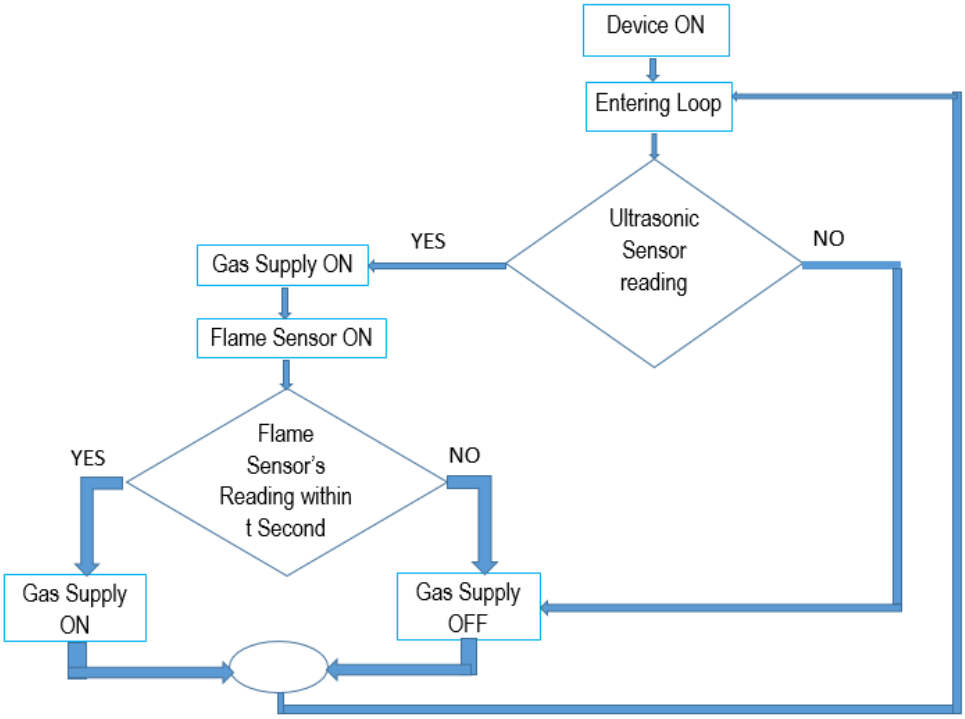

Figure 2. Flow chart of the working principle of the whole system showing more details.

3. Product Design and Analysis

As it mentioned earlier that the whole Internet of Things based house hold gas monitoring and wastage prevent system has been developed thorough combination of hardware and software system. In order to design the system the required hardware are listed as ultrasonic sensor, flame sensor, Arduino microcontroller, and stepper motor. Table 1 list the price of hardware components in Bangladeshi Taka and also in US dollar. From the Table 1, it is observed that the cost of the hardware components are very cheap. In Bangladesh Taka is noticed to be only 1383 Taka which is equivalent to 10.4 US Dollar. The system is very much cost effective. More description about the hardware components are provided in next paragraph.

Figure 3 demonstrates the ultrasonic sensor. This ultrasonic sensor module has transmitter and receiver parts and it also has control unit. Ultrasonic sensor module work very high frequency such as 40 KHz sound wave. The HC-SR04 ultrasonic sensor module has four pins: VCC (power), Trig (Trigger), Echo (Receive), and GND Ground [8]. The HC-SR04 ultrasonic sensor module is basically a distance sensor which can detect the presence of any object within its working range. In this paper HC-SR04 ultrasonic sensor has been utilized to detect the presence of any cooking pot on the cooker. The basic use and working principle of this sensor has been described in earlier section.

Table 1. Cost of the hardware components.

No	Name of the Components	Quantity	Price in BD Taka	Price in USD
1	Ultrasonic Sensor	1	118	1.39
2	Flame Sensor	1	300	3.54
3	Arduino UNO Microcontroller	1	465	5.48
4	Motor	1	500	5.89
	Total	4	1383	10.41

Figure 3. Ultrasonic Sensor [8].

Figure 4 shows the flame sensor that has been used in this paper. A flame sensor usually a detector that is designed for detection of fire. This sensor/detector can be built with an electronic circuit using a receiver like electromagnetic radiation. This sensor uses the infrared flame flash method. The flame sensor module has IR receiver which can sense infrared of a definite frequency that usually can be found in flame. This senor module has four pins: Pin 1(VCC pin), Pin 2(GND), Pin 3 (Analog output known as AOUT), Pin 4 (Digital output known as DOUT). The detection angle of this flame sensor is 60 degree [9]. This module is responsive to the flame range it detects the flame after lighting up the burner and starts the processing part to run the algorithm as described in the previous section.

Figure 5 shows Arduino Uno microcontroller that has been used in his paper. Arduino is an open-source platform usually used for building electronics project. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board. In this paper Arduino Uno microcontroller has been used as the controller unit for each sensor and action. It is working as a mother component for the proposed system. This Arduino Uno microcontroller maintains al the sensors and processes the data and takes the action based on the data. This Arduino Uno microcontroller is programmed and worked based on the algorithm. The operation principle of this component in this system is described in earlier section. Arduino Uno has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button [10]. A stepper motor is an electromechanical device it converts electrical power into mechanical power. A high torque stepper motor was attached with the knob of the cooker for precision rotation [11]. This stepper motor turns the knob on/off according to the algorithm. "Arduino IDE" was used for generally programming the Arduino UNO microcontroller [12]. A cloud storage feature also has been integrated with the proposed system with a view to monitor the usage of gas for per day of per user. Basically data will be uploaded in a central database and that will be shown on the website. This process will help to detect the misuse of natural gas of per user at the end of the day.

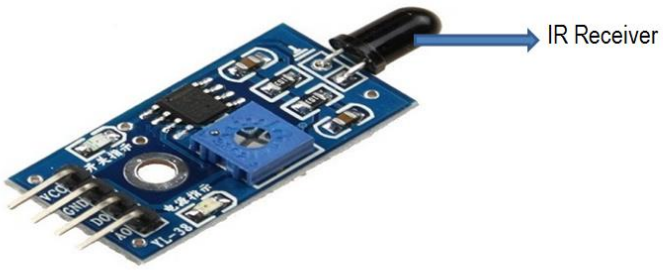

Figure 4. Flame Sensor [9].

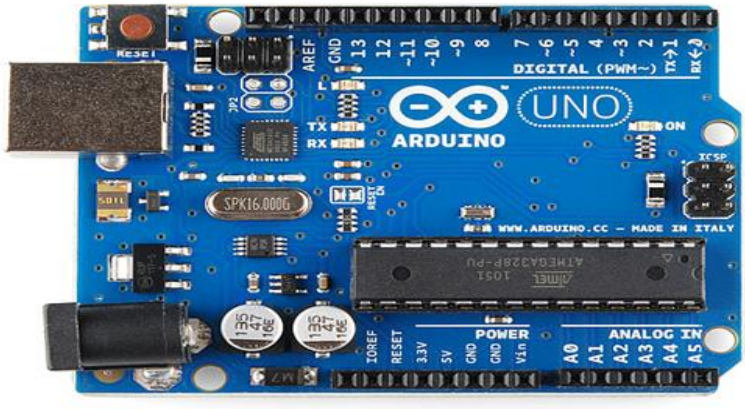

Figure 5. Arduino Uno microcontroller [10].

4. Discussions

The proposed system has been developed and tested. The system is working fine. Due to lack of page and space limit more technical details, results and analysis are not added in this paper. However authors of this paper are working to integrate more features with the proposed system. The authors has plan to add more features in the cloud based web system and also a mobile application is developing to display the data on the mobile phone as well of the user. A gas leakage detection and alarm system are merging with this system so that it can also detect the gas leakage and control the dangerous accident. GSM module will be added also with the new prototype so that in case of any accident information of the incident can be sent to the emergency services like ambulance and fire services. This product is innovative and due to low cost it will be sustainable. However more testing for more number of user cases are needed for real life implementation as a commercial products. Authors are writing a journal paper where all the results will be summarized with more implementation and technical details. The article will be submitted to MDPI journal for review.

5. Conclusions

Development and discussion of a smart Internet of Things (IoT) based system to monitor and prevent house hold gas wastage are presented in this paper. The whole system is based on hardware and software based. An Arduino UNO microcontroller, ultrasonic senor, flame sensor, stepper motor has been used for the development of hardware part of the proposed system. The design working principles are described. The function of each segment of the proposed system are analyzed. Discussion about the required hardware and software are provided. The development

cost of the system is very cheap. It cost of hardware components is only 1383 Bangladeshi Taka which is equivalent to 10.41 UD Dollar. The device has been developed and tested. Authors of the paper are working to introduce more features with the system to make it more smart. After integration of new features with the system it will be tested and implemented in real life scenarios. However the application of this proposed system will be implemented in the industrial areas and final device may be optimized based on the industry requirement. This system will stop unnecessary stop of natural gas rather than cooking. This system will help the wastage of natural gas and save the country form reducing the storage of it. Country will be benefitted greatly by using the final product of this system.

Author Contributions: All authors contributed for the development of the system. The main author of the paper also has written the manuscript. Inputs also were taken from the co-authors. Currently all co-authors are working for the further development and integration of new features of the existing system with the guidance of main author.

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Conflicts of Interest: The authors declare no conflict of interest.

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