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Design and Analysis of IoT based LPG Cylinder Leakage and Weight Detection System

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ABSTRACT

The main purpose of this paper is to portray a method of showing the level of gas in a gas cylinder so that it gives us a idea of the level of gas remaining in a cylinder. It can be used in homes as well as industries where gas cylinders are big and is almost impossible to detect the level of the gas. It enables the user to book a gas right on time, so that user doesn't have to worry about a empty cylinder. Furthermore, sometimes the leakage in the gas cylinder cannot be detected by human nose and requires more sophisticated equipments to detect these gases in order to avoid any mishap, in this project whenever Gas leakage is detected, there is a display on the LCD (3) along with a message sent through GSM(2) modules to our GSM(2) module alarming the user about this Leakage so that some action can be taken. It avoids accidents caused by GAS Leakage in cylinders. Furthermore this project also includes Analysis of the gas used in every month, and will indicate which month has a high gas usage and similarly would also indicate months of lower gas consumption, it will help companies who manufacture gas cylinders for both domestic as well as Industrial purpose.

Keywords: *Arduino UNO, MQ 135, GSM (2) modem, Load Cell, Ethernet Shield.*

I. INTRODUCTION

Almost 80% of the Homes in India have LPG gas cylinders in their homes nowadays. Prime Minister of India has been taking several steps for making LPG gas compulsory even in rural areas. A drastic change has been observed in the usage of gas cylinders, which was 54% in the last three years and now it has been given a push to a direct 80%. To maintain these many gas cylinders, a effective way of Gas weight and leakage analysis is necessary, for smooth working of LPG manufacturing companies. This project aims at detection of weight and notifies user if the gas needs to be refilled so that the user can never run out of a gas cylinder at home. Furthermore, it prevents accidents in home and industries by notifying users about gas leakage if any. This project also analyses the gas consumption for each month and notifies users or concerned companies about which month has the maximum usage of gas cylinders.

The proposed system uses GSM(2) module to notify the user if a refill is required or any gas leakage is also notified to the user by sending SMS to via the module. The same message is displayed on the LCD (3) screen which is a part of this project and is connected to the Arduino UNO. This project detects weight with the help of a load cell. There are many varities of load cell available in the market, but this project requires a load cell weighing 40 kg.

2. LITERATURE REVIEW

There have been many reviews under this Project; many were done in past either for technical reports or in form of research papers. Reviews for various activities related to Gas cylinders have been performed. Activities like:
1) Gas weight detection
2) Gas leakage detection
3) Automatic Gas booking

In the year 2011 MAHALINGAM, R. T. NAAYAGI,1, N. E. MASTORAKIS, "Design and Implementation of an Economic Gas Leakage Detector", This project developed system to detect the gas leakage and providing immediate alarm or intimation to the user.

Later in 2013, few people developed the design proposed for home safety. This system detects the Leakage of the LPG and alerts the consumer about the leak by buzzer. This project was developed using Microcontroller ARM version 7 processor and simulated using Keil software.

In the year 2014, Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, designed a system, They provided security issues against thieves, leakage and fire accidents. In those cases their system sends SMS to the emergency number provided to it.

In the proposed system we have designed "Iot(1) based Gas cylinder weight detection and leakage and analysis using GSM(2) module". This report focus on detection of economic fuels like petroleum, liquid petroleum gas, and alert the ©surrounding people about the leakage through SMS. It also sense surrounding temperature, so that no fire accidents occurs.
This project alerts the user by sending message to mobile through SMS in two conditions.
They are

- When LPG gas weight reaches to maximum threshold value. (i.e. below 1 kg in our case)
- When the LPG gas leakage is sensed

This project gives alert message by displaying the message on the LCD(3) screen . Also, this project focuses on analyzing the consumption of gas cylinder, on a monthly basis, it gives an idea of which month the gas has been consumed the most. For example, gas cylinders have less consumption in the summer and more in the winter, furthermore gas consumption is less during a holiday period, it analyses data like this. This activity helps the gas cylinder companies to boost the production of LPG

3. DESIGN AND IMPLEMENTATION

A.Abbrevations and Symbols

This proposed paper includes various abbreviations and symbols used, which are as follows.

(1) Iot: Internet of Things
(2) GSM: Global System for Mobile Communications
(3) LCD: Liquid Crystal Display
(4) SPI: Serial Peripheral Interface
(5) PWM: Pulse Width Modulation
(6) ICSP: In circuit serial Programming
(7) SRAM: Static Random Access Memory
(8) EEPROM: Electrically erasable Programmable Read only Memory

B.Design and Working

This proposed project consists of Arduino UNO, Load cell, Gas sensor, GSM(2) Module, LCD(3) screen and a comparator.

The proposed project is programmed on arduino 1.8.5, and the program is written in embedded C language. The program is the heart of the hardware and it connects every hardware to the program via the arduino UNO. Arduino UNO is one of the most commonly used IOT(1) boards as it is easy to implement and connection between devices can easily be created.

In arduino, various libraries are used for connection or working of various devices. Libraries are written in C or C++.The basic function of a library is to provide extra functionality to the sketch (example: ability to control LED or control GSM(2) module, like in this project). A list of 1347 libraries is registered with the Arduino Library Manager. Some common libraries are as follows:

Bridge,EEPROM,Esplora,Ethernet,Firmata,HID,Keyboard,LiquidCrystal,Mouse,Robot Control, Robot IR Remote, Robot Motor, SD,SPI(4), Servo, Software Serial etc.

The libraries used in this project are: SPI(4), Ethernet, Liquid Crystal, and Software Serial.

The main descriptions for the components used below are as follows:

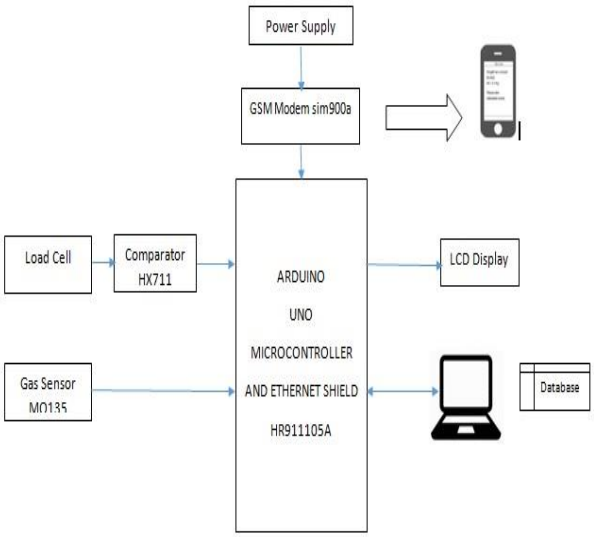

Figure 1: Block diagram of the overall system

C.Arduino UNO

The main component of the proposed system is Arduino Uno microcontroller which works on ATMega328P (datasheet). It operates on voltage of 5V. Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of 14 digital input / output pins out of which 6 pins can be used for PWM(5) output and 6 analog input / output pins. It has a 16 MHz quartz crystal oscillator, a USB connection jack, an ICSP (6) header button and a reset button. It uses a flash memory of 32kb (0.5 kb for boot loader), SRAM (7) of 2kb and EEPROM (8) of 1kb. It has a clock speed of 16 MH. Arduino are capable of reading inputs from different devices connected to it and turn it into output – publishing it on internet. Arduino Uno is connected to the internet by using Ethernet shield HR91115A. The HR91115A is a mini Ethernet shield used to connect the microcontroller to the internet via LAN cable RJ45. This shield enables the user to send and receive data from anywhere in the world with and internet connection. It is based upon the W51000 chip, which has an internal 16K buffer. It has a connection speed of 10/100 Mb. It operates by using Arduino Ethernet library available in the software platform of Arduino Integrated Development Environment. The software platform of Arduino Microcontroller used by the system is Arduino IDE version 1.8.5. It is an open source software which supports easy code writing and uploading the program on the board. It runs on Windows, Mac OS X and Linux.

D.Load Cell

The second component of the proposed system is the load cell used for detection of weight. As per dictionary, a load cell is described as a “weight measurement device necessary for electronic scales that display weights in digits.” However, load cell is not restricted to weight measurement in electronic scales. Load cell is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as “Load transducers”. The load cell used in this system has a limit of 40 kg input.

The load cell requires to be amplified to pass its input to the microcontroller. Hence it is connected to an analog to digital comparator HX711 module. HX711 IC is a 24bit Load Cell Amplifier that allows you to easily read load cells to measure weight. It operates on voltage of 5V. It is connected to the microcontroller to read the changes in resistance of the load cell. It uses two wire interface (clock and data). The HX711 IC can be operated by using the HX711 library in the Arduino IDE.

E.GSM(2) Module

GSM(2) (Global System for Mobile) / GPRS (General Packet Radio Service) TTL modem sim900a quad-band GSM(2) / GPRS device, works on frequencies 850 MHZ, 900 HZ, 800 MHZ and 1900 HZ. It is very compact in size and easy to use as plug in GSM(2) Modem. The Modem is designed with 3V and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V microcontrollers (Arduino, 8051, AVR etc.) as well as 3V Microcontrollers (ARM, ARM Cortex XX, etc.).

The GSM(2) modem operates on voltage supply of 12V. It follows UART (Universal Asynchronous Receiver / Transmitter) protocol for data transmission. It can be connected to the computer by using either USB connection or RS232 interface. Sim900a modem has internal TCP/IP stack which enables users to connect the modem to the internet using GPRS.

F.LCD(3) Module

The proposed system uses Liquid Crystal Display (LCD(3)) for displaying the output provided by the weight sensor and notifications sensed by the gas sensor. A Liquid Crystal Display is a flat-panel display that uses the light-modulating properties of liquid crystals. LCD(3) screen is energy efficient and has low power consumption. LCD(3) screen is connected to the Arduino Uno microcontroller.

G. Gas Sensor

Gas sensor module used in the proposed system to sense any alcoholic substances or hazardous gases is MQ-135 Gas Sensor module. It is highly sensitive to hazardous and explosive gases, especially Benzene, alcohols, other smokes, etc. The operating voltage of this gas sensor is 2.5-5V. The output voltage of the sensor increases with the increasing concentration of measured gases. The sensitivity is adjustable. It is connected to the microcontroller simply using three wired connections.

The description of Libraries used in this project are as follows:

A. SPI(4) :

This library allows you to communicate with SPI(4) devices, with the Arduino as the master device. SPI(4) is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances. It can also be used for communication between two microcontrollers.With an SPI(4) connection there is always one master device (usually a microcontroller) which controls the peripheral devices. Typically there are three lines common to all the devices:

MISO (Master In Slave Out) - The Slave line for sending data to the master,

MOSI (Master Out Slave In) - The Master line for sending data to the peripherals,

SCK (Serial Clock) - The clock pulses which synchronize data transmission generated by the master

And one line specific for every device:

SS (Slave Select) - the pin on each device that the master can use to enable and disable specific devices.

In this proposed project, we have used SPI(4) library as a master.(i.e for the Arduino UNO to connect with other devices).

B. Ethernet

As mentioned earlier Ethernet is used to work with the Ethernet shield. The libraries allow an Arduino board to connect to the internet. The board can serve as either a server accepting incoming connections or a client making outgoing ones. The libraries support up to four concurrent connection (incoming or outgoing or a combination). Ethernet library (Ethernet.h) manages the W5100 chip. Arduino communicates with the shield using the SPI (4) bus. This is on digital pins 11, 12, and 13 on the Uno and pins 50, 51, and 52 on the Mega. On both boards, pin 10 is used as SS. The Ethernet class initializes the ethernet library and network settings. begin(),LocalIp(),maintain(). This project supports a combination of both incoming and outgoing.

C. Liquid Crystal

As the name suggests Liquid Crystal library is used for connecting the LCD(3) with the arduino UNO board. It allows the user to control the LCD(3). Some functions which can be used with this library are as follows:

Autoscroll : Shift text right and left.
Blink: Control of the block-style cursor.
Cursor: Control of the underscore-style cursor.
Display: Quickly blank the display without losing what's on it.
Hello World: Displays "hello world!" and the seconds since reset.
Scroll: Scroll text left and right.
Serial Display: Accepts serial input, displays it.
Set Cursor: Set the cursor position.

Text Direction: Control which way text flows from the cursor.

D. Software Serial

The SoftwareSerial library has been developed to allow serial communication on other digital pins of the Arduino, using software to replicate the functionality (hence the name "SoftwareSerial"). It is possible to have multiple software serial ports with speeds up to 115200 bps. A parameter enables inverted signaling for devices which require that protocol.Some functions which can be used with this library are as follows:

SoftwareSerial() , available(), begin() isListening() ,overflow() peek() ,read() ,println().

E. Implentation of the proposed project

The thing which connects the working mechanism and hardware in our program is the code. The code as mentioned earlier is written by using various libraries. The proposed project is easy to implement and also can be easily operated by the user. Depending on the load cell, the user can weigh any amount of gas cylinder by placing it on top on the load cell. When any kind of weight is placed on

top of the load cell, the LCD screen displays the weight of the cylinder, along with this a message is sent to the mobile phone, a number is feeded to the code, which helps arduino to detect which number the message is to be delivered to. A gas sensor is to be placed just near the load cell, so that if any kind of gas leakge occurs it will recognize and will immediately notify the user by displaying on the LCD as well as by sending a SMS through GSM modem. This project also consists of a HTML page which will display the message on the HTML page when the IP adress as per the code is opened on the browser. The HTML page will display both the weight, and status of whether gas leakage is detected or not. In addition to this if the weight of the gas cylinder goes below threshold value, a notification is displayed on the screen as well GSM modules. Along with this, the database stores monthly gas usage for a particular month, so that the user can easily analyse monthly consumption of Gas cylinder and order accordingly.

4. RESULTS AND DISCUSSIONS

In this project the input devices used are arduino UNO, Load cell, MQ 135 gas sensor. The output devices are GSM Module and LCD screen.

In the initial setup a connection of adapter to the GSM module was done. This switched on the entire setup. Then LAN cable (RJ45) was connected between the Ethernet Shield and the Computer. Then the DHCP settings are changed by enabling the DHCP. This can be done by providing a IP address, which should match the IP address written in the code. The IP address can vary with each computer. Now, after the entire connections, the HTML page is opened and then the program is uploaded onto the board. Now, whenever a weight ranging from 1kg-40kg is placed on the load cell, LCD screen displays the weight as a result, as well as HTML page updates itself about the weight .Message is sent to the GSM Module, if the LPG needs a refill (i.e. if it is below 1 kg). And the next task which should be performed to check the result is by placing a lighter in front of the MQ-135 gas sensor, in this case also the LCD screen and HTML page updates itself about the gas leakage. Also, a GSM Message is sent to the mobile phone.

Finally, these readings are stored in the MYSQL database and analysis of monthly gas consumption becomes easy to the user and indicates which month has the maximum gas consumption and which month has the least.

5. CONCLUSION

In our modern scenario the usage of lpg has increased in a greater manner. As a result of this , the damages caused by the leakage of gas is increasing day by day. So as to eradicate this problems we are introducing highly advanced system known as “design and analysis of iot based lpg cylinder leakage and weight detection system”

. It has a wide scope in the future and can further develop to be used in large scale industries and can also be used in day-to-day life. Our proposed system is more effective and ecofriendly due to the reason of detecting the leakage of gas and alerting the users via lcd and gsm module. So it is mainly designed for the safety of people and property. In this project when the weight of the gas cylinder reduces below a threshold value, one can book a gas cylinder to avoid delay in the gas booking, so that people could easily use their time effectively. It also uses to alert the consumers about the leakage of the gas,so that it prevents hazardous accidents.

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