Design of Gas Stove With Timer & Automatic Closure of Regulator In Gas Cylinder By Stepper Motor Using Arduino

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Abstract- *The Ideology focuses on unwanted usage and carelessness while using the gas stove results in over consumption of fuel without a need and Leakage in gas cylinder leads to alleged incident with huge loss and sometimes even a loss of human life. A solution is proposed to overcome these problems by fixing a stepper motor with regulator of the gas cylinder to avoid the incident, if there is any leakage is detected. A solenoid valve is attached to the regulator of the gas stove to control the flow of gas and a relay with timer is also integrated with gas stove to fix a pre-set time for the burning duration of the gas stove. These hardware components are controlled and commanded by using Arduino Nano Board by a pre-loaded programming code.*

I. INTRODUCTION

A Gas stove is a stove that is fuelled by combustible gas such as syngas, natural gas, propane, butane, liquified petroleum gas or other flammable gas. Before the advent of gas, cooking stoves relied on solid fuels such as coal or wood. The first gas stoves were developed in the 1820s. This new cooking technology had the advantage of being easily adjustable and could be turned off when not in use. A typical LPG cooking system is made up of a steel cylinder filled with LPG, a pressure controller, a tube connecting the cylinder to the pressure controller and the burner, and finally the burner itself. The burner can consist of one or more cooking tops. The size of the system depends on the size of the cylinder. Cylinders exist in various sizes for e.g. 2.7 kg, 6 kg, 12 kg or 16 kg.

A survey in 20 countries showed that low-income countries households mainly use cylinders smaller than 6 kg. Nevertheless, the majority of currently available LPG cylinders are larger (up to 47.5 kg). This proves problematic for low - income households both in the acquisition as well as the recharge of LPG. The important feature of LPG is that its stove efficiency of about 55 – 60 % is much higher than that of many other stoves.

Arduino Nano is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc..., to support the microcontroller. Arduino Nano has 14 digital input / output pins (out of which 6 can be used as PWM outputs), 6 Analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers.

II. LITERATURE SURVEY

In this section, we analyse a review of related existing systems reduction of usage of unwanted fuel in gas stove and also the safer usage of cylinder, which are implemented using various solutions. Each of these systems using different solution has its own features and limitations. This section also highlights some gaps which are required to be filled up in this aspect.

III. PROPOSED SYSTEM

The proposed system consists of three parts as follows,

- Block Diagram of the proposed system
- Hardware module & Interfacing
- Working of the proposed system

3.1 CIRCUIT DIAGRAM OF THE PROPOSED SYSTEM

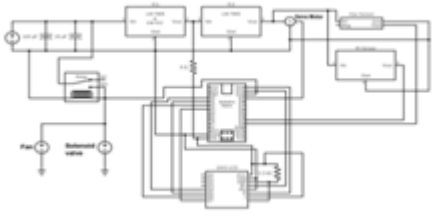


Fig. 3.1 (Circuit diagram)

3.2 HARDWARE MODULE & INTERFACING

3.2.1 ARDUINO BOARD

Arduino Nano is a microcontroller board based on 8 - bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc..., to support the microcontroller.

Arduino NANO has 14 digital input / output pins (out of which 6 can be used as PWM outputs), 6. Analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer.

The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a . inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB - to - serial chip and USB connection to the computer (not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the NANO's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

3.2.2. SOLENOID VALVE

A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its centre. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field.

The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves. A Two - way solenoid valve has two ports, an inlet and an outlet. Flow direction is critical to ensure proper operation, so there is typically an arrow indicating the flow direction. A Two - way valve is used to open or close the orifice. A Three - way valve has three connection ports. Typically, it has 2 states (positions) it can be in. So, it switches between two different circuits. A Two - way valve is used to open, close, distribute, or mix media.

TYPES OF SOLENOID VALVE

Normally closed solenoid valve

For a normally closed solenoid valve, the valve is closed when de - energized and the media cannot flow through it. When current is sent to the coil, it creates an electromagnetic field that forces the plunger upwards overcoming the spring force. This unseats the seal and opens the orifice allowing the media the flow through the valve. Figure - 5 shows the operating principle of a normally closed solenoid valve in the de - energized and energized states.

Normally open solenoid valve

For a normally open solenoid valve, the valve is open when de - energized and the media can flow through it. When current is sent to the coil, it creates an electromagnetic field that forces the plunger downwards overcoming the spring force. The seal is then seating in the orifice and closing it, which prevents media from flowing through the valve. Figure - 6 shows the operating principle of a normally open solenoid valve in the de - energized and energized states. A normally open solenoid valve is ideal for applications that require the valve to be open for long periods of time as this is then more energy efficient.

Bi-stable solenoid valve

A bi - stable or latching solenoid valve can be switched by a momentary power supply. It will then stay in that position with no power. Therefore, it is not normally open or normally closed as it stays in the current position when no power is applied. They accomplish this by using permanent magnets, rather than a spring.

3.2.3. SERVO MOTOR

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Due

to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc.
Servo motor is linear dashboard which helps to control linear or angular position, velocity and acceleration. Servo motor consists of motor coupled to a sensor for feedback of position. In order to use servo motor sophisticated controller are used for dedicated module design. Servo motor is often use in a closed loop control system.

3.2.4 RELAY

A relay is popularly known as electrical switch. Relay had set of input terminals used to connect more than single control signals and a set of operating contact terminals. Relay had many number of input contacts in multiple contact forms, such as make contacts, combination and break contacts.

Relays are used mainly to control a circuit which as low-power signal, or where several circuits which must be controlled by one signal. Before, Relays were used in long-distance telegraph circuits as signal repeaters which help the signal to boost up the signal strength and also refresh the signal from one circuit by transmitting it on another circuit.

3.2.5 GAS SENSOR

A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor,

Fig. 3.1 (MQ-5 Sensor)

Which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated.

The type of gas the sensor could detect depends on the sensing material present inside the sensor. These comparators can be set for a particular threshold value of gas concentration. When the concentration of the gas exceeds this threshold, the digital pin goes high. The Analog pin can be used to measure the concentration of the gas.

Different Types of Gas sensors

Gas sensors are typically classified into various types based on the type of the sensing element it is built with. Below is the classification of the various types of gas sensors based on the sensing element that are generally used in various applications:

- Metal Oxide based gas Sensor.
- Optical gas Sensor.
- Electrochemical gas Sensor.
- Capacitance-based gas Sensor.
- Calorimetric gas Sensor.
- Acoustic based gas Sensor.

Gas Sensor Construction

Of all the above-listed types, the most commonly used gas sensor is the Metal oxide semiconductor-based gas sensor. All Gas sensors will consist of a sensing element which comprises of the following parts.

1.Gas Sensing Layer
2.HeaterCoil
3. Electrode line
4.Tubular Ceramic
5.Electrode

The purpose of each of these elements is as below:

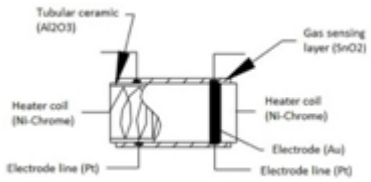


Fig. 3.2 (Mos Gas Sensor)

Gas Sensor Working

The ability of a Gas sensor to detect gases depends on the Chemi-Resister to conduct current. The most commonly used Chemi-Resistor is Tin Dioxide (SnO2) which is an n-type semiconductor that has free electrons (also called as donor). Normally the atmosphere will contain more oxygen than combustible gases. The oxygen particles attract the free electrons present in SnO2 which pushes them to the surface of the SnO2. As there are no free electrons available output current will be zero. The below gif shown the oxygen molecules (blue colour) attracting the free electrons (black colour) inside the SnO2 and preventing it from having free electrons to conduct current.

3.2.6 IR SENSOR

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named William Herschel in 1800. While measuring the temperature of each colour of light (separated by a prism), he noticed that the temperature just beyond the red light was highest.

IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation.

3.2.7 IC 7805

The maximum value for input to the Voltage regulator is 35V. It can provide a constant steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. If the input voltage is near to 7.2V to 12V then it does not produce any heat and hence no need of heatsink. Higher the input volts - the more it gets heated up, and excess electricity is liberated as heat from 7805. Hence the provision of

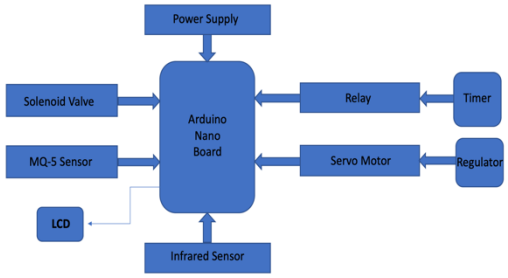
3.2.8 LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

3.3 WORKING

BLOCK DIAGRAM



Working of the proposed system consists of three applications so, that it is further subdivided into three parts and are explained in detail in the following topics.

3.3.1 GAS REGULATOR SECTION

The 12V voltage supply is given to the Arduino Nano board. The gas sensor is connected to the Arduino Nano board, the sensor works on the basis of photovoltaic effect detects the leakage of the LPG gas material. When the LPG gas is detected by the Gas sensor, the detection will be shown as “GAS DETECTED” in the LCD Display.

When the LPG gas is not detected by the Gas sensor, the detection will be shown as “GAS NOT DETECTED” in the LCD Display. Also when the LPG gas odour is detected by the gas sensor, it will also directed to the Servo Motor fixed for the control of Knob Present at the Gas regulator .To ensure the closure of the gas regulator valve, the message “GAS VALVE CLOSED” is shown in the LCD display.

3.3.2 CHIMNEY SECTION

The 12V DC Voltage supply is given to the Arduino Nano board. When the Optical Smoke sensor (IR sensor) detects the High flamed smoke evolved at the time of cooking and roasting of certain foods. When the detection of smoke is identified by the sensor, the fan of the chimney is automatically turned ON for the suction of that smoke.

For the confirmation of detection of the smoke evolved near the stove, the LCD Display will be displayed as “HIGH FLAME,CHIMNEY ON”**.** When the smoke is below the threshold point of the Optical smoke Sensor, then the chimney will be in the OFF condition.

3.3.3 TIMER BASED FLOW CONTROL SECTION

The Arduino Nano board is powered by 12V DC voltage supply. The relay circuit is used to activate the timely based control for the flow of the gas. The switches are followed by the relay circuit to provide the timer to the gas

stove, the switches will vary in time(i.e. in Seconds / Minutes) according to the program coded to the Arduino.

Once the time is set to the gas stove to control the wastage of food and in order to avoid the hazardous action to be occurred, So that the solenoid valve is used for the control and flow of the gas at the pre-set timer.

When the timer is come to an end the gas flow will be stopped by the solenoid valve, where there is a no flow in gas after the cooking process and after the end of the pre-set time and will be back to an actual manner.

In order to identify the stoppage of gas flow done by the Solenoid valve, there will be an message like **"GAS STOVE TURNED OFF "** at the LCD display.

IV. RESULTS AND DISCUSSION

4.1 OVERVIEW

In this chapter the output of various hardware modules and the overall project output are discussed. The Software tool used is the Arduino IDE and the language used is the Embedded in C. The simulation of the project was done using Proteus 8 Professional and the results have been analysed.

4.2 HARDWARE IMPLEMENTATIONS

4.2.1 GAS REGULATOR SECTION

Fig.4.1 (Regulator control system)

Step 1 : The 12V voltage supply is given to the Arduino Nano board.
Step 2 : The gas sensor is connected to the Arduino Nano board ; the sensor works on the basis of photovoltaic effect detects the leakage of the LPG gas material.
Step 3 : When the LPG gas is detected by the Gas sensor, the detection will be shown as "GAS DETECTED" in the LCD Display.
Step 4 : When the LPG gas is not detected by the Gas sensor, the detection will be shown as "GAS NOT DETECTED" in the LCD Display.
Step 5 : Also when the LPG gas odour is detected by the gas sensor, it will also directed to the Servo Motor fixed for the control of Knob Present at the Gas regulator.
Step 6 : To ensure the closure of the gas regulator valve, the message "GAS VALVE CLOSED" is shown in the LCD display.

4.2.2 CHIMNEY SECTION

Fig.4.2 (Chimney control system)

Step 1 : The 12V DC Voltage supply is given to the Arduino Nano board.
Step 2 : When the Optical Smoke sensor (IR sensor) detects the High flamed smoke evolved at the time of cooking and roasting of certain foods.
Step 3 : When the detection of smoke is identified by the sensor, the fan of the chimney is automatically turned ON for the suction of that smoke.
Step 4 : For the confirmation of detection of the smoke evolved near the stove, the LCD Display will be displayed as "HIGH FLAME, CHIMNEY ON".
Step 5 : When the smoke is below the threshold point of the Optical smoke Sensor, then the chimney will be in the OFF condition.

4.2.3. TIMER BASED FLOW CONTROL SECTION

Fig4.3 (Timer based control system)

Step 1 : The Arduino Nano board is powered by 12V DC voltage supply.
Step 2 : The relay circuit is used to activate the timely based control for the flow of the gas.

Step 3 : The switches are followed by the relay circuit to provide the timer to the gas stove, the switches will vary in time (i.e. in Seconds / Minutes) according to the program coded to the Arduino.

Step 4 : Once the time is set to the gas stove to control the wastage of food and in order to avoid the hazardous action to be occurred, So that the solenoid valve is used for the control and flow of the gas at the pre-set timer.

Step 5 : When the timer is come to an end the gas flow will be stopped by the solenoid valve, where there is a no flow in gas after the cooking process and after the end of the pre-set time and will be back to an actual manner.

Step 6 : In order to identify the stoppage of gas flow done by the Solenoid valve, there will be an message like "GAS STOVE TURNED OFF" at the LCD display .

4.3 RESULTS AND ANALYSIS

Step 1 : GAS REGULATOR SECTION :

Fig.4.4 (Before gas detection)

Fig.4.5 (After gas detection)

Step 2 : CHIMNEY SECTION

Fig.4.7 (On working of Chimney)

Step 3 : TIMER BASED FLOW CONTROL SYSTEM

Fig.4.8 (Variety of pre-set times)

Fig.4.9 (After the cut of gas flow)

V. CONCLUSION

When the leakage is detected from the regulator of gas cylinder or from the gas stove, Immediately it is sensed by the MQ - 5 sensor (Gas Sensor) and the signal is given to the Arduino board and thus it closes the regulator of the gas cylinder through the servo motor fixed to the regulator.

Real time clock Helps us to manually set the prior countdown to restricts the flow of gas from gas cylinder to gas stove by using solenoid valve. Thereby it can be concluded that by using servo motor, regulator is controlled if there is any leakage and an alleged incident can be avoided. In the case of solenoid valve, unwanted usage of fuel is avoided and high efficiency is achieved.

VI. FUTURE SCOPE

In this Proposal, it is only possible to preload the functioning of components once by loading the algorithm into the Arduino Uno board. But, If the Arduino is connected to the IOT, it can be made possible to control the functioning of every components remotely by the user.

Once the Arduino is connected to the internet, if the leakage is detected, we can able to get the notification to wireless device (Mobile Phone) and can be controlled through the application which is pre - installed for this special work. Pre-set time for gas burning can be also set remotely from the mobile devices.

By installing load sensor for gas cylinder, it is possible to get the daily usage of fuel which is mandatory, to reduce the unwanted usage is an extra application to be notified.

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