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Design and Implementation of an IoT Based Liquefied Petroleum Gas Monitoring System

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ABSTRACT: The number of deaths due to the explosion of gas cylinders in the world has been increasing in recent years. The hazardous situation can be reduced with implementation of a system to detect and provide warning on the leakage of LPG remotely and in real time. In this Paper, we design and implement a system to detect and monitor any Liquefied Petroleum Gas (LPG) leakage to ensure the safety of the operator and authorized personnel. This is an IOT based solution which offers mobile application and web-based interface for convenience and easy access to information. In this work we use Arduino based microcontroller and Wi-Fi shield module as a tool to collect data, process and sending the data to the IoT platform. A highly sensitive LPG gas sensor was employed to detect any leakage in close vicinity to highly flammable compound.

KEYWORDS:LPG, Remote Monitoring, Arduino, IoT.

I.INTRODUCTION

Gas leakage leads to various accidents resulting into both financial loss as well as human injuries. The risk of fires, explosion, suffocation, all are based on their physical properties such flammability, toxicity etc. The number of deaths due to the explosion of gas cylinders has been increasing in recent years. The reason for such explosion is due to sub-standard cylinders, old valves, worn out regulators and lack of awareness using gas cylinders add to risks [1]. Liquefied petroleum gas (LPG) is currently the most used gas in our home for cooking purposes. LPG gas is a flammable gas, if leaked it can cause major damage to life and property. Therefore, it should be used in safe handling manner and additional care has to be taken in order to prevent any leakage possible [2]. The present work aims at designing a system that detects gas leakage and alerts the subscriber through an alarm by buzzing the buzzer and sending the notification or data via the IoT to the management team or person in-charge. The management team or person in-charge will receive the notification through their smart phone and they will take an immediate action fig. 1 show the state with and without using LPG monitoring system [1]. The additional advantage of the system is that it continuously monitors the level of the LPG present in the cylinder using weight sensor and if the gas level reaches below the threshold limit of gas so that the user can replace the old cylinder with new in time and books the cylinder by automatically send a notification to the gas agency. An added feature is that if the users accidently forget to turn off the gas burner, the system will inform by activating an alarm. so, the problem of wastage of the energy is solved [2].

Fig. 1 Protection against gas leakage

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Nowadays, the explosion of domestic LPG is becoming more serious. Liquid petroleum gas (LPG) is usually used at home for focal warming, boiling water and essentially for cooking purposes. This energy source is a highly flammable chemical compound that composed of propane and butane. It can be very dangerous as it contributes to the explosion and causing a fire in buildings.

There is a deficiency for a system to detect LPG leakage because when 1% of gas leak occurs it takes nearly 60 minutes to detect it. A monitoring system of the gas detector by a wireless system needs to be developed in order to solve the problem. In this project, an embedded system designed using Arduino Uno with a gas sensor of MQ2 for the purpose of detection of toxic gas leakage, which in turn neglects the dangers that have adverse effects on human lives. This unit consists of an alarm unit to sound an alarm if any LPG leakage. The sensor gives a quick response time and has good sensitivity. If any leakage is detected, a message to the family member or authorised person using Wi-Fi module called ESP8266 will automatically send based on Internet of Things (IOT).

The system is reasonable and can be implemented in chemical factories and in localities which are surrounded by the chemical industries or plants [3].

IOT gives the ability of various things to be connected to each other through the Internet,IoT is a network of physical devices (vehicles, building) connected to embedded device (software, sensor) through internet. IOT gives the ability to sense and collect remotely across network of infrastructure. IOT contains various domains, protocols, application the interconnection of these embedded devices, IoT is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid and expanding to the areas such as smart cities. At the same time, IOT is strongly tied to the big data era due to the enormous data that the “Things” can generate. For the interconnection of these devices, different wired or wireless standards exist. IOT provide various residential and enterprises solution through latest technology. it broadly covers M2M communication, smart grids, smart building, smart cities and many more applications. Using IOT in smart cities/smart buildings can certainly provide reliable and efficient solutions as it will allow the user to interact with the entities [2] [8].

The system block diagram comprises parts as shown in fig.2. It consists of a microcontroller (Arduino Uno), the Gas sensor (MQ-2), Wi-Fi module (ESP 8266), display (LCD), servo motor, weight sensor and buzzer.

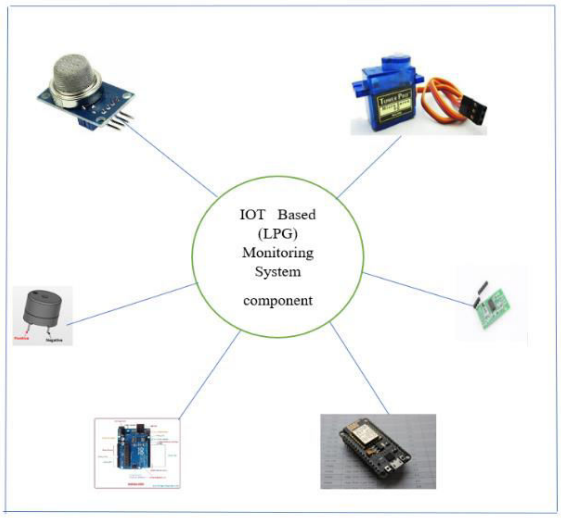

Fig.2Basicsystemcomponents

The Liquefied petroleum gas (LPG) has no colour and no smell. The LPG gas liquefies under moderate pressure and vaporize upon discharge of pressure. Therefore, the LPG is stored in liquid form (concentrated). In general, LPG obtained from sanitized crude oil, in this way, it is under pressure form and also from natural gas or crude oil streams. The LPG can be odorized by adding an appropriate odour for the prevention of explosive attacks. The most important property of LPG is that, it is heavier than air. As concentration of LPG increases, it creates hazards to human health. The LPG can be used as a fuel for many sectors, viz. domestic, industrial, cooking processes etc. LPG is also used as a fuel for vehicles.

Due to the flammable behaviour of LPG gas, out of harm's way handlings of LPG must be useful in the domestic and industrial situations. Its liquid form is very harmful for the skin. Therefore, to avoid the hazards from this, monitoring and controlling of LPG leakage is carried out through this work [4].

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II.LITERATURE REVIEW

In 2017, Madura Ghule, Komal Hole, Sayali Pathak, Nishigandha Patil and Santosh A. Darade, detect the gas leakage system using MQ6 sensor to send message to users on android application using IoT.Monitor the home temperature and fire, buzzer will on when temperature exceed above threshold value. Automatically controlling of gas leakage using relay. All such status i.e temperature above threshold value, gasleakage detected is shown on android application of mobile user.Fig.3 shows the block diagram for LPG Level Monitoring [5].

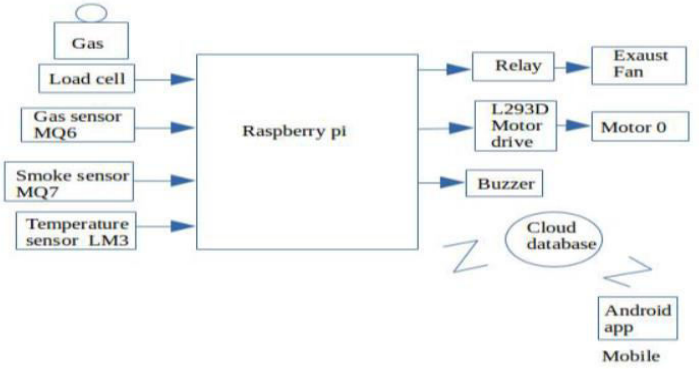

Fig.3 LPG level monitoring, booking andgas leakage detector

A similar work was conducted by P. Kanaka Maha Lakshmi, P.S.G. Aruna Sri and P.Gopi Krishna in 2019. An IOT Based LPG Leakage Sensing and Alerting System was implemented. The framework provides protection to the citizens the fire break open are not made easy in the livestock. The Framework will assist in allowing effective protection to human being and belongings. This framework won't just ready to distinguish the spillage of gas yet in addition cautioning through perceptible alerts. The system can encourage the public administration about the state before the danger occurs through a message. Cell interfaces are used to caution the whole concerning the people by sending SMS around gas spillage. Internet of things-based Gas Spillage Recognition Framework, Expectation and Shrewd Cautioning will recognize gas spillage using MQ5 sensor is used for recognizing LPG, vaporous oil, town gas, keep up a vital separation from the upheaval of alcohol and cooking vapor and smoke. With the help of IOT it'll caution as to in regards to the gas spillage condition through the SMS abuse gas application and elective texts send to gas association with individual areas and a ready SMS are sent through Email for explicit talented fig.4 shows the block diagram of the LPG Gas Leakage Sensing and Alerting System [6].

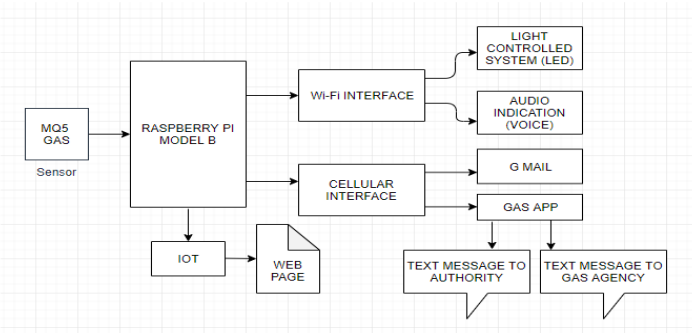

Fig.4 LPG gas leakage sensing and alerting system

In 2019, another work is introduced by A. Adsule, P. Jalkote, P. Deharekar and Sonali,the work developed the idea to detect gas leakage and control it automatically after the detection of LPG leakage. The valve is automatically closed and the gas leakage is prevented. At the same time electric power supply gets shut down and buzzer start beeping to indicate the LPG leakage. LCD will display that there is LPG leakage. For detection of LPG leakage, the gas sensor has been used which is highly sensitive to gas like butane and propane. This work mainly focuses on the detection of gas leakage and providing security when the user is around or away from home. The system is Short Message Service

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(SMS) based and uses wireless technology for providing security against gas leakage to users hence cost effective and more adaptable.

The system comprises of sensors for detecting gas leak interfaced to microcontroller that will give an alert to user whenever there is a gas leakage, display warning information by using Liquid Crystal Display (LCD), sending SMS to the user for notification wherever he/she might be and turning off electric power with the help of magnetic relay. This will enable the user to take precaution of explosion disaster which may result on Liquefied Petroleum Gas (LPG) cookers like loss of properties, injury or even death. GLDS provides ideal solution to gas leakage problems faced by home owners in daily life [7].

III.SYSTEM COMPONENTS

In this section we introduce the components that we used to design the proposed system such as micro controller, sensors, electronic devices and the function of each component.

3.1 Arduino Uno

It is an open-source platform used for building electronics projects. 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, The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board, can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package, fig.5 show the Arduino UNO. Arduino considered the heart of the proposed system [8].

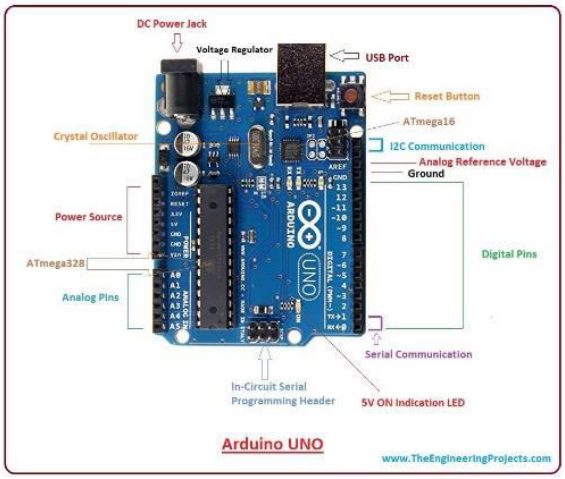

Fig.5 Arduino UNO

Arduino IDE uses open-source programming language, Arduino language codes they look like C++ or c programming language and is considered one of the easiest programming language used to write microcontroller programs [8].

3.2 Smoke Sensor MQ-2

MQ2 as shown in fig.6 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors, the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected, MQ2 Gas sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 200 to 10000ppm.

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Fig.6 MQ-2 sensor

MQ-2 Sensor begins to work when tin dioxide (semiconductor particles) is heated in air at high temperature, oxygen is adsorbed on the surface. In clean air, donor electrons in tin dioxide are attracted toward oxygen which is adsorbed on the surface of the sensing material. This prevents electric current flow.In the presence of reducing gases, the surface density of adsorbed oxygen decreases as it reacts with the reducing gases. Electrons are then released into the tin dioxide, allowing current to flow freely through the sensor.

3.3Buzzer

A buzzer is a mechanical, electromechanical, magnetic, electromagnetic, electro-acoustic or piezoelectric audio signalling device. A piezo electric buzzer can be driven by an oscillating electronic circuit or other audio signal source. A click, beep or ring can indicate that a button has been pressed.

3.4 Liquid Crystal Display (LCD)

LCD is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

3.5 ESP8266 Node MCU

The ESP8266 Wi-Fi Module is an independent SOC with incorporated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is prepared to either facilitate an application or offload all Wi- Fi organising capacities from another application processor. Each ESP8266 module comes pre customised with an AT summon set firmware that attaches this to the Arduino board, and gets about as much Wi-Fi-capacity. The ESP8266 module is a greatly low-cost board with a colossal and continually developing group, fig.7 shows the ESP8266 Node MCU [3].

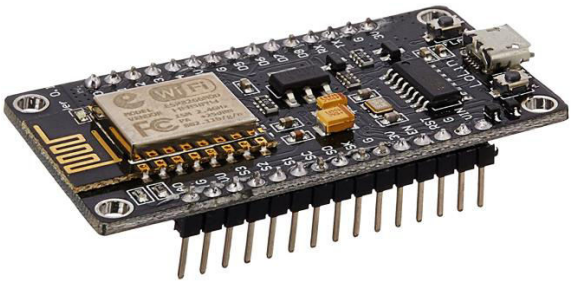

Fig.7 ESP8266 Node MCU

3.6 Servo Motor

A servo motor is an electrical device which can push or rotate an object with great precision. In order to rotate and object at some specific angles or distance, then the servo motor can be used. 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. It can get a very high torque servo motor in a small and light weight package. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc, servo motor is shown in fig.8.

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Fig.8 Servo motor

3.7 bread board

A breadboard is used to build and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted.

3.8 USB cable

Universal Serial Bus (USB) is an industry standard that establishes specifications for cables and connectors and protocols for connection, communication and power supply (interfacing) between computers, peripherals and other computers. Released in 1996, the USB standard is currently maintained by the USB Implementers Forum (USB-IF). There have been four generations of USB specifications: USB 1.x, USB 2.0, USB 3.x and USB4.

3.9 Connection wires

An electrical connector is an electromechanical device used to join electrical conductors and create an electrical circuit. Most electrical connectors have a gender. the male component, called a plug, connects to the female component, or socket. The connection may be removable (as for portable equipment), require a tool for assembly and removal, or serve as a permanent electrical joint between two points. An adapter can be used to join dissimilar connectors.

IV. PROPOSED SYSTEM

Each component used in this work have software design especial for it, to work the project correctly, the block diagram of the proposed system is shown in fig.9.Fig. 10 shows the system component connections.

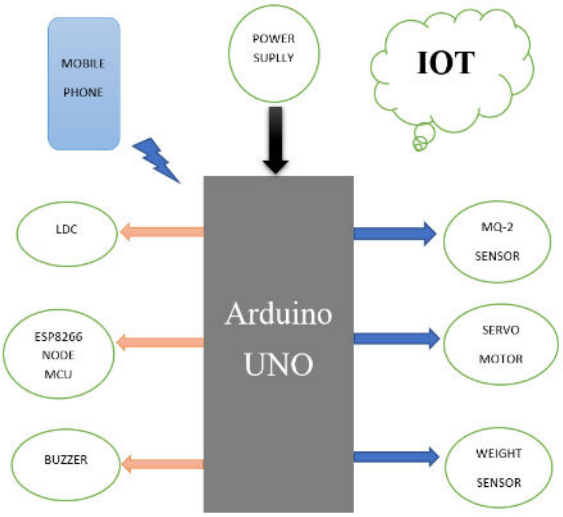

Fig. 9Proposed system block diagram

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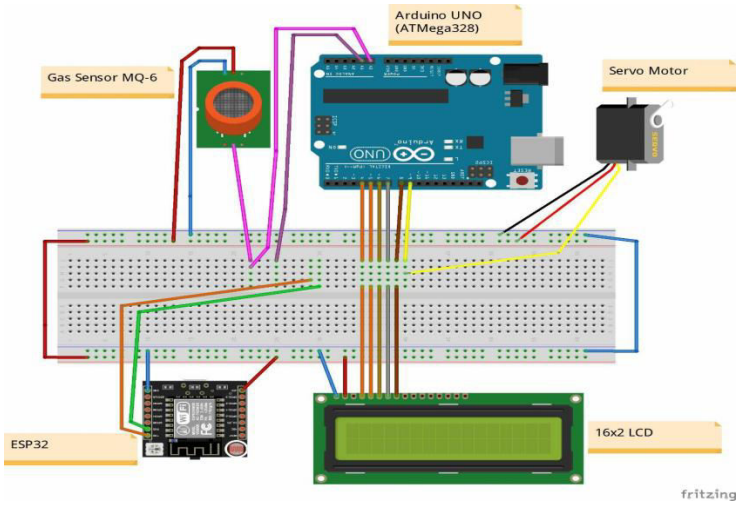

Fig.10Proposed system components

V. SYSTEM IMPLEMENTATION

When you buy an Arduino board, it is usually preinstalled with a sample blink program that will make the little built-in light-emitting diode (LED) flash. The LED marked L is wired up to one of the digital input output sockets on the board. It is connected to digital pin 13. This limits pin 13 to being the one used as an output. However, the LED uses only a small amount of current, so can still connect other things to that connector.

All need to do, get Arduino up and running is supply it with some power. The easiest way to do this is to plug in it into the USB port on the computer. It will need a type-A-to-type-B USB lead. This is the same type of lead that is normally used to connect a computer to a printer. If everything is working OK, the LED should blink. New Arduino boards come with this blink sketch already installed so that can verify that the board works.

Using the Arduino Integrated Development Environment (IDE)software, Arduino is supported with the power over the USB. After installing the Arduino IDE software and USB drivers successfullywe upload a program to the Arduino board as shown in fig.11.

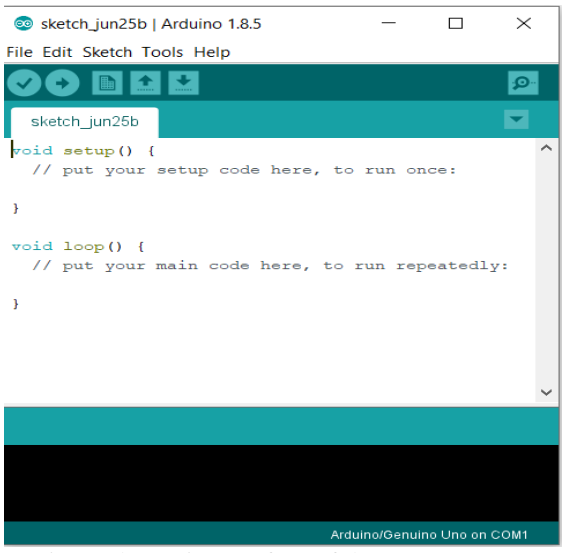

Fig.11The Main Interface of the IDE Program.

Project implementation process done by linking the components that were explained previously in the design work section and after running the simulation of these components, the proposed system worked successfully, fig. 12 shows the proposed system hardware implementation.

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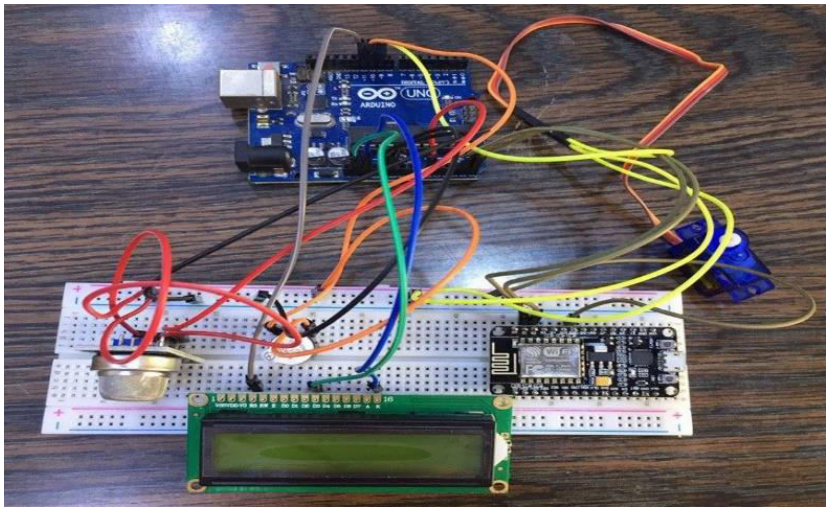

Fig.12Proposed system implementation

VI.CONCLUSION

Implementation of IOT Based Liquefied Petroleum Gas (LPG) Monitoring System makes the detection of the gas and its prevention much easier. The system sends alert notifications to the user and the user responds accordingly with the help of the connected devices like a smartphone from any location. In our project we connected the hardware part together represented Arduino (IDE), MQ2-Smoke Sensor, Buzzer, LCD, Esp8266NodeMCU, Servomotor, Breadboard, USB cable. With the help of MQ-2 sensor sends a signal to microcontroller, in the next step microcontroller sends an active signal to other externally connected devices, triggers buzzer to alert people when LPG leakage is detected, and thus keeping people's lives safe from the dangers of diversion.

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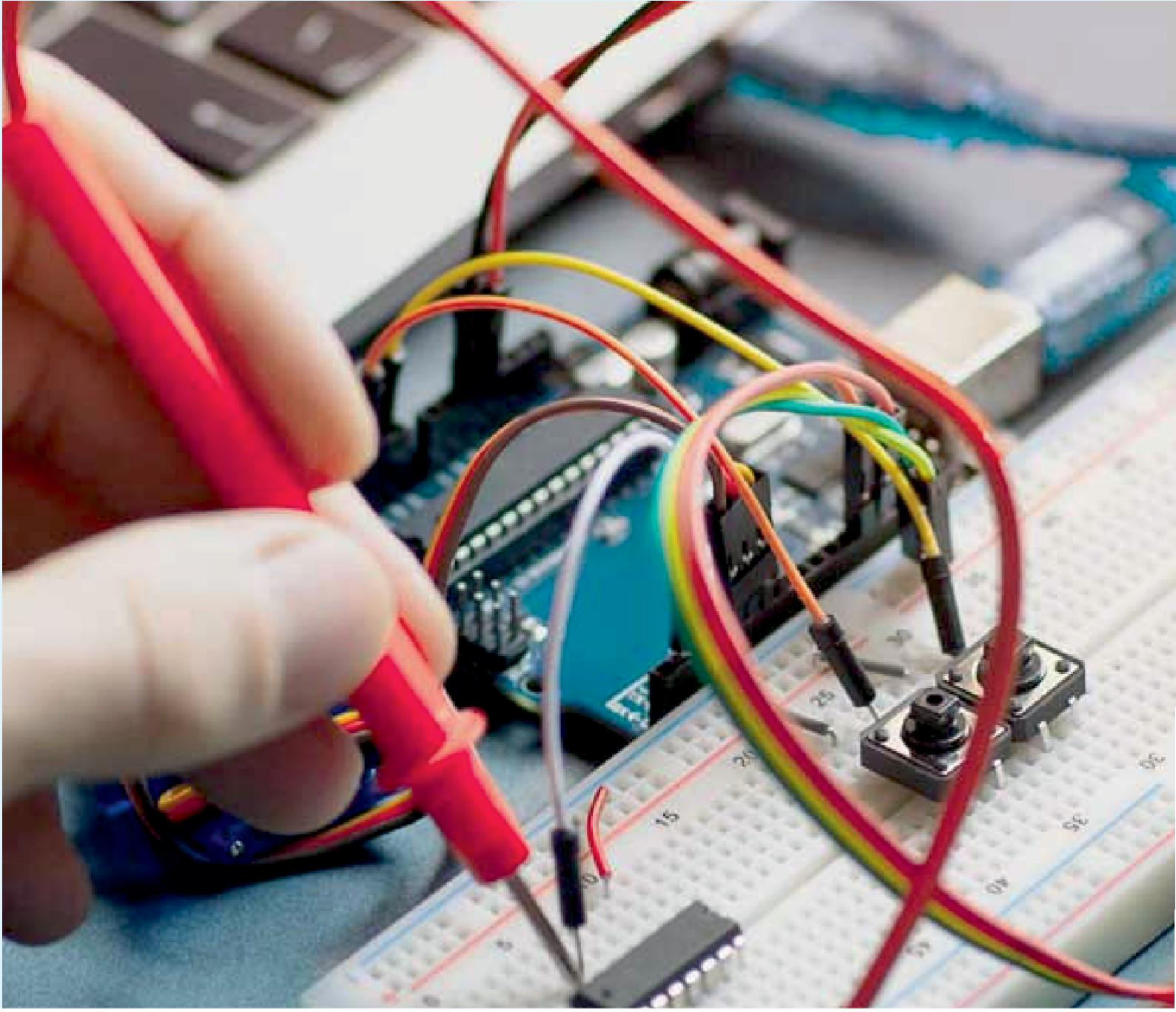

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