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IOT Device for Sewage Gas Monitoring and Alert System

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ABSTRACT: This project aims at providing smart solutions to monitor poisonous sewage gases and works on a system of live sewage level detection and monitoring. Whenever, a certain threshold is crossed, an alert is sent to the observer who is examining the conditions from a remote location. The information is then forwarded along with different gas ppm values indicating whether it is safe for the worker to clean or work in that environment or not. The remotely placed IoT monitoring equipment and IoT platform are integrated to create proposed system. This requires calibration of gas sensors for industrial purposes and determining the correct threshold levels for septic plants and facilities. The hardware is designed such that it shall send a prior alert to the sewage worker to ensure their safety, if damaging gaseous constituents increase in concentration over time. Various types of sensors are utilized to monitor parameters present in sewage like gas, temperature etc. When the threshold value is lesser than the sensed values, this system alerts the sewage worker/cleaner by sending SMS and call alerts by analyzing concentrations of different toxic gases and graphing out their results for real-time monitoring thereby aiding in protection from hazardous diseases and hence serves a social cause as well. In the proposed system, sample values for sensors have been recorded and plotted on ThingSpeak analysis tool. Carbon monoxide and methane sensors charted values up-to 2.3 and 60 ppm respectively, and this breached threshold and GSM module was utilized for sending alert to mobile number fed in thecode.

KEYWORDS: Arduino, Gas Sensors,ThingSpeak ,GSM module,Analysis tool.

I.INTRODUCTION

Sewage environment IoT device and IoT platform to monitor poisonous gas has been proposed as a solution to help the sewer workers who put their lives at jeopardy, and ensure minimal health risk. Because of these poisonous gases, the death rate of sewer workers has increased in the recent years. The lack of treatment of sewage after crossing dangerous levels leads to the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid that occur due to sudden or sustained exposure to hazardous gases. Septic tanks are devices which are found commonly in different types of localities, ranging from residential areas to largely developed industrial areas to provide solutions for treatment of sewage wastes. Sewage gases generally arise from the natural decomposition of sewage and their mixtures formed byslurries which leads to the production of toxic wastes that release hazardous gases. These gases can be lethal if inhaled in high concentrations or for a prolonged period of time. Septic tank gases are primarily constituted of methane, subtle traces of carbon dioxide, some parts of sulphur dioxide, ammonia, hints of hydrogen sulphide (H2S), nitrogen dioxide and traces of carbon monoxide.

In order to evaluate the gases which are present in sewage environment, sensors have been used to analyse the amount of hazardous gas and send an alert. The hazardous gases like hydrogen sulphide, methane and carbon monoxide emitted from sewage are sensed by gas sensors every moment and updated when it surpasses the normal grade. The project aims at designing a prototype for monitoring a sewage plant or septic tank in real-time for keeping a check on concentration levels of gases. The designed system can be installed in various sewage facilities, both rural and urban. The system can be made to work properly in both domestic as well as industrial plants, by changing small specifications of design. For remote access of concentration or ppm levels, ThingSpeak IoT platform can be accessed from anywhere in the world via internet. This project constituted development of an IOT platform as its major part as well as the hardware to monitor the setup. As compared to pre-existing systems, which lacked realtime monitoring and online updating of status of gas concentrations in the air,this system provides as solution to the dynamically changing

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sewer environment. This happens because flow of sewage water varies substantially with time and depends on a number of factors, like water pump condition, gas retention and damage to facility. This system checks on these factors as minute by minute analysis is accessible from remote locations, thanks to online monitoring. This enables accurate understanding of CH4, CO and other sewer gases and their emission from sewers and aids in quantifying and dynamically altering municipal planning, a feature that was missing in previous proposals.

II. RELATED WORKS

The utilization of a sewage monitoring system sets in place a useful approach to remind individuals or facilities employing these workers, to evacuate areas when ppm levels of certain gases goes higher than recommended. This saves lives of the employees working in harmful environments and saves them from hazards. Organisations often employ septic tanks and chemical treatment of sewage sites in industries prior to sending in manual workers on site, however no system is in place to check on hazardous levels. A smart system is defined as a cyber-physical system or an embedded system, that can process sensor data and assure a wireless communication to the server. Different systems have been proposed earlier by scientists researching the environmental pollution and air hazards due to industrial sewage. For example, IoT might be used to address the air pollution problem, as proposed in pollunio [2] to check Ground-level ozone and particulate matter that gives rise to respiratory diseases such as sulphur dioxide, nitrogen oxides or airborne particles caused by emission of polluting gases from vehicles that degrade air quality. In survey [9] a design is proposed that brings in Wireless Sensor Networks (WSN) for air pollution monitoring system, called Wireless Sensor Network Air Pollution Monitoring System (WAPMS). This utilizes Air Quality Index (AQI) as the main parameter and employs data aggregation algorithm to merge data to remove duplicates and filter out invalid readings. Proposal [5], the authors have designed an intelligent residential security alarm and remote- control system on the basis of single chip computer to check on toxic gas leakage in homes. The Internet of Things (IoT) [6-9] is broadly being perceived by analysts as a standout amongst the most modern advancements with the plan to significantly change wellbeing, security and security and addresses real effects inside the general public. This breakthrough in technology can be used in collaboration with sensors, and a smart system is designed for industrial purposes.

III. COMPONENTS USED IN THE PROPOSED SYSTEM

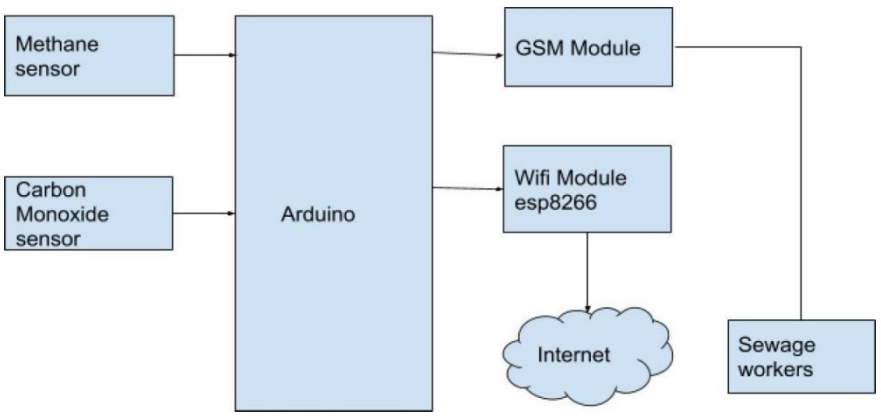

Fig 1: Block diagram of Proposed System

In the proposed system we use various gas sensors inclusive of MQ4 (Methane sensor) and MQ7(Carbon Monoxide sensor) for detecting the presence of hazardous gases insewage.

Arduino UNO and GSM module are the primary components which make up this project model.Arduino UNO enables it to read sensor data such as the ppm values collected from Methane sensor (MQ-4) and Carbon Monooxide sensor (MQ-7) of respective gases from wastes and sewage. Further, these realtime ppm values are simultaneously updated to the cloud using ThingSpeak IoT platform. The graphical representation of ppm values of these gases is plotted using the analytics tools in ThingSpeak. Finally the status or an alert is send to the mobile of the user when the values reach the threshold value using the GSM module. The data of the ppm values of the sensors can be stored and monitored by user.

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so as to avoid any accident that might occur with the labour working at the sewage tanks and rescue them from health issues caused because of these harmful gases.

Fig 2:Arduino UNO

The hardware components used in this paper for implementation are listed below:

1) Arduino Uno:- The Arduino Uno is a microcontroller board based on the ATmega328P. It comprises of14 digital input/output pins from which 6 can be utilised as PWM outputs. Apart from that, it contains 6 analog inputs , a USB connection, a power jack, an ICSP header and reset buttons which allow externally controlled hardware resetoption.

2) Methane gas sensor:- MQ-4 sensors are used to sense Methane gas. It has digital input signals Low and High. If the input signal is Low there is no gas affected and vice-versa for signal High. It can be configured for three states- low, medium and high.

Fig 3:Methane Gas SensorModule(MQ4)

3) Carbon Monoxide sensor:- CO sensors are used to sense carbon monoxide gas and has operation similarto that of MQ-4. Normally it is used to measure heat and motion of anobject.

Fig 4:Carbon Mono Oxide Sensor(MQ7)

4) GSM module: A GSM module is also known as GPRS module stands for Global System for Mobile module. It is basically a device that is utilised to establish communication between a GSM or GPRS system and a mobiledevice.

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Fig 5:GSM Module

1. Methodology

Figure shows the system methodology which includes Arduino UNO as a microcontroller board. The simulation of sensors, Software based SMS generation, and calling is done on this microcontroller.

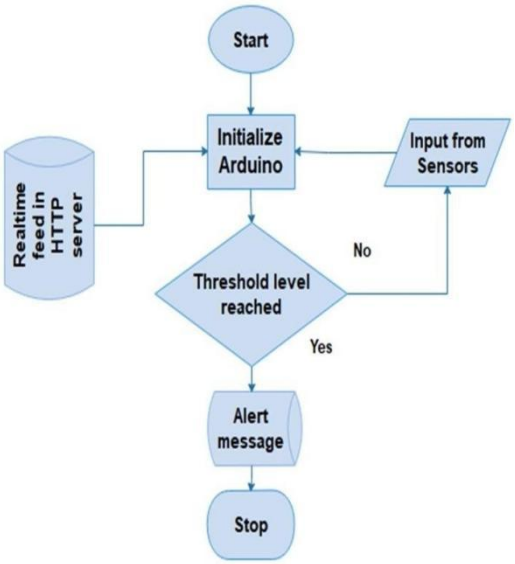

Fig 6: Flow diagram depicting methodology

Calibrating the sensors- MQ series sensors use a small heater inside with an electro-chemical sensor in order to measure different kind of gases combinations. It is recommended to calibrate the detector for 5000 ppm of CH4 concentration in air and use value of Load resistance (RL) about 20KΩ. The sensor itself yields a analog voltage that can be transformed using an ADC. The transformed value can be used in designs to get the ppm value of the sensed gas.

Connecting GSM Module to Arduino - Serial communication occurs between Arduino and GSM module. Hence, the use of serial pins of Arduino (Rx and Tx) and GSM is done by connecting the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino. So, there is a need to disconnect wiring in Rx and Tx each time we burn the program to Arduino.

Connecting GSM Module to ThingSpeak- ThingSpeak is an IoT platform that uses channels to store data sent from devices. By altering the settings in Channel configuration, creation of a channel is done, and then data is sent to and from the channel and retrieved in the same way. Channels are made public to share data. There is use of the REST API calls such as GET, POST, PUT, and DELETE.

MQTT Publish method can also be used to update a channel feed and MQTT Subscribe to receive messages whenever there is a channel update.

Sending the readings to ThingSpeak server and analyzing graphs using MATLAB in ThingSpeak- ThingSpeak is an open source IoT platform with incorporated Wi-Fi chip. In the proposed design, it is used to take readings from

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sensors and upload the value of ppm concentration of gas on the cloud using GSM that uses HTTP protocol for updating.

Further in the proposed design, use of software-based SMS module allows users to send/receive information over GPRS, send/receive Short message service and make/receive voice calls. It communicates consecutively with the devices like microcontroller, PC using AT commands. On pressing the emergency button, LED glows and sends message to the concerned.

Design

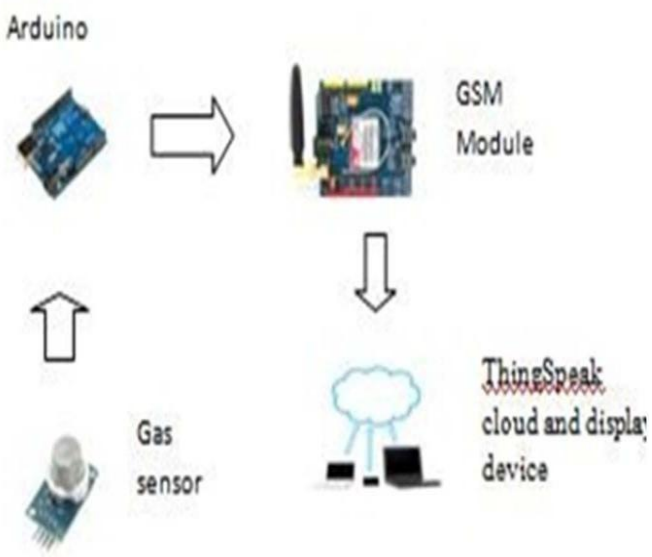

Fig 7: flow of GSM Module

IV. EXPERIMENTAL RESULTS

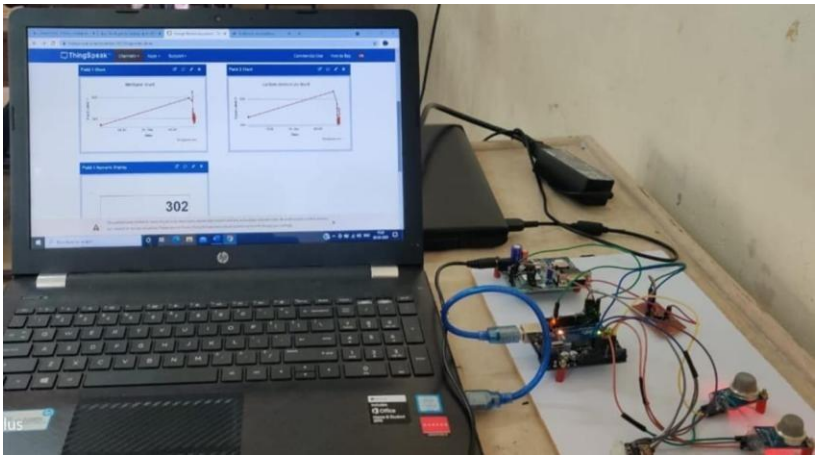

Fig 8: Real time implementation of the proposed system

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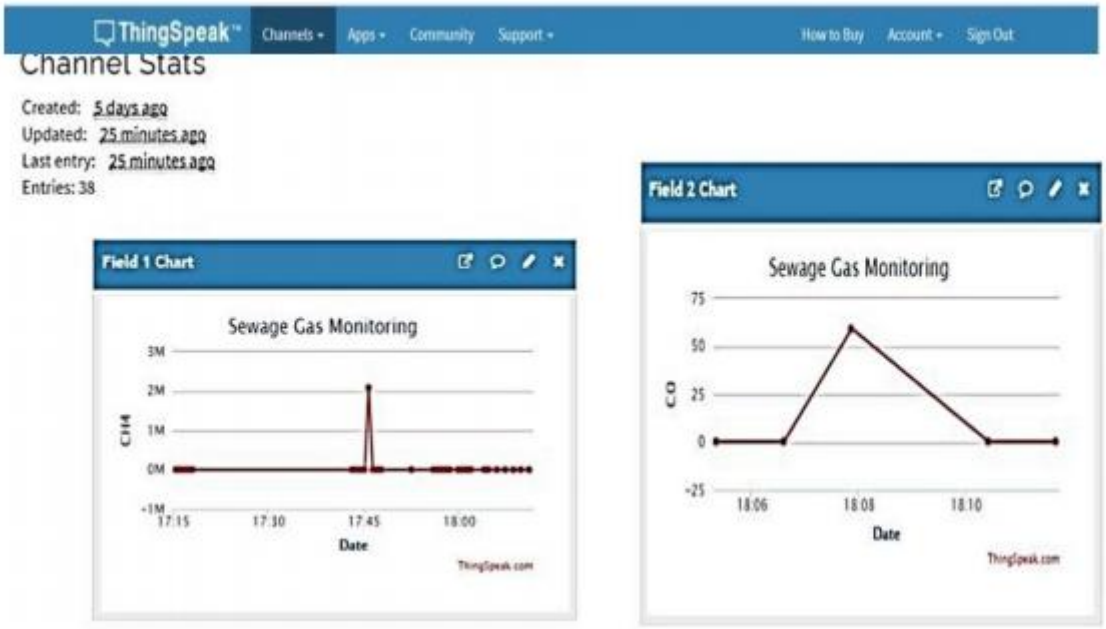
The real time implementation of the system is show in figure above and corresponding cloud output is shown below We use ThingSpeak IoT platform to update the ppm values of the gases information and send SMS to the worker, agency or any user. The hardware setup is first made with coding simulation.

The code is run after GSM module is set up. The following steps are initiated to precise work with the proposed system-

1. Sensors arecalibrated.
2. Sensors are exposed to atmospheric containing harmful sewage gases.
3. The readings are updated in real-time over ThingSpeak IoT platform.
4. Readings are continuously checked to see if they exceed threshold.
5. As soon as threshold is breached, SMS alert is sent via GSM module.

Sample testing of system is done and the values are recorded. As observed from the graphs plotted by Graphical analysis of results



ThingSpeak analysis tool, the data charted by sensors, shows a peak increase around 17.45 where CH4 level rises to 2.2 ppm sharply. This indicates, threshold was breached, and automatically, SMS alert is sent to mobile via GSM module at17.45.

Next graph it can be observed that Carbon monoxide levels rise steadily, to 60 ppm at 18.08 pm and as soon as threshold for CO is breached, alert is done and levels are again brought down after this point. As it can be seen, data from sensors is charted in real time and can be observed on a minute by minute basis.

V. CONCLUSION AND IMPLEMENTATION

Septic tanks are a method to check on hazardous release of gaseous components into the environment in areas inclusive of both residential and industrial premises. Sewage, on natural decomposition, often leads to production of toxic gases. These gases can be poisonous if inhaled for a long period of time and may lead to chronic illnesses in work force, if it is introduced in the body in high concentrations. Septic tank gases contain sulphur dioxide, hydrogen sulphide (H2S), methane, ammonia, nitrogen dioxide, carbon dioxide and traces of carbon monoxide. These toxic gases thus become dangerous especially for sewage workers and cleaners and sometimes lead to their death. Therefore, to prevent exposure to such workplace hazards, an IOT based monitoring system was proposed and designed which monitored their levels and analyzed the quantities present in the environment. In this project carbon monoxide gas was sensed using sensor module MQ-7 and methane gas using sensor module MQ-4.

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These sensor modules detect ppm levels. As the readings obtained lied between analog levels of 0 to 1023, by calibrating the sensors the concentration was converted parts per million (ppm). Finally, the ppm concentration values were converted to percentage and a graph was plotted accordingly using ThingSpeak api. ThingSpeak is open source Internet of Things request and API platform used to gather and recover information from things using the HTTP protocol over the Internet. In the proposed system, it was used particularly to plot the chart analysis and then access it from anyplace in the world.

Previous systems proposed manual sampling for sewer gas analysis at decided intervals of time. This did not take into account several factors like water pump condition, gas retention and damage to facility which altered sewer conditions occasionally. It is tough to capture the fluctuation in gas concentration if manual charting is done, and is also harmful for the engineer installing systems repeatedly to be exposed to such areas. This is a serious limitation, which is overcome by online monitoring. This also captures values which vary from site to site and this type of sampling is feasible for long-term quantification of gas concentration across extensive sewer networks.

A.Applications

1. It prevent exposure to such toxic workplace hazards for Sewage workers.
2. It used to monitor their levels and analyzed the quantities present in the environment.

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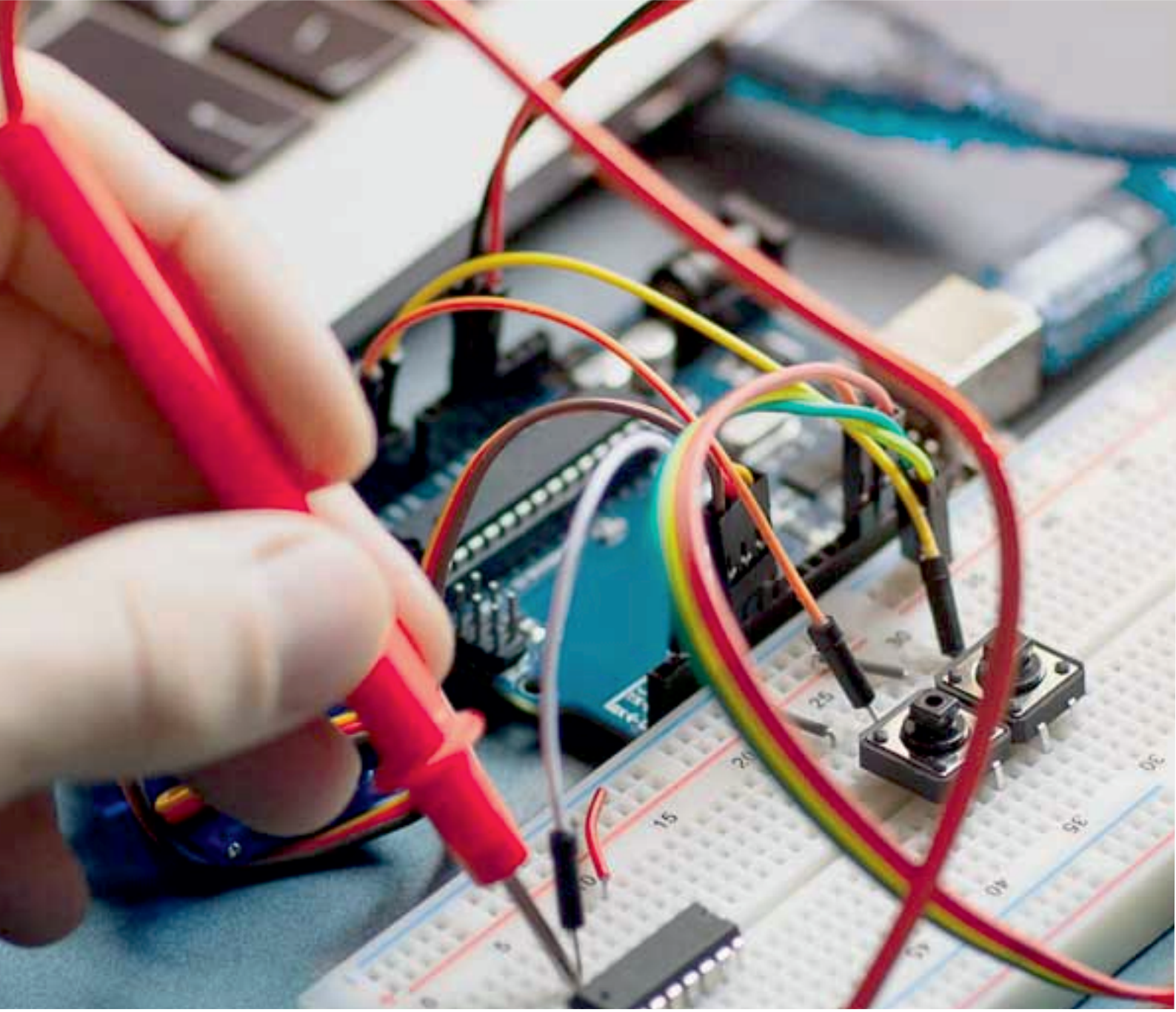

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