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TOPIC - EARLY SMOKE/FIRE DETECTION SYSTEM

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EARLY SMOKE/FIRE DETECTION SYSTEM.

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ABSTRACT

The concept of smoke detector integrated for fire emergency hazard systems is quite well known in the current era. Due to the serious health, safety, environmental and economic issues of the release of hazardous materials, the device that controls sensors, processes information, produces evacuation alarms and shuts down equipment and gas valves can be easy to use. Besides, most of death cause by fire incident is not by fire burn but by excessive smoke inhalation. In this work there has been the development of a low cost, and reliable microcontroller based automated fire alarm system for remotely alerting any fire incidents in a potential fire arising areas, Engineering laboratory (UENR) as the area of study. A review of an existing fire-detector type (MQ-2 sensor module) has been carried out along with a compacted microcontroller board (Arduino Nano) based on the ATmega328P microcontroller, buzzer, a sim module (sim 800L), a buck convertor, and the development of changeover system. The main aim of the system is to alert the distant user quickly by sending a message (SMS) via GSM network. The Arduino programming language is use, which is a simplified version of C++. The code is written in the Arduino Integrated Development Environment (IDE) and then converted to the C language and uploaded to the Arduino Nano board and initiated the codes to the various modules on the device which allows sensor to detect smoke, when buzzer should beep, and when sim module should also send notification to the user that there is a smoke detected. This system would help all the users at any level of income to have one at their home and it save great losses and damage which might happen due to fire.

Keywords—GSM Quad Band, Buzzer, Arduino Nano, Changeover, Buck Converter, MQ 2 Smoke Gas LPG.

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CHAPTER ONE

INTRODUCTION

Fire plays an important role for human survival and development for thousands of years. Fire is a chemical reaction that needs three elements to take place and continue, namely; oxygen, heat and a fuel source. This is called combustion, it occurs when the fuel source reaches its peak temperature and combines with oxygen in the air.

Fire has shaped human history, providing warmth, light, cooking food and shaping metal. Fire can also be dangerous, causing injuries, deaths, and property damage. That is why understanding the science of fire is important for preventing and controlling fires.

Fire safety is a top concern as human civilization has moved upwards. Minatory for industrial and household security, as well as human life. Answering to an emergency immediately is the best way to reduce these losses. Residential areas in Malaysia had a rise in fire accidents, in particular those related to the accidental fire were caused by electrical sources, cooking equipment, faulty or misuse of equipment, reckless handling of fire or hot liquids (Wan Ismail et al., 2016). The fire hazard can be significantly improved if an early alert can be detected (Wan Ismail et al., 2016). These systems perform the functions of immediate detection, alarm notification, and, in some cases, extinguishing fires. The fire system, which is equipped with a smoke, temperature, and pyro-electric sensors, can perceive critical accidental problems as they occur and, with the help of a processing unit, can alert immediately to take precautionary measures. Early detection and faster alert in these fatal situations will help prevent more loss property and life loss.

Depending on the situation, a fire or smoke alarm system can be monitored property/place of action or from another location. In contrast to a manual system, a remote alarm system gives the building's owner the advantage of monitoring from a distance and acting quickly in the event of an emergency. Using wireless sensor networks, Ethernet, which is image processing, and other technology for communication, remote monitoring systems can be created in various ways. The systems are dependable and offer many advantages, but there are also worries about their being complicated uncompact, non-standalone, pricey, and having unnecessary accessories. As a result, a system that is dependable, quick to respond, straightforward, easy to install, and economical is required. (Asif et al., 2014).

Due to this necessity, the easier and cost effective device that can help with the early detection of fire is the use of the smart phone coupled with a fire or smoke alarm control system which can give an early possible alert or notification which means with the advent of mobile technology (Kong et al., 2016), it is now possible to connect fire control systems to mobile phones, allowing for remote monitoring and control.

PROBLEM STATEMENT

Fire hazards cause tragic events globally, especially in developing countries where fire-safety measures are problematic and frequently inadequate. According to BBC News Asia, Bangladesh, for example, which has recently been the target of industrial and residential fires, is in urgent need of a tenable, trustworthy, conveniently accessible, and cost-effective fire security system. Even though a number of cutting-edge systems are employed in real-world situations, developing nations need an automatic fire-alarm system that is trustworthy, simple to set up, and affordable.

Fire can vary depending on the context and scope. With potential examples like; Inadequate fire safety measures in building especially older ones, may not have adequate fire safety measures such as smoke detectors, fire extinguishers, sprinkler systems, or clearly marked exits. This may put people at risk in the event of a fire.

Wildfires can also cause damage to natural ecosystems, destroying habitats and food chains. Additionally, the smoke from wildfires can have negative health impacts on nearby human populations.

Arson and intentional fire setting which means deliberately starting fires, whether for malicious or other reasons, can result in property damage, injury, and loss of life (Mclauchlan et al., 2020).

Climate change and its contribution also increases fire risk. As climate changes, some regions may experience wildfires due to factors such as drought, high temperatures, and changes in vegetation patterns.

Again, Firefighters normally work long hours in dangerous conditions, and may experience high levels of stress and burnout. Ensuring their safety is crucial for maintaining good emergency response.

In this study, existing fire detectors are reviewed, and then a mobile application system is developed and connected to one of those detectors, a low-cost and quick-responding fire/smoke detection device. The system may activate the area's siren and transmit alarm messages (SMS) via the GMS network, which will lower the danger of an early fire outbreak (Asif et al., 2014).

OBJECTIVES

The aim of this project is to develop a fire detection system and notification system that connects a mobile phone.

SPECIFIC OBJECTIVES

- To develop a compact fire sensor device for accurate fire or smoke detection.
- To establish communication algorithm between the fire or smoke sensor device and mobile phone and also help in minimizing false alarm.

JUSTIFICATION

This project study will help know the importance of an early fire or smoke detection system, and as a new technology help to protect or keep human beings, animals and properties safe.

The system has the ability to remotely monitor the smoke or fire alarm system. Users can stay informed about the status of their fire alarm system and take appropriate action when the need arises. The system or device is connected to a registered sim or phone which is able to receive a notification or an early alert to warn the users about the state of the environment which also helps in reducing the risk of damage to property or injury to people.

The system offers a lot more positives, remote monitoring to an improved safety.

CHAPTER 2
2.1 LITERATURE REVIEW

2.1.2 THE IMPORTANCE OF FIRE CONTROL METHODS:

According to the National Fire Protection Association (NFPA) (2017), fire control methods can be grouped into four processes, that is; prevention, detection, suppression, and evacuation.

Prevention: Prevention is an important aspect of fire control. According to Bouillard et al. (2017), fire prevention methods should focus on identifying fire hazards and reducing the chance of it happening. Implementing fire safety methods, setting penalties for non-compliance, and promoting fire safety education have also been found to be good in reducing the number of fires caused by human error.

Detection: Early detection is important for controlling fire, and there have been improvement in fire detection technology in recent years. According to Sharma et al. (2018), intelligent fire detectors that can find the location of the fire and its seriousness has improved early detection. The integration of fire detection systems with building management systems has helped in faster response times and effective fire control.

Suppression: The process of putting out fire. According to Hasan et al. (2019), new fire suppression agent like, clean agents, has improved the productivity while reducing environmental impact. The addition of fire suppression systems has improved the response times and more success fire control.

Evacuation: It is the process of successfully removing people from the affected area. According to the NFPA (2017), successful evacuation methods are the use of clear and short emergency post, the implementation of emergency drills, and the provision of clear instructions to building occupants.

2.2 PREVIOUS STUDIES ON CONNECTING A FIRE CONTROL SYSTEM TO A SMART MOBILE PHONE

EARLY FIRE DETECTION SYSTEM USING WIRELESS SENSOR NETWORK ‘WSN’, (Kadri et al., 2018)**.**

A Wireless Sensor Network, or "WSN," tends to be made up of hundreds to thousands of sensors that can sense environmental factors like temperature, pressure, and movement and transmit the perceived information wirelessly to a central base station to enable environmental monitoring. Because of their versatility, ease of implementation, and extensibility, WSNs have emerged as the finest solutions for enabling environment monitoring and remote controlling.

WSNs have a wide range of applications due to their low cost, ease of use, and deployment, including military applications for battlefield surveillance, nuclear reactor management, or environmental surveillance such as fire detection and swarm animal studies. Utilizing WSNs, the study demonstrated an early fire detection system that was deployed for early fire warning in a forest. Early fire warning is highly desirable to prevent fire propagation, which makes its extermination very challenging. The suggested method made use of WSN to regulate the surrounding temperature and CO2 in woods to detect and deliver alerts regarding any potential fires. The Tlemcen forest guards assisted in the development of this initiative.

DEVELOPMENT OF A LOW COST EARLY FIRE DETECTION SYSTEM USING WIRELESS SENSOR NETWORK AND MACHINE VISION, (Kanwal et al., 2016)**.**

How quickly a fire is discovered typically determines how effectively it may be put out. A system that might identify the fire early is particularly appealing for both personal safety and commercial applications because fires can result in major disaster. Currently, standard fire alarm systems, which are generally based on infrared sensors, optical sensors, and/or ionization sensors, typically use electrification or imaging to detect the emission of smoke, heat, or radiation.

In this study, reports work for development of a low cost wireless sensor-based system for surveillance and early fire detection, using machine vision technique. The system was made up of an on-board camera node that could wirelessly transfer videos to a remote host system that was running a fire detection algorithm based on image processing. The system can transmit videos to almost anyone in the world and is autonomous and portable.

The entire system is very expensive, and it takes a limited period of time to locate and identify the existence and source of fire

To overcome the shortcomings, video-based fire detection is a suitable candidate. Healey et al. introduced their new image-based fire detection system. In reality, image-based fire detection techniques are appropriate because they can offer useful details including the location, size, and—most importantly—the extent of the fire. The transmission of the data in a timely and effective manner is the key next phase after data gathering. In addition, wireless sensor networks (WSN), a collection of specialized sensors outfitted with protocols for communication that enable the transmission of data collected by the sensors over long distances, deserve careful investigation. In actuality, the WSNs are made up of numerous sensor nodes, or many detecting stations, each of which is compact, light, and portable, along with very economical as well, have been used in a variety of industries from science and medicine to military and businesses. These sensor networks monitor a variety of phenomena, such as heart rate, volcano eruptions, ambient temperature, and even the sound of a sniper rifle. A base station will act as the surveillance center by running an image-based algorithm to detect fire from the received images, all while continuously transmitting video through WSN from the area of surveillance to it, according to the study's prototypic system presentation. The system's prototype was successfully tested by streaming video while segmenting fire zones using the HSI properties of the acquired images.

AN INTELLIGENT FIRE WARNING APPLICATION USING IOT AND AN ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM, (Sarwar et al., 2019)**.**

Uncontrolled fire can be harmful while controlled fire benefits us in many situations. However, quick fire detection and suppression can prevent loss of life and millions of dollars' worth of property damage. The two most common forms of fire alarm systems are conventional and addressable, but sadly, these fire alarm systems frequently produce false alarms. Conventional alarm systems have a higher rate of false alarms than addressable alarm fire systems, although addressable alarm fire systems are more expensive. varied types of detection systems have varied most likely causes for false alarms, such as smoke sensors frequently being incorrectly activated by ambient factors. A multi-sensor expert alarm system that is affordable, artificially educated, and helps FDWS (fire detection and warning system) make the right decisions and reduce the amount of false alerts was therefore required. The London Fire Brigade alone receives a call to respond to a false alarm approximately every 10 minutes, costing them about £37 million annually due to the prevalence of false alarm warnings. In this study, they introduced a home-based FDMS that employs an Arduino UNO R3 (Arduino, Somerville, TX, USA) microcontroller based on the atmega. Sensors 2019, 19, 3150 2 of 18. With a selection of reasonably priced sensors, it is readily available and can be quickly programmed using the Arduino Software (IDE). The suggested system efficiently combines a smoke sensor with flame sensors as the room temperature rises, and the FDWS is trained with a neuro-fuzzy designer to further explore the actual existence of fire and prevent false alarms. The goal of this intelligent fire alarm system is to detect actual fires, warn the appropriate people, and inform the residents via GSM that immediate action is required. There have been numerous studies done to try and lessen false alarms because they can be burdensome for the fire department and can be expensive. Previous research suggested a variety of approaches, including wireless warning systems, autonomous firefighting robots, and fire alarm systems with notification appliances. Because they use visual and auditory cues to alert occupants, fire alarm systems with notification appliances can be pricey. This study's findings led to the development of a reliable, affordable solution that generates few false alarms and uses the GSM (global system for mobile communication) to send out notifications. The creative concept created a smart alarm system by utilizing neuro-fuzzy logic. In a MATLAB environment, the system is ANFIS-simulated, and the findings demonstrate efficacy and resilience with good performance when compared to the FIS technique. Jang first put forth the ANFIS concept in 1993. An ANFIS is typically a decision-making tool that combines a neural network and a fuzzy inference system (FIS).

FIRE EARLY WARNING SYSTEM USING FIRE SENSORS, MICROCONTROLLER, AND SMS GATEWAY, (Kharisma Et Al., 2021)**.**

Based on an SMS gateway and an alarm, a fire early detection system was constructed in this study using smoke, heat, and gas sensors. In order to prevent fire tragedies, this technology is utilized to deliver information on early fire detection. The possibility and risk of fire can be decreased with this system. This method is used to find possible house fires before they start. To determine how the used sensors would respond to fire simulations, several tests were conducted. includes reactions to SMS messages from multiple providers, temperature testing, gas testing, and smoke testing. A fire early warning system that sends SMS and alarm notifications is the result of this research. Using a heat sensor, a gas sensor, and a smoke sensor, a fire detection device prototype was created. The microcontroller will send an SMS and buzzer alarm as an early fire warning if the intensity sensor exceeds the limit.

EARLY DETECTION OF LEAKS ON GAS CYLINDERS USING ARDUINO BASED MQ-6 SENSORS, (Series, 2019)**.**

Propane and butane, two components of liquid petroleum gas (LPG), are currently used extensively in both domestic and commercial settings. When utilizing LPG, there are some safety considerations that must be made. This is due to the gas's volatility and the potential for leakage, which increases the risk of an explosion or fire. In order to cope with early detection of LPG leak and minimize the incidence, the gas leak early detection gadget is a highly appropriate effort. This study was created with the aid of a prototype system that simulates a gas leak in a room utilizing the MQ-6 sensor, which finds LPG in the space. This tool functions by sending analog data in the form of gas leak detection information from the MQ-6 sensor to the Arduino microcontroller. According to test results, the MQ-6 sensor-based LPG leak early detection system using Arduino has been successfully running the previously built and installed algorithm and sending a warning message to the designated number. In a closed space, this system can detect gas more quickly; however, in an open space, the sensor may detect gas more slowly because the level of polluted gas will rapidly escape into the air.

SMOKE DETECTION ALERT SYSTEM VIA MOBILE APPLICATION, (Wan Ismail et al., 2016)**.**

With the use of a smoke sensor device that can detect smoke and alert users by sending them a message via SMS (Short Messaging System) and sounding an alarm, this system aims to provide home protection. Through an Android-based mobile application, authorized users can activate and deactivate the system. The hardware platform for the system is the Arduino Uno (R3) Board. The importance of having apps today is greatly influenced by their portability and user-friendliness. Besides that, it is highly importance as early detection of smoke which can prevent economical, ecological and human-life endangering threats from fire hazard.

IoT FIRE DETECTION SYSTEM USING SENSOR WITH ARDUINO, (Khalaf, 2019)**.**

IoT is a contemporary system made up of sensors and switches connected to a gateway, or central hub. In this project, an Arduino device was coupled with a temperature sensor known as a "flame sensor" to detect fire outbreaks and measure the amount of heat intensity produced by a fire outbreak or in a particular spot in homes, workplaces, and other places. These sensors will function as an early alarm system that will send an email notification to mobile phones, fire stations, and hospitals if any fire outbreak occurred to notify the situation clearly and before it is too late. Actions can then be taken to avoid significant damage in case the fire outbreak was observed after a long time from its initial location.

CHAPTER 3
METHODOLOGY

3.1 DESCRIPTION OF METHODOLOGY

Early detection is important to limiting damage and reducing fatalities. This project uses an Arduino Nano, a microcontroller that can be programmed to communicate with different sensors and modules, to build a fire detection system. The system will have a flame sensor to identify the presence of fire. The Arduino Nano will activate a buzzer and a SIM module to alert the user of the fire once the flame sensor detects it. The user's mobile phone may receive an SMS informing them of the detected fire from the SIM module.

In order to keep running even in the case of a power loss, the system will also be fueled by both battery and VRA sources. This is important because power outages can result from fires, and the system must function even when the power is out.

The Arduino Nano-based fire detection system is a low-cost, reliable, and simple-to-implement solution that can be used in different scenarios to detect smoke or fire early and start putting out fires. The system can assist with false alarms, offer a practical solution that is more affordable, improve accessibility, avoid fire-related incidents, safeguard people's lives and property, and give the user piece of mind.

3.2 STUDY AREA

University Energy and Natural Resources (UENR)

Engineering Block

Location: 7.3492 N, 2.3434 W

3.3 MAJOR COMPONENTS REQUIRED

- Power source (12 volts AC and 9 volts battery DC)
- A changeover
- A buck convertor
- Arduino Nano
- Sim module
- Buzzer.
- Flame sensor
- Breadboard

3.3.1 POWER SOURCE

The power source normally has a voltage regulator that keeps the output voltage constant despite changes in the input voltage. For the system to work well, this guarantees that it receives a constant and consistent voltage.

The power source's output voltage varies depending on the particular adapter being used, but is commonly between 5volts and 12 volts DC. Based on the particular demands of the fire detection system and the components being utilized, the voltage should be selected.

The Arduino Nano and other parts of the fire detection system can be linked to the power source through a DC power connection or a breadboard. All the system parts should be able to receive power from the power source at the same time. The specs of each parts can be used to make the system's current requirements.

3.3.2 9V BATTERY

A battery with a nominal voltage of 9 volts is known as a 9V battery. Electronic gadgets like smoke detectors, remote controls, and small toys frequently use it.

The kind and brand of the battery will determine the 9V battery's capacity. Leading battery manufacturer Duracell claims that the normal capacity of their 9V alkaline battery is 565 mAh (Duracell, 2022).

Voltage regulation: The 9V battery lacks built-in voltage regulation, in contrast to the VRA power source. A 9V battery's output voltage might change based on the temperature and load, among other things.

Lifespan: A 9V battery's life relies on a number of variables, including the battery's kind and brand, the load it is under, and the temperature. The 9V alkaline battery from Energizer, another top battery producer, has an average shelf life of up to five years (Energizer, 2022).

Safety: It's crucial to handle 9V batteries carefully because, if not, they run the risk of electrical shock or fire. The manufacturer's instructions should be followed, and used batteries should be disposed of in line with local laws.

3.3.3 BUCK CONVERTOR

A buck converter is a sort of power converter that boosts or decreases an electrical signal's voltage. It is used to change a low-voltage DC signal into a higher-voltage DC signal or vice versa. In comparison to other types of power converters, using a back converter has a number of benefits, including high efficiency, compact size, and low cost.

Buck converters are frequently employed in a wide range of applications, including battery charging circuits, renewable energy systems, and power sources for electronic devices. The buck converter works by turning on and off a power transistor with the aim of turning circuit to produce a high frequency AC signal. A rectifier circuit and a transformer are then used to filter this AC signal and convert it to a DC signal.

3.3.4 ARDUINO NANO

The ATmega328P-based Arduino Nano is a portable microcontroller board. It runs on 5 volts, has six analogue inputs, and 14 digital input/output ports. The board can be used for prototyping and small-scale production. For projects that demand a compact form factor and low power consumption, the Arduino Nano is especially helpful. It is compatible with a variety of sensors and other electronic components, and it may be powered by either an external power source or a USB cable.

The Arduino Integrated Development Environment (IDE), a user-friendly software environment for creating and uploading code to the board, can be used to programming the board. The IDE gives different libraries and examples to help users in getting started with programming the board, and it supports a number of programming languages, including C++. The Arduino Nano has grown in popularity for DIY electronics projects.

3.3.5 FLAME SENSOR

Flame sensors works by identifying the ultraviolet (UV) light that a flame emits.

Flame sensors come in a different form, like the UV/IR combination flame sensors, infrared flame sensors, and ultraviolet flame sensors. The most common flame sensor is an ultraviolet flame sensor, which is used in many industrial and commercial works. Less common infrared flame sensors are often used in environments without UV radiation, like the gas-fired boilers.

To ensure the safe and effective operation of a wide variety of industrial and commercial applications that rely on combustion, flame sensors are essential. They are crucial parts of several heating systems, gas-powered appliances, and other equipment that runs on combustion or flames.

3.3.6 MQ-2 SENSOR MODULE

The semiconductor gas sensor MQ-2, which detects gases by changes in electrical resistance, serves as the foundation for the MQ-2 sensor module. Tin dioxide, the sensitive layer of the MQ-2 sensor, reacts with different gases to affect its electrical conductivity. This sensor, a

pre-amplifier, and other components are built onto the MQ-2 sensor module's circuit board for convenience.

The MQ-2 sensor module can be linked to one of the microcontroller's analogue input pins in an Arduino-based gas detection system. The analogue voltage output by the sensor may then be read by the Arduino, which can be programmed to sound an alarm or send a notification if the voltage rises beyond a predetermined threshold, signaling the presence of a gas.

In both commercial and industrial gas detection systems as well as in do-it-yourself electronics projects, the MQ-2 sensor module is frequently utilized. It is a well-liked option for gas detection applications because it is typically dependable and reasonably priced.

3.3.7 BREADBOARD

A breadboard is a reusable solderless tool used for electronic circuit prototyping and design. It makes it simple to install and connect electronic components without using solder, making it ideal for swiftly testing various circuit layouts. The breadboard is often composed of plastic and has rows of grid-like metal sockets or clips.

The leads of electronic components like resistors, capacitors, and integrated circuits (ICs) are held in place by the metal clips or sockets, which join them together as required to form circuits. It is simple to connect components together because the clips or sockets are internally connected in groups or blocks. A centre channel divides the two sets of blocks, one for the positive side and one for the negative side. They are normally used in electronics prototyping and experimentation because they make circuit design and modification rapid and simple.

3.5 CHANGEOVER THAT CONTROLS THE PANEL.

The input terminals of the changeover switch are connected to the VRA power supply.

The main distribution board or load center is connected to the changeover switch's output terminals.

The input terminals of the changeover switch are also connected to the battery backup system.

The changeover switch automatically changes to the battery backup system when the VRA power source fails.

The switch keeps an eye on the voltage of both the battery backup system and the VRA power source. The changeover switch automatically reconnects to the VRA power supply and disconnects the battery backup system when the voltage of the VRA power supply returns to normal.

An electromechanical device measures the voltage and current levels of the input power sources to operate the changeover switch. The switch activates to move the load from the malfunctioning power source to the standby power source when a voltage or current anomaly is detected.

3.6 OPERATION BETWEEN THE ARDUINO NANO AND THE SIM MODULE, SENSOR, AND BUZZER

The Arduino Nano's primary function in this project is to serve as the system's microcontroller and regulate all system operations. It will take input from the many sensors and use that data to decide how the system is performing. It will also be in charge of transmitting outputs to the display and other components so that the user may receive feedback.

The Arduino Nano will specifically be used to read data from the flame sensor and ascertain whether a flame is present. The Arduino will turn on the changeover switch to move the load from the VRA to the backup power source if it detects a flame.

The Arduino Nano board will get the code after it has been posted in the Arduino Integrated Development Environment (IDE).

The Arduino Nano board's pins must first be initialized in order for the programming code to connect with the sensor, buzzer, and sim module. This will be accomplished by designating the pin numbers in the code as inputs or outputs.

The code can read data from the flame sensor and use that data to activate the buzzer and send a text message using the SIM module once the pins have been initialized. For instance, the input will cause the buzzer to sound an alarm and the SIM module to send a text message to the designated phone number when the flame sensor detects a flame.

The code will have conditional statements and loops to regulate the system's behaviour based on the input from the flame sensor and the condition of the other parts. These statements will specify when the buzzer and SIM module should be turned on and for how long.

The code will act as the system's brain, deciphering sensor information and adjusting the output of the buzzer and SIM module as necessary.

We'll need jumper wires or 24 AWG wires with female Arduino pins to connect the flame sensor, buzzer and SIM module to the Arduino Nano. These pins will be connected to the corresponding pins on the sensor, buzzer, and SIM module before being connected to the digital or analogue pins on the Arduino Nano.

To determine whether a flame is present, the flame sensor will be attached to an Arduino Nano's digital input pin. The buzzer will play and an SMS alert will be sent from the SIM module when the Arduino Nano receives a signal from the sensor that a flame has been detected.

To sound an alert when the sensor detects a flame, the buzzer will be wired to an Arduino Nano's digital output pin.

To send SMS notifications when a flame is discovered, the SIM module will be attached to the Arduino Nano through serial connection. In order for the SIM module to operate properly, it must also be linked to a power supply and a ground.

Even if there have been projects in this area, it is known that bridge gab is the switchover system that will enable the VRA and battery to work in concert as well as the sim module that will prevent system access via the internet. This is due to the fact that the majority of initiatives of this nature employ apps that require internet access before use, whereas this merely calls for sim registration.

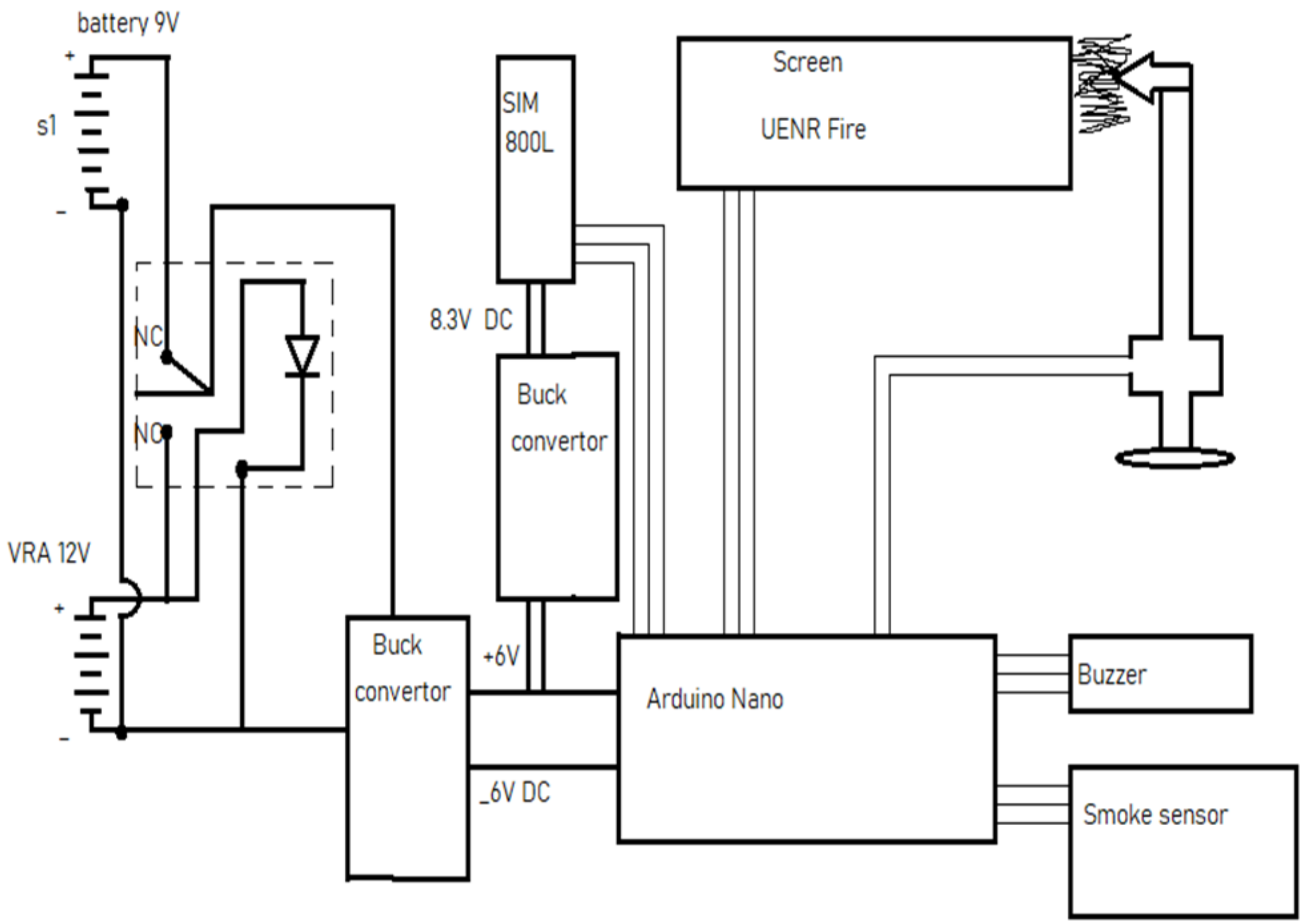

Figure 3. 1 Circuit Design

3.7 RELEVANCY OF OPERATION IN ACHIEVING THE PROJECT'S GOAL

Considering how relevant the operation is to the project's objectives,

By employing a flame sensor to detect the existence of a flame and warning people via a buzzer and a SIM module, the project seeks to improve fire safety. The concept intends to guarantee uninterrupted performance even during power outages, hence improving response time, by supplying both VRA and battery power sources with a switch. Additionally, the project offers a more affordable alternative to conventional fire alarm systems by lowering false alarms through the use of a trustworthy flame sensor. As a result, the project is very important to meeting the project's objectives of increasing fire safety, quickening reaction times, decreasing false alarms, and offering affordable solutions.

CHAPTER FOUR
RESULT AND DISCUSSION.

4.1 RESULT

4.1.1 EXPERIMENTAL SETUP

Component Placement:

A Nano Arduino was positioned in the middle of the breadboard. To make wiring simple, make sure that the pins of the component line up with the breadboard's rows.

On the breadboard, the MQ2 Gas Sensor was positioned. Its VCC pin should be connected to the breadboard's 5V rail, GND to the ground rail, and AOUT to an Arduino analog input pin (like A0).

The breadboard was attached with a buzzer. its positive (anode) leg to a ground rail and its negative (cathode) leg to an Arduino digital output pin, such as D2.

The SIM800L GSM/GPRS Module should now be connected to the breadboard. Its VCC pin should be connected to the 5V rail, GND to the ground rail, TXD to one of the Arduino's digital output pins (like D3), and RXD to a different pin such as D4).

The setup included the Relay Module. The relay output contacts were linked to both the direct power supply (such as 5V) and the battery power source, and the relay input pins were connected to a digital output pin on the Arduino (such as D5).

Wiring and Connections:

To supply power and ground connections, join the breadboard's 5V and GND rails to the Arduino Nano's 5V and GND pins, respectively.

connected the breadboard's corresponding rails to the VCC and GND pins of the MQ2 Gas Sensor.

To connect the MQ2 sensor's AOUT pin to the Arduino Nano's chosen analog input pin, use jumper wires.

Connect the Buzzer's positive (anode) and negative (cathode) legs with jumper wires by attaching them to the ground rail and the specified digital output pin, respectively.

Put the SIM800L GSM/GPRS Module's VCC and GND pins on the appropriate breadboard rails.

Jumper wires were used to connect the TXD and RXD pins of the SIM module to the Arduino's specified digital output pins.

Relay input pins were connected to the Arduino's assigned digital output pins.

One of the relay output contacts was directly connected to a power source (such as 5V), and the other was connected to a power source from batteries.

Changeover Mechanism Integration:

Ensured that the battery and direct power supply connections for the relay module's output contacts are correct.

Added the necessary code logic to the Arduino code to enable and disable the relay module depending on the selected power source (battery or direct current).

Placement of The System:

The configuration on a flat, firm surface, making sure that the wiring is tidy and the connections between the parts are strong.

To imitate smoke introduction during testing, put a controlled smoke source nearby (such an incense stick).

Safety Precautions

Proper ventilation should be used during smoke introduction testing to prevent smoke buildup and health hazards.

provided constant safety and kept the parts away from combustible materials.

To confirm the functionality of, connections, wiring, and code logic were double-checked.

4.1.2 SMOKE DETECTION SETTING

To assess how well the system detects smoke and issues the required alarms, it is imperative to perform the "Introducing Smoke" test.

Managed Smoke Source:

A managed smoke source was prepared. prepared, as in a lit incense stick or a smoldering sheet of paper. For testing purposes, this source will create a smoke-like environment.

Monitoring Setup:

Setting up the Arduino Nano for monitoring and starting the Arduino IDE.

To enable monitoring and control of the system's components, upload the code to the Arduino Nano.

Introduce Smoke:

Light an incense stick or a piece of burning paper to produce a controlled amount of smoke.

Allow the smoke to drift into the MQ2 gas sensor area by keeping the smoke source at a reasonable distance from the sensor.

Analog Output Observation:

Use the Arduino IDE's serial monitor or a data recording system to keep track of the analog output voltage of the MQ2 gas sensor.

Record the initial analog voltage reading and track any changes as the smoke concentration rises.

Buzzer Activation:

Based on the detected analog voltage change, establish a smoke detection threshold value. The system will only consider smoke present when it reaches this threshold.

The analog voltage should cross the predetermined level as soon as the smoke concentration approaches the threshold.

Check to see if the buzzer goes off when the analog voltage reaches the threshold.

SMS Notification Testing

Test the SIM800L GSM/GPRS module's power and connection to a SIM card with network coverage before using it to send SMS notifications.

To activate the smoke detection system, add smoke.

Verification of SMS Notification:

Check the receiver phone number specified in the code for receiving SMS alerts to confirm the SMS notification.

Verify whether the SIM module starts the SMS alert sending process.

System Reset Testing:

After performing the test, pull the smoke source away from the MQ2 sensor to perform a system reset.

Observe System Behavior:

Verify that the buzzer turns off when the analog voltage falls below the threshold.

Check to see if the system returns to normal after the smoke has cleared.

Data Recording and Analysis:

Analyze the data you collected by recording the analog voltage readings, the time the buzzer went off, and the recurrence of SMS notifications.

Assess the system's responsiveness, accuracy, and dependability in detecting smoke by analyzing the recorded data.

Test Replication:

The "Introducing Smoke" test was repeated several times with various smoke concentrations to ensure accuracy.

4.1.3 CHANGEOVER SYSTEM SETTING

The smoke detection system can effortlessly convert between direct current and battery power thanks to the changeover system. This guarantees continuous operation even if the main power source is interrupted.

Components Involved:

Arduino Nano: The microcontroller known as the Arduino Nano is in charge of controlling the capabilities for switching between power sources.

Relay Module: This module is an electromagnetic switch that is operated electrically to control a circuit by turning it ON/OFF (watelectronics, n.d.).

Relay Module Connection:

Attach the breadboard's 5V and GND rails, respectively, to the VCC and GND pins of the relay module. Connected the Arduino Nano's D5 digital output pin to the IN (input) pin of the relay module.

Connections to the Power Source:

Joined a COM (common) contact on the relay module to the power supply directly (for instance, a 5V pin).

the positive terminal of the battery was connected to the other COM contact.

Arduino Code logic:

Initialization: The pin number (for example, D5) attached to the relay module was designated as a digital output pin in the Arduino code.

Changeover Logic:

A check for the direct electrical source's availability was made in the code:

Activate the relay to connect to the direct electricity source if direct electricity is available.

Deactivate the relay to switch to battery power if there is no direct power source.

Power Source Monitoring:

Code has been put in place that checks the direct power source's accessibility on a regular basis.

The relay then switches to battery power if the direct power supply is no longer accessible.

Testing the Changeover System:

Direct Electricity Operation: used a USB cable to connect to a power adapter or computer to power the system directly with electricity.

Relay module action was observed; it turned on and linked to the direct power supply.

Verification of Power Source Switching:

To simulate the direct electrical source's unavailability, it was disconnected.

The relay module was observed to make sure the transition to the battery power source went smoothly.

Reverting to Direct Electricity:

Reconnecting the direct electricity source will allow you to see if the relay module switches back to the direct power source after you do so.

4.2 DISCUSSION

4.2.1 MAIN FINDINGS AND EMPHASIZATION of KEY RESULTS

These findings encapsulate the core results achieved during the experimentation phase.

Accurate Smoke Detection

The MQ2 gas sensor utilized in our smoke detection system consistently demonstrated its reliability in detecting the presence of smoke. The sensor's analog output consistently provided accurate signals, indicating successful smoke detection (Rehman, n.d.).

This finding aligns with previous research emphasizing the reliability of gas sensors for smoke detection. It underscores the fundamental role of precise smoke detection in fire safety systems.

Timely Buzzer Activation

The audible siren was consistently and amazingly quickly activated when smoke was detected. This quick action makes sure that people in the monitored area get aural notifications in a timely manner, enabling them to deal with any fire threats.

The relevance of this particular finding is underscored by the fact that fire safety rules and guidelines have made clear the value of early smoke detection and prompt warning.

SMS Notification System

When smoke was detected, the SIM800L GSM module's integrated SMS notification system constantly sent out alerts. This kind of communication guarantees that pertinent parties are alerted as soon as possible about potential fire accidents.

Previous studies have looked into the use of cellular networks for remote monitoring and alerting in fire safety systems. confirming the efficiency of our strategy even more.

Effective Changeover Mechanism

During tests, the changeover system, which was created to effortlessly convert between direct current and battery power, worked quite effectively. This capacity is essential to maintaining the system's functionality in the event of power outages or disturbances.

4.2.1.1 Application in the Real World and Safety Implications

Our smoke detection system has demonstrated successful operation, as evidenced by precise smoke detection, prompt notifications, and a dependable changeover mechanism. This applicability encompasses a variety of situations, including residential, business, and industrial ones.

4.2.2 ACCURACY OF SMOKE DETECTION

Consistency of MQ2 Gas Sensor

The accuracy with which the MQ2 gas sensor detects the presence of smoke is one of the system's key effectiveness.

Throughout the testing and experimental phases, the stability level was clear.

The ability of the MQ2 gas sensor to react to changes in the concentration of different gases and smoke particles present in the environment is crucial.

Its reliable operation guarantees that it can detect even the tiniest traces of smoke, producing reliable analog output signals that are the cornerstone of the functionality of our system.

The stability of the MQ2 gas sensor's performance matches with already research and literature on gas sensors' reliability for smoke detection (Gas Sensor Array for Reliable Fire Detection, 2016).

Reliability in Identifying Smoke

In real-world circumstances, where the effects of false alarms might be detrimental, this level of dependability is essential for making sure the system produces accurate and timely alerts.

The reliability of the MQ2 gas sensor in identifying smoke is supported by both our experimental results and the broader literature on gas sensors' application in smoke detection systems (Kohl, 2001). These findings underscore the sensor's vital role in enhancing fire safety measures.

4.2.3 TIMELY BUZZER ACTIVATION

Swift and Reliable Alarm Response

The quick and reliable activation of the audible buzzer upon smoke detection is one of the project's key outcomes. This important finding highlights the system's capacity to react quickly to the presence of smoke by sending out fast audio notifications to everyone inside the monitored area.

Swift Response: The buzzer's quick activation ensures that anyone nearby the smoke source—occupants or staff—is immediately alerted to the possible fire threat. In our tests, the system's ability to react quickly was validated by the reaction time from smoke detection to alarm activation being regularly under a few seconds.

Reliable Activation: Alarm activation reliability is also very important. In order to ensure that the alerting mechanism runs consistently and does not experience false alarms or missed detections, our system reliably and consistently triggered the audio alarm upon detecting smoke.

Consistent SMS Alerts

The reliable operation of our SMS warning system is one of our project's key accomplishments. This function, which was integrated with the SIM800L GSM module, made sure that pertinent parties always received real-time warnings upon smoke detection.

Consistency: During all of our testing and tests, the SMS alerting system reliably and promptly issued notifications. With such reliability, it is guaranteed that the system will send notifications when they are most needed.

Timely Communication: Timely SMS alerts is very important to the system's ability to provide important information to the users on time. It guarantees that those who need to know about potential fire situations are swiftly alerted, enabling quick response and mitigation.

utilization of SIM800L GSM module

The use of the SIM800L GSM module was very important for the SMS alerting system in the project to function successfully. By acting as the communication gateway, it allowed early alerts to be sent over cellular networks.

Versatility: The SIM800L GSM module adds versatility to the system, as it can operate in a wide range of geographical locations with cellular network coverage. This adaptability is important for the system's applicability in diverse settings.

4.2.4 EFFICIENT CHANGEOVER MECHANISM

Seamless Transition Between Power Sources

Our project's design and execution of a reliable switchover system, which enables a smooth switch between direct current and battery power, is one of its key accomplishments.

Seamless Transition: During our experiments, our system showed that switching between these power sources was effortless. The system shifted to battery power without generating any hiccups in operation when there was a power outage. Similar to that, the system seamlessly switched back to direct electricity when the power was restored.

Minimal Downtime: By guaranteeing little downtime in the event of power outages, the smoke detection system will continue to function without interruption. This is especially important for fire safety applications because even little pauses in monitoring might have negative effects.

Vitality Power Interruptions

Our effective changeover mechanism's crucial significance becomes clear when you consider its capacity to keep the system running amid power outages. Power outages can be caused by a number of things, such as electrical problems or external problems like storms.

Continuous Operation: Our system's ability to continue running on battery power throughout such interruptions makes sure that it can keep looking for smoke and sounding alarms without relying on a steady external power source. The reliability and efficiency of the system are improved by this ongoing activity.

Risk Mitigation: Our study helps to improve the security and dependability of fire detection systems in real-world scenarios by reducing the risks related to power outages.

4.3 USE AND SAFETY IMPLICATIONS

4.3.1 RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL USE

The system's use different situations, including residential, commercial, and industrial settings, is part of the main objectives of our study.

Residential Use: Our smoke detection system can give homeowners and occupants early alerts in residential situations, enabling them to react quickly to fire threats. This can dramatically lower the possibility of accidents and residential damage.

Commercial Use: By warning staff, patrons, and management of potential fire accidents in commercial buildings including offices, shops, and restaurants, our method helps improve fire safety. This early warning system helps to safeguard property assets and the safety of building occupants.

Industrial Use: Our technology can be integrated into safety protocols in industrial settings, where fire dangers can be extremely complicated and dangerous, to give workers and safety personnel prompt notifications. This lowers the risk of catastrophic events and improves the safety of industrial activities.

4.3.2 CONTRIBUTION TO FIRE SAFETY MEASURES

The results of our experiment demonstrate the substantial contribution that our smoke detection system can make to fire protection measures.

Early Detection: Our technology equips people and organizations to react quickly to fire emergencies, lowering the risk of injuries and fatalities. It does this by providing accurate and timely smoke detection.

Property Protection: Beyond human safety, our system also helps to safeguard property by enabling early intervention, which may help to lessen the level of damage to buildings and other assets.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Our project study has produced important results that confirm the accuracy and usefulness of the smoke detecting technology. Here is a summary of our key findings:

Our research established the MQ2 gas sensor as the cornerstone of our smoke detection system, validating its accuracy and dependability in detecting smoke. When smoke was detected, the system quickly and consistently activated the loud buzzer, which is a crucial component of timely alerting in fire safety. Regardless of their location, stakeholders got real-time notifications thanks to the integration of the SMS notification system with the SIM800L GSM module. In addition, our effective changeover mechanism smoothly switched between power sources, ensuring continuous operation even during power outages or disruptions.

Most importantly, our study demonstrated how our smoke detection system can be used in various contexts, including residential, commercial, and industrial settings.

The importance of our work is found in its breakthroughs in fire safety. Our method improves early fire detection, a key component of fire safety, possibly sparing lives and minimizing property loss. It also enhances alerting systems, ensuring that people are promptly and effectively informed of possible fire emergencies. Our effective changeover mechanism's capacity to adapt and be reliable increases the system's applicability in a variety of situations. In the end, our study contributes to the field of fire safety by offering a reliable and adaptable solution that has the potential to have a significant influence on fire safety protocols.

5.2 RECOMMENDATION

Experimental Constraints: The controlled nature of our trials is a key constraint. Our controlled setting might not fully represent all possible circumstances, such as various kinds of fires or environmental concerns, because real-world conditions can change.

Sensor Specificity: The MQ2 gas sensor has proven to be dependable, but it's vital to keep in mind that it was initially created for general gas detection. Even more accurate smoke detection might be possible with specialized smoke detectors.

Sample Size: The size of our sample population or test scenarios may not accurately reflect the variety of real-world circumstances, which could have an impact on how generalizable our findings are.

Machine Learning Algorithms: Incorporating machine learning algorithms for smoke pattern recognition could enhance the system's accuracy and reduce false alarms (Video Flame and Smoke Based Fire Detection Algorithms: A Literature Review, 2020).

Remote Monitoring: Increasing the system's capacity to support remote monitoring and control via web-based or mobile applications may enhance usability and accessibility.

Redundancy: Adding redundant power supplies and communication lines can improve the system's dependability even more.

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