

An Automatic School Dormitory Safety Monitoring System for Possible Fire Outbreaks

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Abstract: Existing school dormitory safety technologies in Ugandan schools have not caught up with the reality of today's school dormitory and hostel buildings and way of living. This paper focuses on building an automatic school dormitory safety monitoring system that integrates three capabilities, namely, detection, communication, and suppression. It seeks to address the salient issue of real-time communication in the face of an unpredictable daily routine and first-line suppression moves at the onset of a fire outbreak that most advanced fire detection systems in schools today have failed to address. The implemented system uses an Atmega328p microcontroller unit, which is interfaced with fire detection, overload detection, and flammable gas detection sensors for monitoring purposes, for real-time communication with concerned personnel, the system uses the Global System for Mobile Communication modem to co-ordinate the operation of a network of radio frequency transmission.

Keywords— Fire, school, Dormitory, safety, Monitoring

1. INTRODUCTION

In Uganda, a number of school dormitories have been prone to fire incidents killing a number of students. The incident in April 2008 where a fire caught a girls' dormitory at Buddo Junior School left 20 pupils dead. There have been more fires at different Schools and hostels in the recent past. In November 12, 2018, a school in Rakai district caught fire and left ten Senior three students dead and more than 50 with critical injuries. According to the Rakai District Police Commander, Ben Kashumbusha, the incident happened at around 2am when the boys' dormitory for mostly Senior three students caught fire. "We suspect the fire was set by fellow students who had been expelled from school and had to commute from home to write their final UCE exams," Kashumbusha told the Nile Post in a phone interview on Monday morning. According to the District police commander, investigators suspect that after being expelled from school, the students who were unhappy with the decision by the management planned to revenge by collaborating with other people inside the school. Those students coordinated with some of their friend they left inside the school and eventually managed to access the school dormitory easily. On entering, the assailants who were armed with petrol and matchboxes first put padlocks on the dormitory's door setting it ablaze.

In January 2022, The New vision newspapers reported several school fire outbreaks just after the schools have been officially re-opened. This paper seeks to help protect the students and school stakeholders from the effects of the fires by providing ways of early detection of the likely causes of these fires.

2. BLOCK DIAGRAM

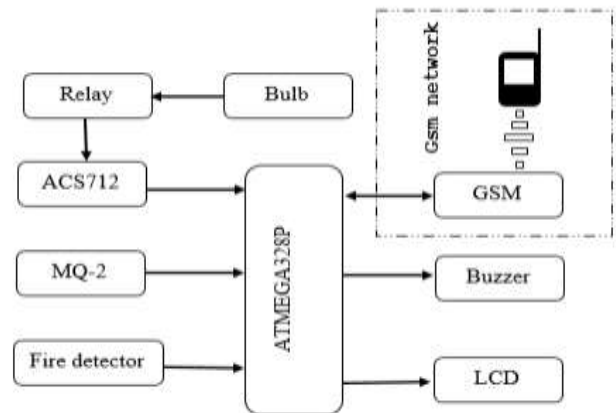


Fig.1. Block diagram of the project

Microcontroller Unit

The Microcontroller chosen is the ATMEGA328P. It is specifically chosen because it has 16MHz speed and can be placed on Arduino Uno board and burn the program into it. It also has a 32KB internal Built-in memory.

Crystal oscillators

A crystal oscillator uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an

electrical signal with a constant frequency. This will act as an external clock source that operates at 16MHZ interfaced to the Atmega328p.

Pull-up resistor.

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. In this Paper, a pull-up resistor connects unused input pins (AND NAND gates) to the dc supply voltage, (Vcc) to keep the given input HIGH. To disable the continuous reset of the Atmega328p, a pull-up resistor should be connected to its reset pin.

Liquid-crystal display (LCD)

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. This module was used to display the status of the whole system.

Current sensor

Current flowing through a conductor causes a voltage drop. The relation between current and voltage is given by Ohm's law. In electronic devices, an increase in the amount of current above its requirement leads to overload and can damage the device. Measurement of current is necessary for the proper working of devices. Measurement of voltage is Passive task and it can be done without affecting the system.

MQ-2 Gas sensor module

The Grove - Gas Sensor (MQ2) module was useful for gas leakage detection. It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted using the potentiometer.

Fire detector

For fire detection, there are two parameters that are considered first and foremost is the infrared beams created by fire flames which can be detected by a photo diode, smoke is the second parameter and this can be detected by MQ-2 smoke sensor.

Relay switch

Relays are constructed with electrical, mechanical and magnetic components. They are made with a coil that induces a magnetic field when energized. This magnetic field attracts the armature which closes or opens the contacts. In this project a relay switch is used to switch off electricity in case of a fire outbreak.

GSM modem

SIM800L GSM/GPRS module is a miniature GSM modem, which can be integrated into a great number of projects. This module can be used to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more. To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world. It is used to send text messages in the implemented project.

Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

3. WORKING PRINCIPAL OF THE PROJECT

The implemented project uses the current sensor to monitor the usage of electricity in the dormitory and incase of short circuits, the circuit breakers triggers to break connections so that power is cut off to prevent and spikes or chances of fire outbreak. The project uses the MQ2 sensor for smoke or gas detection and it alerts the ATMEGA328P to trigger alarm through buzzer and SMS alerts through the GSM modem. A fire detector also senses if there is any fire, smoke anywhere near or in the dormitory. In case of fire, electricity is automatically switched off to stop the easy spreading of fire in case it happens. All these functions were coordinated by a C code running in an Integrated Development Environment called Arduino. This software uses a programming board called Arduino Uno which programs AVR microcontrollers like ATMEGA328p. The figure below shows the flow of the program.

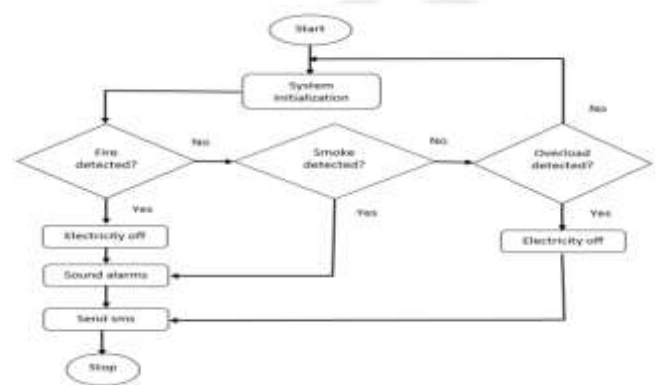


Fig.2. Flow chart of the project

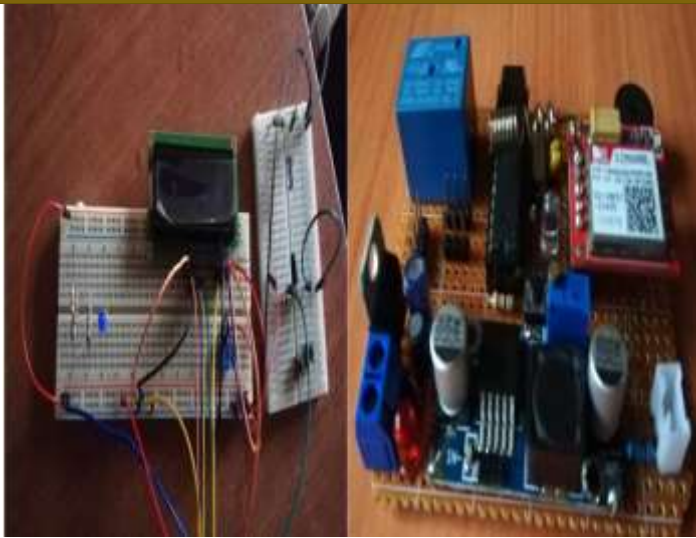


Fig.3. Assembled Electronic circuit of the project

4. CONCLUSION

This system was able to monitor parameters like fire outbreaks, Dangerous gas leakages like LPG and circuit overload using flame detector sensor, MQ-2 and ACS712 current sensors respectively interfaced to the MCU, when a fire was detected, a relay switch automatically triggered to cut off electricity preventing it from distributing fire, a buzzer was immediately triggered to alert the nearby concerned people and a text message was sent to the fire brigade police for immediate evacuation and stopping of the fire. The project was also able to monitor Leakages of liquefied petroleum gas using the MQ2 gas sensor, it sounded alarms and sent alert message to concerned people to prevent the spread of the fire when the leakages were detected. ACS712 current sensor was also used to monitor the amount of current used such that circuits are protected once overloads are detected.

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