Home Security System using Arduino UNO

CSE2006 - Microprocessors and Interfacing

Final Report

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Abstract

Most home security systems work on the same basic principle of securing entry points and weak links in a home. Home safety systems involving smoke and fire detection work on the principle of spotting and reporting of unusual events. Regardless of the size of the home, the number of doors and windows, or interior rooms, the only difference is in the number of security components deployed in the home. In this project, we have developed a home security application which can be monitored and operated remotely by a primary control panel.

Chapter 1

Aim

To build a standalone, low-maintenance, affordable home safety system which protects users against various dangers like hazardous fires, intruders, and gas leaks. The system which consists of proximity, motion, smoke and temperature detection modules and also a servo motor for revolution of a fan is built using an arduino uno microcontroller and C++ programming language.

Objective

The system will consist of 1 led, 1 buzzer and an LCD (i2c) as outputs. An ultrasonic sensor is used for proximity detection and a PIR sensor for motion detection. A temperature and gas sensor is used as inputs for detection of temperature and smoke. Additionally, we use a servo motor as an actuator to showcase the revolution of a fan on detection of smoke.

Introduction

Most modern homes make use of locks and keys for security and protection of valuable belongings. It was found that in 2021, there were upwards of 3000 cases of home burglary cases in Bangalore and this is understandably a big problem.

Modern homes should come with smart security systems which are robust, reliable, and contain fail-safe mechanisms. This is not possible with a traditional lock and key system. However, using Arduino Uno microcontrollers and IOT, we have created a security system which is not only robust, reliable and fail-safe but can also be scaled up as one's security needs increase. The home security system proposed here is a network of integrated electronic devices working together with a central control panel to protect against burglary, smoke, fire and other potential catastrophic incidents.

The components involved in the home security system are:
- A primary control panel which can be used for remote operation and monitoring of security system
- Gas and temperature sensors
- Motion and proximity sensors
- Led to blink when a dangerous situation is detected
- Piezo buzzer which makes a loud noise to alert when a dangerous situation is detected
- LCD to display temperature
- Servo motor to trigger the sprinklers on detection of a fire

Chapter 2

Related works or literature survey

As a part of the literature survey, few papers were studied by us and the systems proposed in those are as follows:

Smart Home Security System Using IoT

This paper describes a low-cost GSM smart home security system along with features like face recognition and detection. The system not only monitors sensor data but also sends alerts when any form of intrusion happens. The PIR sensor will activate the camera only when intrusion is detected thus saving memory and power. The system will compare the face of the intruder with a predefined database of all authorised people's face images. In this way, the system not only allows authorised people to enter but also it can be operated from anywhere in the world.

Design and implementation of home security system and monitoring by using wireless sensor networks WSN/internet of things IoT

The system proposed in this paper can be used to sense a wide range of things including body temperature, humidity, gas, object motion. Various sensors and devices used for this purpose include: - Arduino processing unit, Raspberry pi 3 mode B, Spark photon, RFID system, PIR sensor. The door lock is password protected and if the password entered is correct then the motor opens the door. The system allows only three incorrect chances after which it goes into a short cooldown period. The PIR sensor sets up motion detection which can be used by owners to monitor suspicious movement. A RFID system is also present for card-based authentication. An interactive app has been developed to warn the owners of any suspicious activities.

Home Security against Human Intrusion using Raspberry Pi

The system proposes a method which aims to make photos of intruders more clear and

properly visible. A smart mirror is designed which will provide both information and security. Yolo technique is used for human detection in this scenario. Although the accuracy of human detection using Yolo technique is considerably quite good, the main problem is to identify intruders during back view or complete side view.

Intelligent Home Security Surveillance System Based on ZigBee

An intelligent remote monitoring system for home security based on ZigBee technology and GSM / GPRS network is proposed in this paper. The experimental results show that the system can attain remote surveillance of intelligent home safety with high availability and reliability. It can completely meet the normal home environment for the communication needs, with a low power therefore, as a whole it is very suitable for family use.

Smart Home Security System Based on Zigbee

The proposed system consists of a hub, a battery powered sensor node and an Android application. The sensor node sends sensor output to the hub via Zigbee. If any kind of intrusion, flood or smoke is detected, the hub will start an alarm and trigger the Android application to display an alarm in real time through the Internet via Firebase. If an intruder is detected, his photo will be taken and processed via a predefined software using haar algorithm where his face will be detected and compared with existing database. All features of the face will be extracted and given as input to the algorithm and distance is calculated and kept for future use. The system not only grants or denies permission but also provides live mobile monitoring.

Smart doorbell system based on face recognition

This paper mainly discusses how to recognise a face. This project uses the Eigenfaces algorithm using OpenCV library to perform face recognition. Face recognition is very important for security. For evaluating the proposed system, the authors use two analysis algorithms which include Eigen face and Independent Component Analysis (ICA). The system proposed here will aid people having hearing impairment or who are completely deaf, to get intimated about someone on the door.

This project mainly builds a home automation system which is wireless. Arduino uno is used to achieve security. Different sensors are used to detect abnormality and if it is found then the concerned person will be warned. The present status of the place can be monitored using this system even when the owner is far from home. It further enhances security by using encryption and decryption of data. The current data can be used for intruder detection, fire accidents etc. The authorised person gets the image of the intruder via sms or email. Also, the count of the number of people who visited the house is obtained.

Existing and proposed system

The security of our homes currently majorly depends only on the lock and key model that is being used to secure our homes and safeguard our belongings but it has various disadvantages like lock picking, etc. so a new and revised system for the security of our homes must be introduced. Ideas about existing systems were obtained from literature surveys and a new system was proposed.

Issues with the existing system

It has been found that using lock and key doesn't keep away cases of robbery and thefts. An ideal security system should be reliable and robust. It should have various fail safe mechanisms and a backup system so that even if a particular safety measure fails, the other can be used. But, the traditional lock and key model is not robust, reliable, scalable or fail safe. Thus, we introduce a model which satisfies the criteria of an ideal security system.

From the literature survey, it can be concluded that an intelligent system consisting of multiple components all connected to a microprocessor can be used to better the current situation.

One of the crucial factors while choosing a security system is cost. Most of the security systems seen are very costly and difficult to set up without proper interference. So, our system will present an affordable system to everyone, without compromising functionality.

Chapter 3

Proposed system architecture

The proposed system consists of *5* broadly classified *General Purpose Input /Output* components and Actuators configured using a Microcontroller. The circuit diagram/ architecture is provided below.
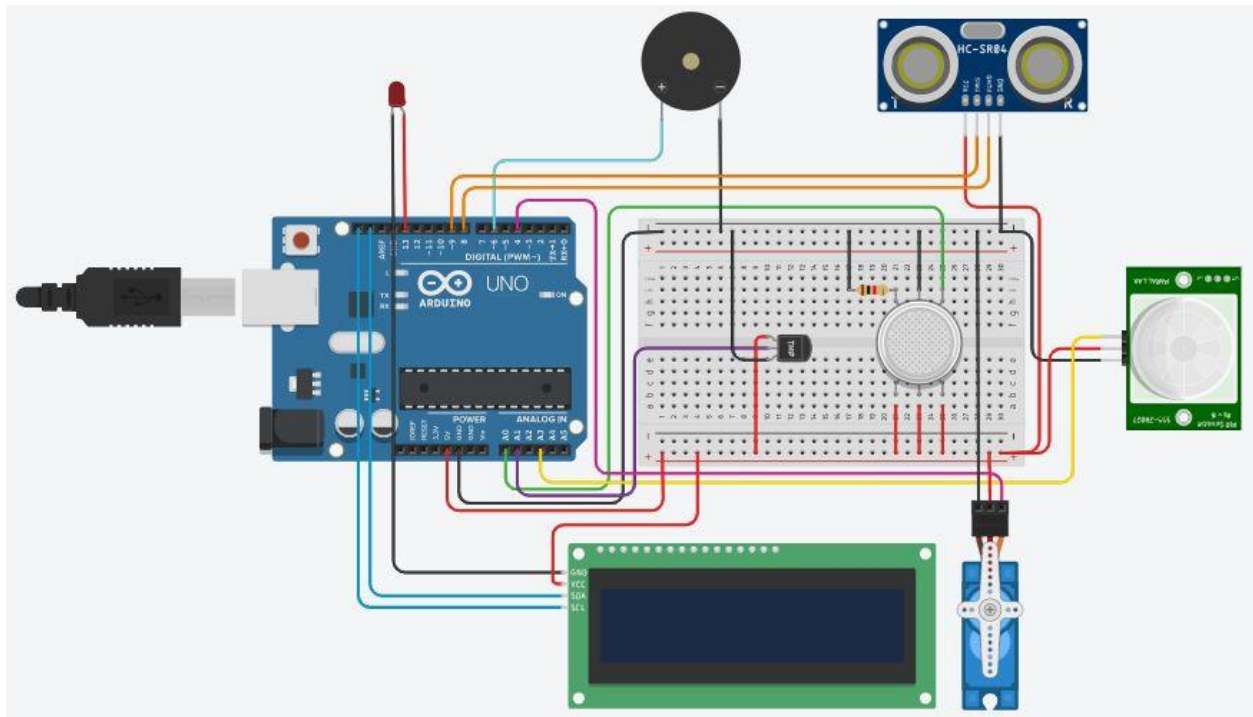
Architecture Diagram/Block Diagram

Architecture Explanation

This section dives deeper into each of the components involved in the architecture of the proposed system.

Arduino UNO

The Arduino UNO is an open source microcontroller based on the Microchip ATmega328P microcontroller. It provides sets of digital and analog input/output pins

that can be interfaced to various devices and other circuits. In our system, these pins help interface the devices listed herewith to create our home security system.

Sensors

1. Temperature sensor - TMP36

   It is a low voltage, precision centigrade temperature sensor which provides a voltage output linearly proportional to the Celsius temperature. It has a temperature range of −40°C to +125°C. In our system, this sensor is used to detect fire and high temperature.

2. Gas Sensor - MQ-2

   It converts the components and concentrations of various gases to standard electrical signals. It is used in the detection of noxious and harmful gases and natural gas leakage. For our system, it acts as a smoke and fire detector.

3. Ultrasonic Distance Sensor - HC-SR04

   It is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Based on the time taken for the transmitted signal to return to the sensor, the distance between sensor and obstacle is computed. This property of the sensor is used in the proposed system as a thief/robber detector.

4. PIR Sensor

   It emits IR radiations to detect motion making it useful in detection of motion of humans, animals, etc. This property is useful in intruder detection in the proposed system.

Actuator - Servo Motor

This device is a linear/rotary actuator that helps in precise control of linear/angular position, acceleration, and velocity. The motor is coupled to a sensor for position feedback. On observing instructions from Arduino when paired with it, the motor can rotate from 0°-360°. The proposed system uses the servo motor as a knob to turn on the sprayer/sprinkler on detection of fire.

LED - Light Emitting Diode

It is a semiconductor device which emits light on experiencing flow of current through it. This component is usually used in small circuits to indicate working on components. In the proposed system, the LED is used in the alert system. It blinks when a dangerous situation is detected.

Piezo Buzzer

It is an electronic device used to produce audio sounds. It is low cost and works across varying frequencies producing different sound outputs. On connecting with Arduino, it can be programmed to ring/sound at any time. In our system, the Piezo is part of the alarm system, ringing when a dangerous situation is detected.

Algorithms and Pseudocode

This section contains the algorithm/pseudocode used to give instructions to the Arduino and its components to function accordingly. Using this algorithm, the code was later written in C++ Programming Language in an Online IDE.

DECLARE THE _PIN NUMBERS_
INITIALISE THE _SET UP_
    DISPLAY "Welcome to Home Security System"
DO WHILE POWER IS PROVIDED
    READ THE _GAS SENSOR VALUE_
    READ THE _TEMPERATURE SENSOR VALUE_
       CONVERT _VOLTAGE_ FROM SENSOR TO _TEMPERATURE IN DEGREE CELSIUS_
    READ _TIME_ FROM ULTRASONIC DISTANCE SENSOR
       CALCULATE THE _DISTANCE_ USING TIME*SPEED OF SOUND/2
    READ THE _PIR SENSOR VALUE_
    IF _GAS SENSOR VALUE_ >= 150 **AND** _TEMPERATURE_ < 75


BUZZER GETS ACTIVATED

DISPLAY "Smoke Detected"

DISPLAY THE *GAS SENSOR VALUE* IN PPM

IF *TEMPERATURE* >= 75 **AND** *GAS SENSOR VALUE* < 150

BUZZER GETS ACTIVATED

DISPLAY "Fire Alert"

DISPLAY THE *TEMPERATURE* IN DEG CELSIUS

IF *TEMPERATURE* >= 90 **AND** *GAS SENSOR VALUE* >= 150

BUZZER GETS ACTIVATED

LED GLOWS

DISPLAY "Fire Alert!! Starting sprayer"

MOTOR STARTS ROTATING

DISPLAY "Started"

IF *DISTANCE* >= 60 // using ultrasonic distance sensor

BUZZER GETS ACTIVATED

LED GLOWS

DISPLAY "Thief Detected"

IF *PIR SENSOR VALUE* > 0

BUZZER GETS ACTIVATED

LED GLOWS

DISPLAY "Motion Detected"

TERMINATE PROCESS **IF** NO POWER

Algorithm/Pseudocode

Chapter 4

## Results and Discussions

Initialization
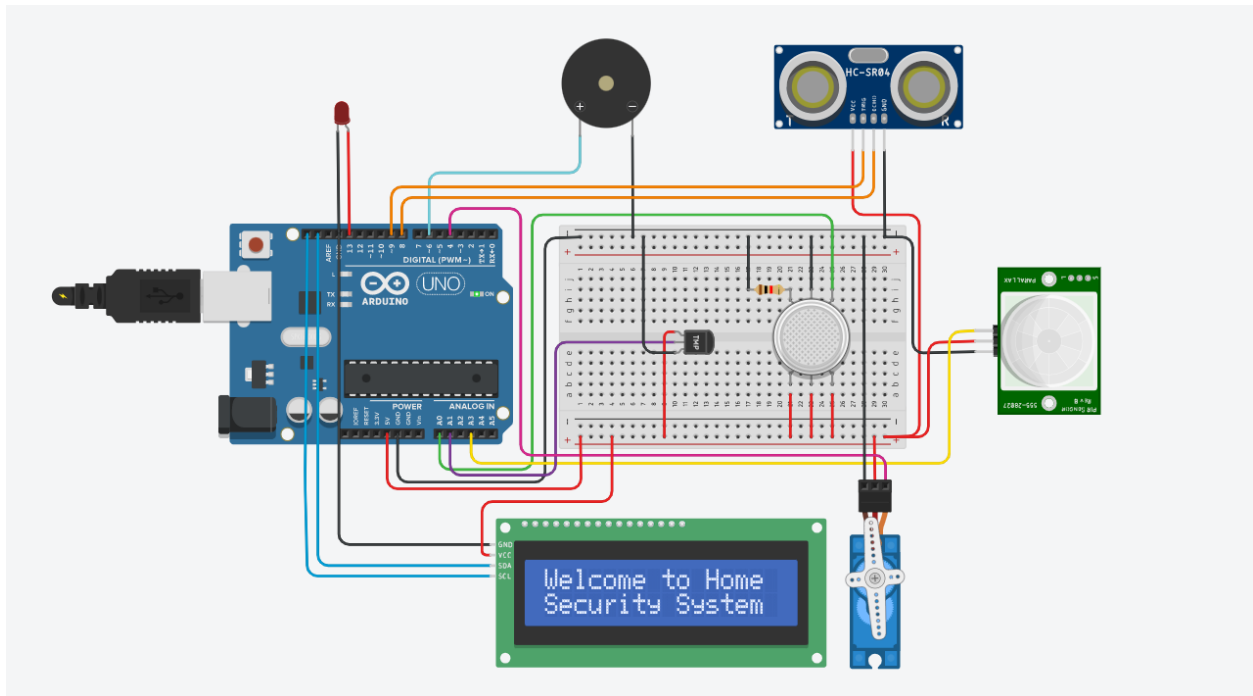
System Initially on supplying Power

When the stimulation starts the LCD displays a welcome message, "Welcome to Home Security System".

Initially, all the sensors are activated and made ready to take input from the surroundings. The Actuator, LED, and Piezo also wait for instructions from the Arduino to start functioning.
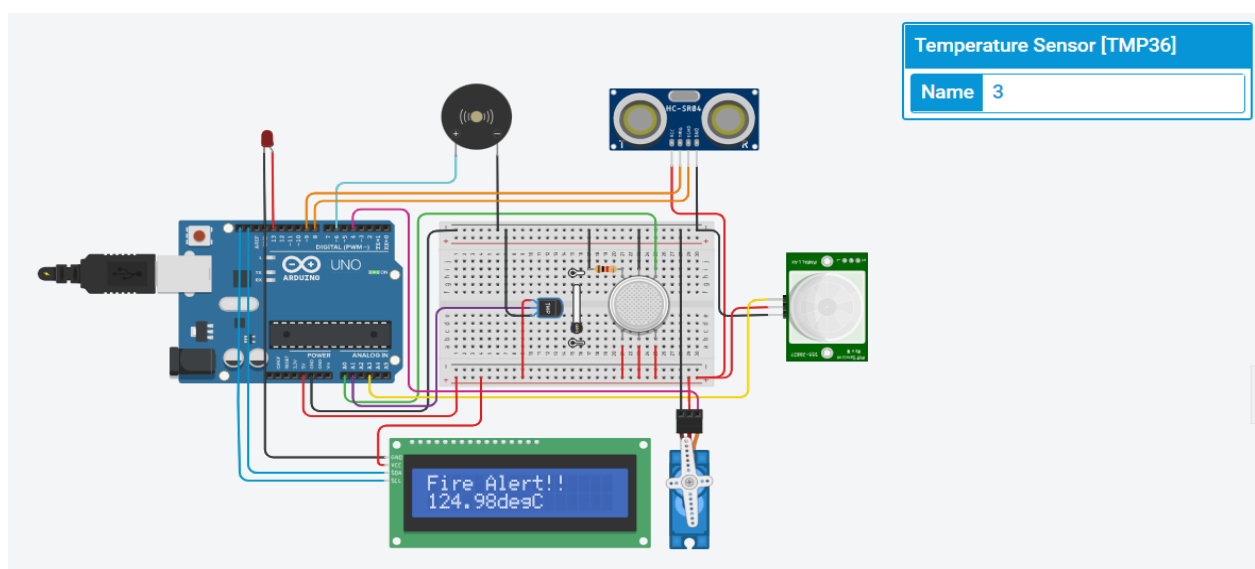
Smoke Alert
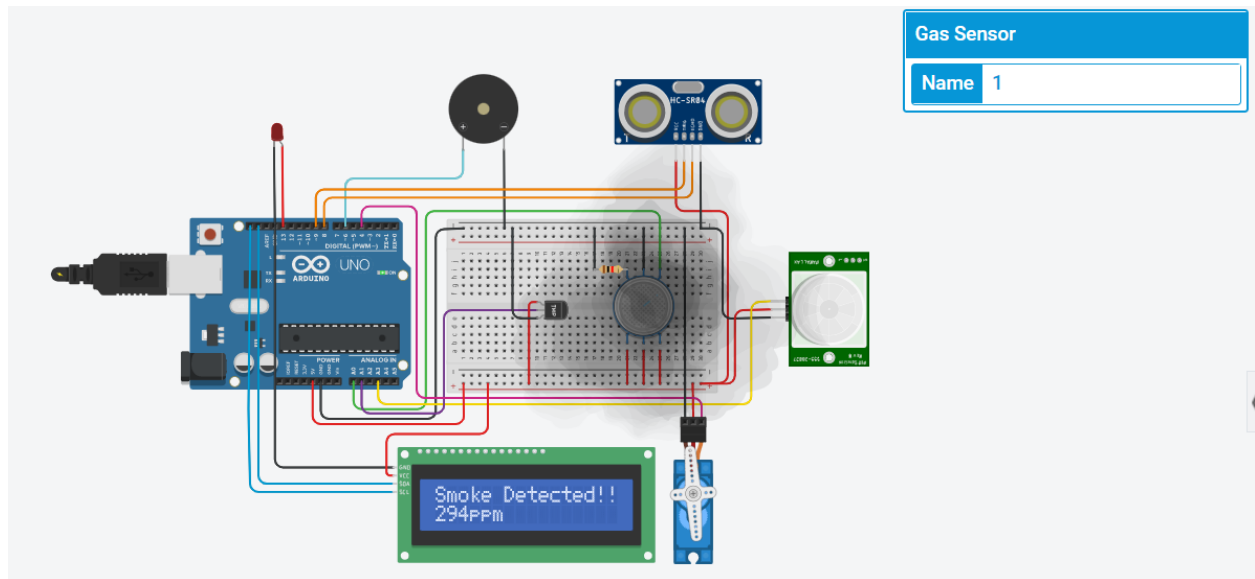
System on detecting Smoke

When the gas sensor detects a gas with a PPM (parts per million) above 150 and the temperature detected is not above 75°C, the alarm sets off and the LCD displays "Smoke Detected!!" along with the concentration of the gas. This keeps happening until the concentration level dies down to below 150 PPM when the buzzer stops and LCD goes to blank state.

High Temperature Alert

System on detecting High Temperature

When the temperature detected by the temperature sensor exceeds 75°C and no smoke is detected, the Piezo buzzer is set off and the LCD displays "Fire Alert!!" along with the current temperature of the room in °C. This happens until the temperature decreases to below 75°C when the alarm stops and the LCD does not display any message.

Fire Alert
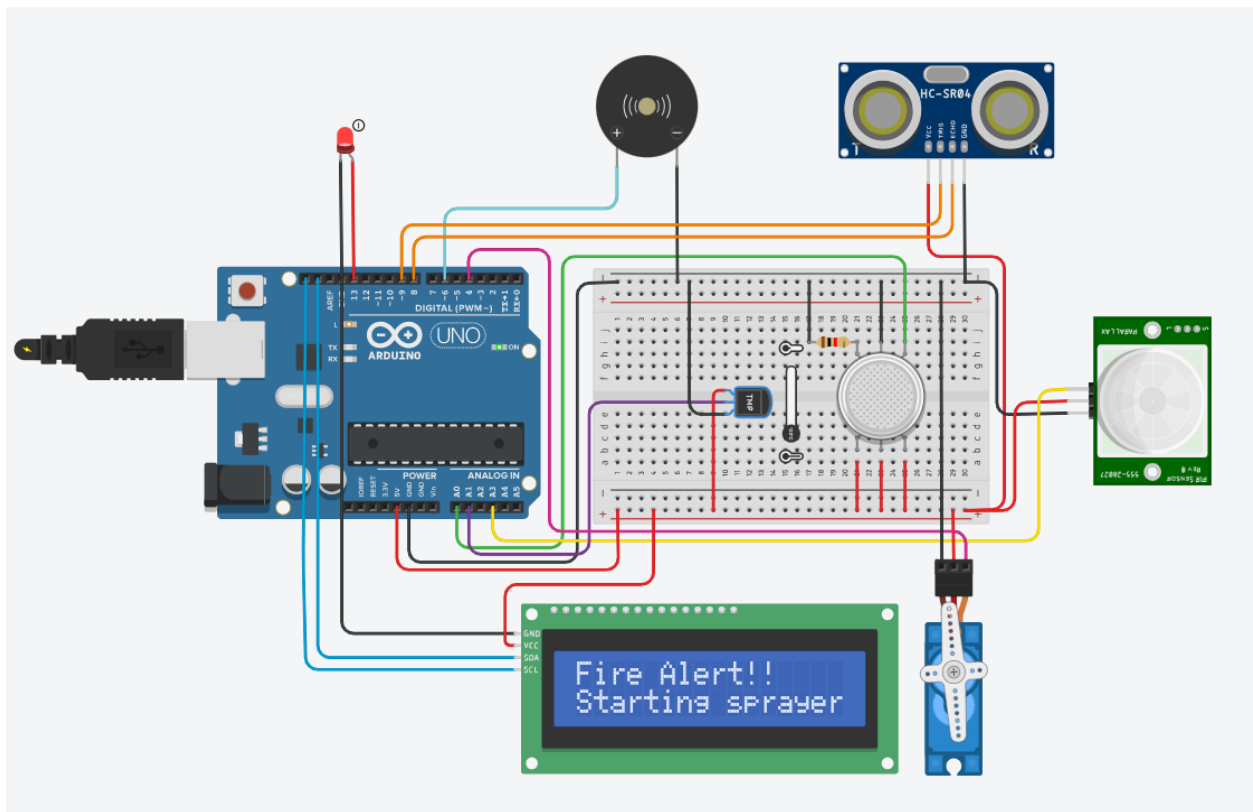
System on detecting fire

When the gas sensor detects a gas with a concentration above 150 PPM and the temperature detected is above 90°C, the alarm sets off, the LED starts blinking, and the LCD displays "Fire Detected!! Starting sprayer" indicating the start of the motor for the sprinkler system. This message is displayed till at least one of the above conditions are not satisfied anymore when the buzzer and LED stop and LCD goes to blank state.
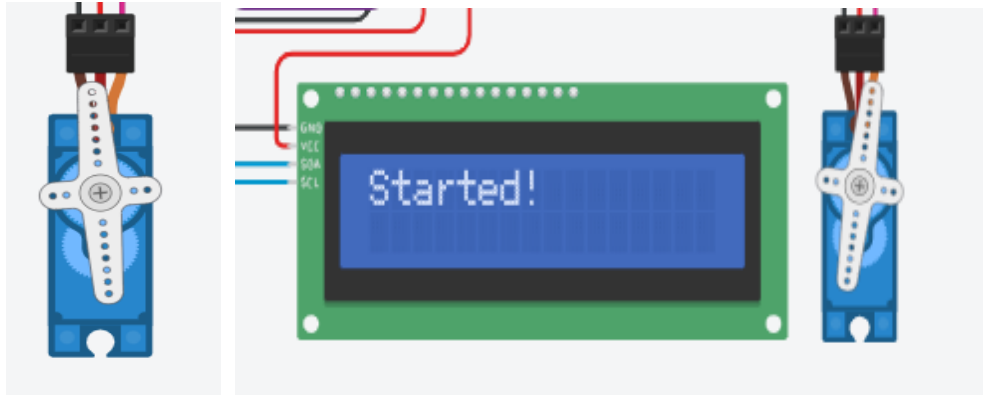
Before and After starting Sprinkler

Robber Alert
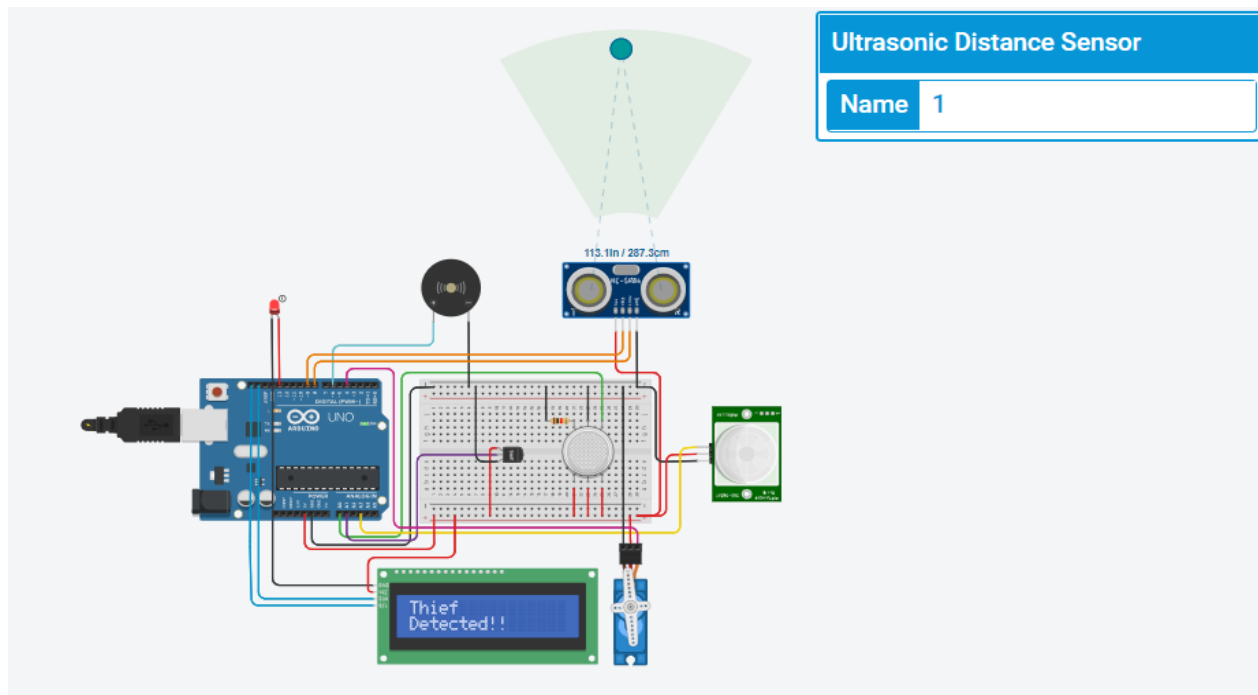
System on detecting Opening of Safe by Robber

When the ultrasonic distance sensor detects the distance as more than 60cm (the assumed depth of a standard safe), the alarm sets off, the LED starts blinking, and the LCD displays "Thief Detected!!". This continues till the safe is closed when the buzzer and LED stop and LCD goes to blank state. Users can disable this feature manually before opening the safe.

Intruder Alert
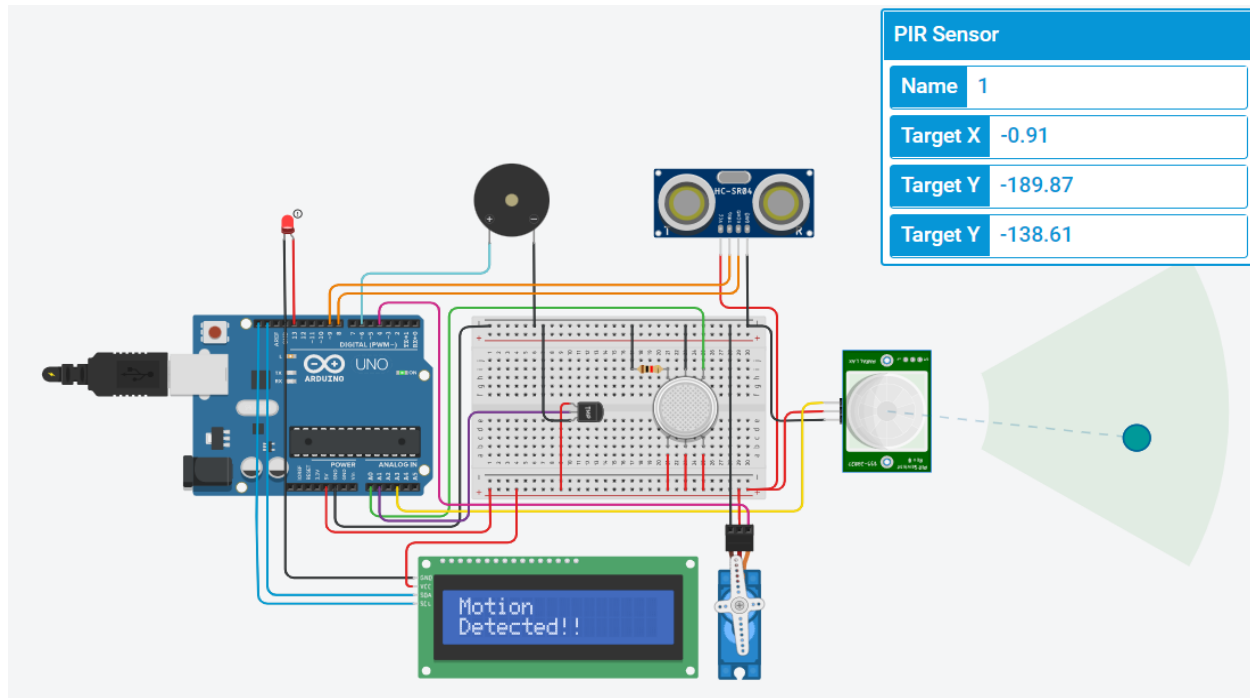
System on detecting Anomalous Motion

When the PIR sensor detects movement based on IR radiations by humans or animals, the alarm sets off, the LED starts blinking and the LCD displays "Intruder Detected!!". The user can set the system to enable the sensor during night hours to avoid false alarms like movement of family, etc. The alarm system goes on until movement has stopped or the system shuts down forcefully, when the buzzer and LED stop and LCD goes to blank state.

Conclusions and future work

The system was constructed successfully and produced the desired results. This system is low cost, needs low maintenance, and is an easy to set system for home security using IOT.

There is scope for a development of a mobile phone companion app where any incidents can be logged to a database. Additionally, using a time and date module,

incidents can be time-stamped and the security system can be configured to operate during certain time intervals and/or a certain day. Moreover, live alerts can be sent to the user through mobile phone notifications through the companion app.

With increasing technology more improvements can be made to this device to suit the needs of the user and help make their home more secure and protected.

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