

EEE 304 (July 2022) **A2**
Digital Electronics Laboratory

Final Project Report

Smart Smoke Detector

Ethics Statement:

IMPORTANT! Please carefully read and sign the Ethics Statement, below. Type the student ID and Write your name in your own handwriting. You will not receive credit for this project unless this statement is signed in the presence of your lab instructor.

"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), or copied from internet. We have cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."

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Evaluation Form:

| STEP | Assessment Tool | Criteria | CO | PO | MAX | SCORE |
|------|-----------------------------|--------------------------------|-----|------|-----|-------|
| 1 | Peer Assessment | Individual Contribution | CO5 | PO9 | 10 | |
| 2 | | Teamwork | CO5 | PO9 | 10 | |
| 3 | | Ethics | CO4 | PO8 | 10 | |
| 4 | Viva | Ethics | CO4 | PO8 | 10 | |
| 5 | | Tool Usage | CO2 | PO5 | 10 | |
| 6 | Report | Technological Limit Evaluation | CO2 | PO5 | 10 | |
| 7 | | Technical Details | CO6 | PO10 | 10 | |
| 8 | | Design Considerations | CO3 | PO3 | 10 | |
| 9 | Project Demonstration | | CO3 | PO3 | 10 | |
| 10 | Recorded Video Presentation | | CO6 | PO10 | 10 | |
| | TOTAL | | | | 100 | |

Course Instructor:

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2. Barproda Halder (PT)

Signature of Evaluator: _____

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1 Abstract

A Smoke Detector is a smoke sensing device that indicates fire. Smoke Detectors are very useful devices as the damage caused by fire accidents is catastrophic. Smoke alarms are an excellent layer of protection to have at any residential or working place. They can notify you of the presence of smoke, most often from a fire. A fast response can minimize damage and allow enough time for people to safely exit the danger zone. New models of smoke detectors are taking advantage of smart home technology, becoming smart smoke detectors. These smart devices can alert you to alert about the smoke faster than traditional alarms and it is loaded with extra features. The aim of our project is to design a smart smoke detector system which can help prevent any unwanted accident in any crowded place.

2 Introduction

Fire accidents are very common in every part of the world. Often in these deadly fires, many properties are damaged, and many people die from these accidents. To prevent this type of accident, a device is necessary which can alert people about the fire beforehand and take steps accordingly. Although there are smoke detectors in the market, many of these are not smart enough to alert people faster about fire accidents. That's why, we have done a project on making a smoke detector which will detect smoke caused from fire and will turn on an alarm to notify about the fire. This project

2.1 Complexity Analysis

Detecting smoke in fire outbreaks at home or in hospitals or workplace, it's indeed an uphill task to build the whole model accurately using only few gates and basic sensors. Much more complexity will arise in detecting the actual threshold crossing value and turning on the alarm system instantaneously. For example, while cooking in the kitchen, the sensors may behave abnormally and turn on the alarm due to the heat and smoke present while cooking. Also, due to propagation and contamination delays present in our logic circuit will also hinder the whole model to respond to

the smoke instantaneously. Again, the timer circuit can also behave abruptly by turning off instantly after giving the alert. This immediate turning off can give a false information that there is no fire which can lead to major accidents. That's why, building this project was indeed a challenging task. As a prototype, it gives a satisfactory performance, but many upgradations can be done to this project.

3 Technical Details of the Design

Our project comprises of 4 blocks. They are:

- ADC Block
- Seven-segment Display
- Comparator Block
- Timer Block

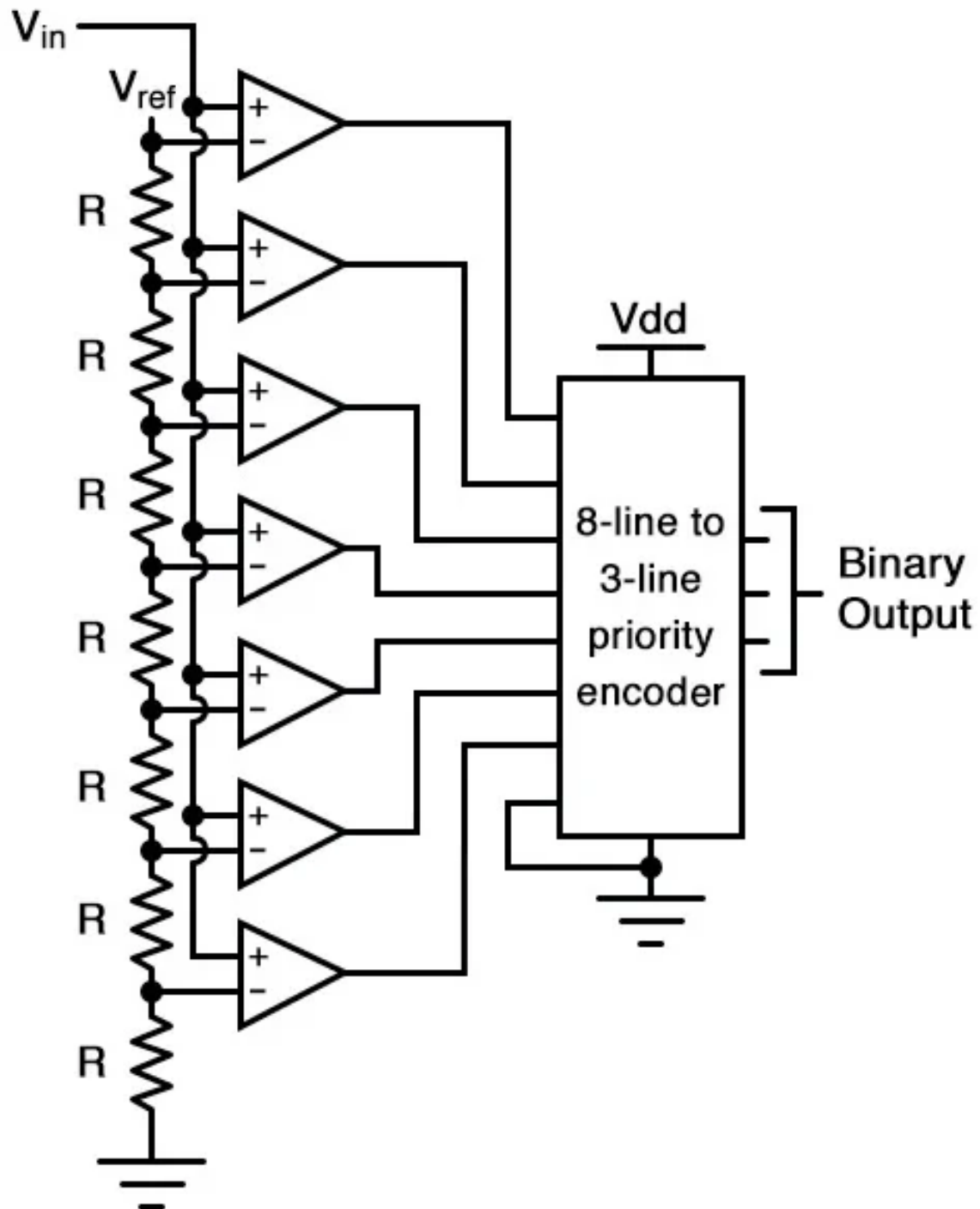
We have Designed each block in Proteus and implemented it on Hardware. We have also used a buzzer which will work as an alarm in case of heavy smoke.

3.1 Design Method

The design methods for each block is given as below:

3.1.1 ADC Block:

We have made an Analog to Digital Converter circuit which takes an analog value and convert it into a digital one. In this project, we have used a MK135 gas sensor which senses the smoke coming from fire and gives an analog value. Then, by converter circuit we convert this value to digital into 0-5 scale. By increasing or decreasing the intensity of smoke, we can see the value going up or down into the range of 0-5. The circuit for ADC block is given below:

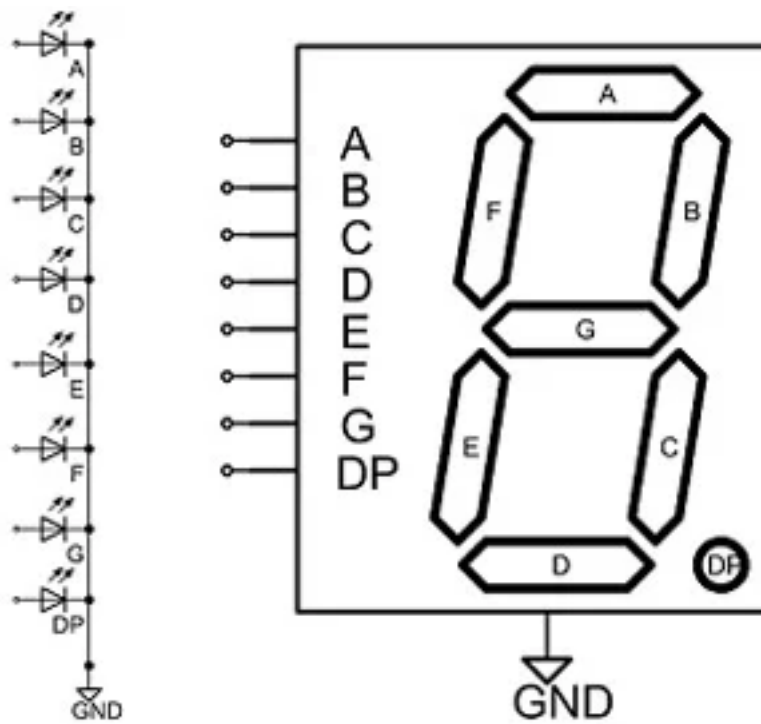


In this circuit, we have used op-amp in open loop configuration. We have used several resistors to divide the voltages and used threshold value to make one LED on. For example, the maximum intensity of gas gives an analog value of 3.8 V, so we make this value as digital value 5. At this time, the LED for value 5 will turn on and other will remain off. We have used xor gates to implement this logic. The truth table for ADC circuit is given as follows:

| A5 | A4 | A3 | A2 | A1 | Y2 | Y1 | Y0 |
|----|----|----|----|----|----|----|----|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

3.1.2 Seven Segment Display Block:

We have used a common cathode seven-segment display to show the value of 0-5. The main characteristics and truth table for seven-segment display are as follows:



The truth table will be:

| Y2 | Y1 | Y0 | a | b | c | d | e | f | g |
|----|----|----|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

3.1.3 Comparator Block:

Our project also has a comparator block which compares the current value with threshold value. We can give any threshold as we want and the comparator IC7485 will compare them. If the current value is greater than threshold value, the buzzer will get turned on. If the current value is equal to the threshold value, the it will give a warning sign by turning a LED on. It can be used to alert the water sprinkler system. Lastly, if the value is less than threshold, the comparator will give the LOW output and the buzzer will not turn on.

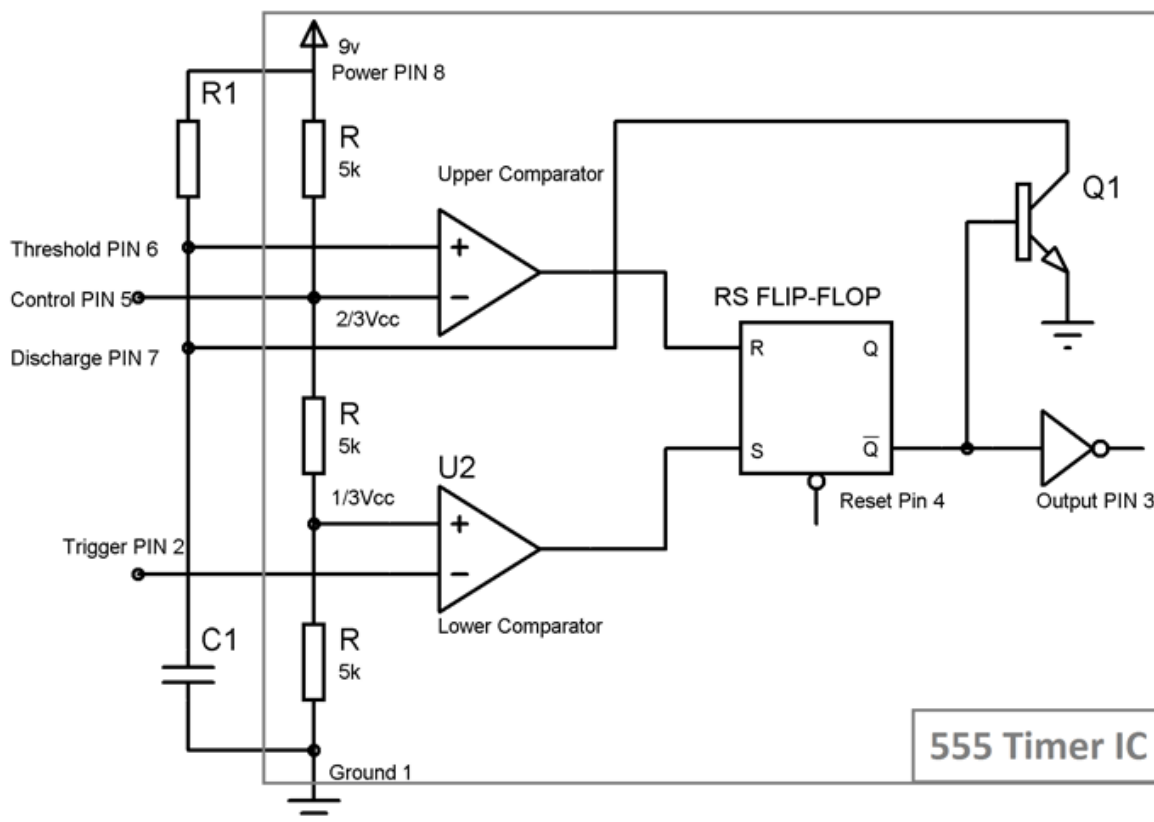
The truth table for $Y > \text{Ref}$ will be:

| Y | R | f |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

So, $Y_{gRef} = T = Y_2 \sim R_2 + i_2 * (Y_1 * \sim R_1) + i_2 * i_1 * (Y_0 \sim R_0)$, if this value is equal to 1, the alarm will turn on.

3.1.4 Timer Block:

We have used 555 timer IC. Monostable multivibrator (MMV) mode of 555 timer IC is also called Single shot mode. As the name indicates, only one state is stable and the other one is called unstable or quasi stable state. 555 timer IC remains in Stable state until the external triggering is applied. An external triggering is required for transition from Stable to unstable state. 555 IC automatically switches back to stable state after some time, this time, for which the 555 stays in quasi stable state, is determined by the time constant of RC network in the circuit. This external triggering is given by connecting the Trigger PIN 2 to the Ground using a PUSH button.



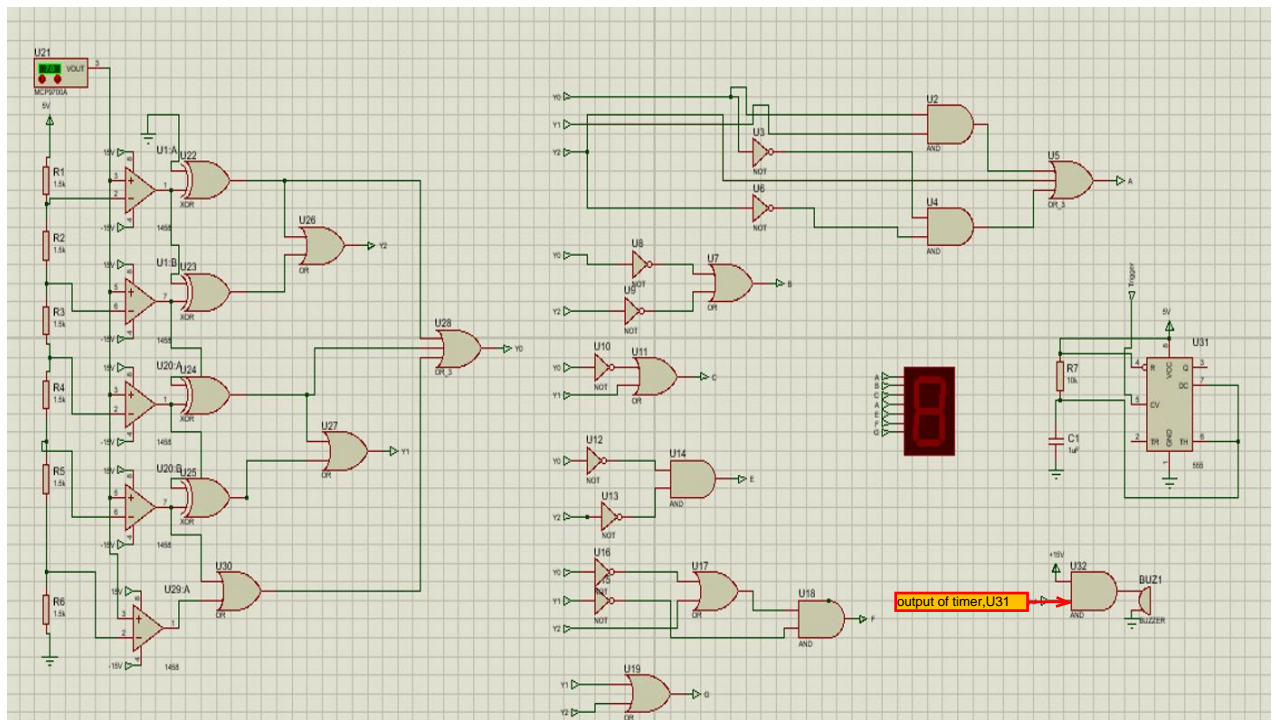
555 IC automatically fall back to the stable state (LOW) after the time determined by the RC network. This duration of quasi stable state is given by the below formulae:

$T = 1.1 \cdot R1 \cdot C1$ Seconds where R1 is in OHM and C1 is in Farads. In our project, we have used this timer as monostable, so it rings for at least 5 seconds and then turns off.

3.2 Novelty Statement

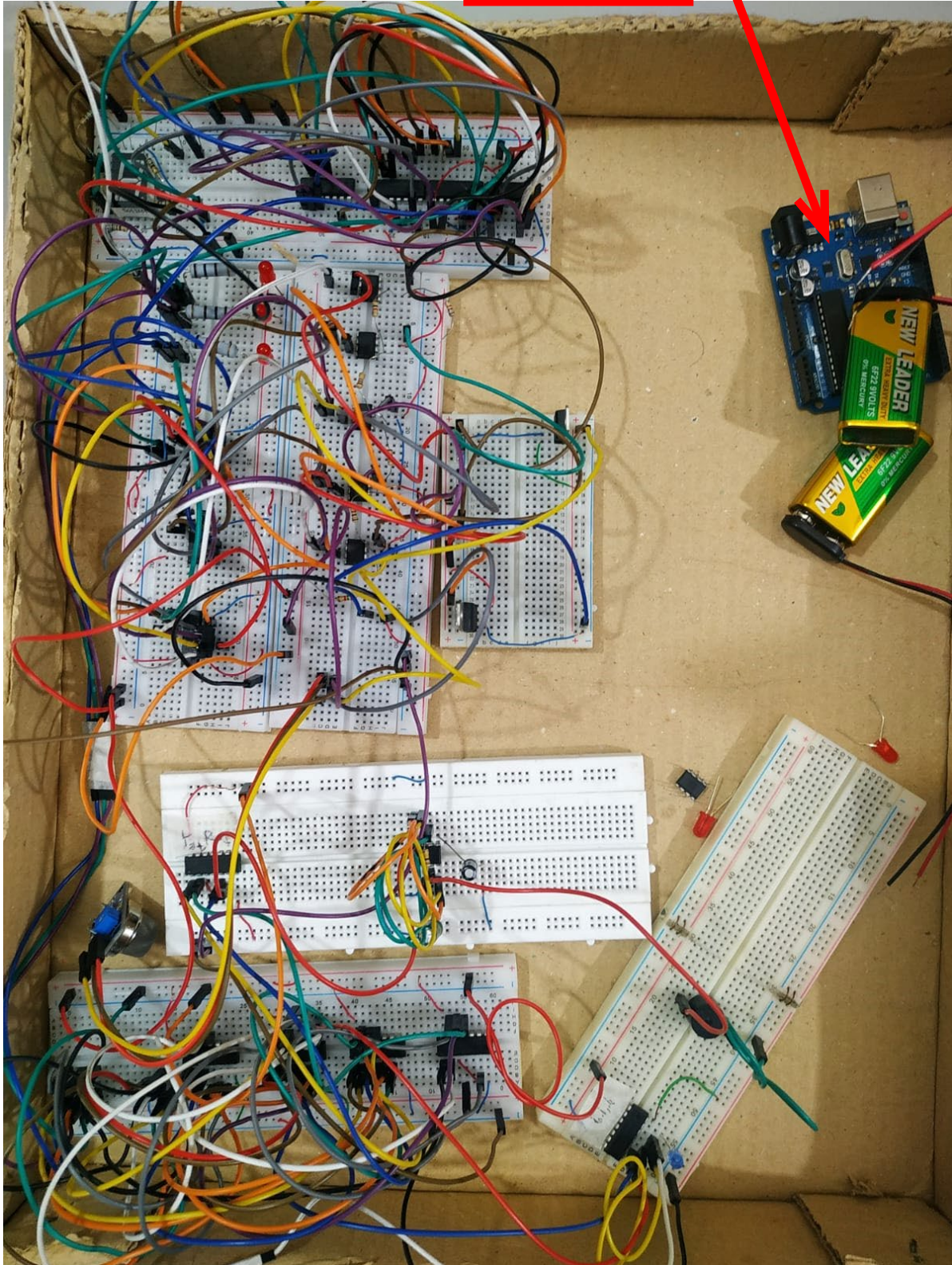
Our design is unique because we can set any threshold value in the smoke detector. So, we can set threshold value into a moderate one so that the detector does not give false alarms on little smoke. Again, for sensor value=threshold value, our project will give a warning sign which will help the other precaution system to get alerted. Moreover, after detecting the smoke, the buzzer will remain on for at least 5 seconds which will give time to evacuate people in case of fire accidents.

3.3 Circuit Diagram



3.4 Pictures of Final Implementation

Arduino only
for 5V power
supply



3.5 YouTube Link

<https://youtu.be/GklhMDmwZN4>

4 Practical Design Considerations

4.1 Considerations to Public Health and Safety

- Smoke detectors detect smoke, indicating the possibility of a fire, and warn individuals in the area.
- Early detection of smoke and fire provided by smoke detectors can significantly reduce the risk of fire-related fatalities and injuries.
- The installation and maintenance of smoke detectors in homes, public buildings, and other locations provide an early warning system in case of fire and help prevent the fire from spreading and causing further damage.
- Smoke detectors can provide a sense of security and peace of mind to individuals, knowing that they are protected in the event of a fire.
- Smoke detectors can be interconnected, allowing for early detection in multiple areas and providing more comprehensive protection.

4.2 Considerations to Environment

- Power management is another important aspect of our design. By incorporating power-saving features our design can reduce energy consumption and extend battery life.
- The materials used in circuit design has no environmental impacts, including the depletion of natural resources and the generation of hazardous waste.
- Our circuit design has affective energy efficiency, and energy-efficient designs can help reduce greenhouse gas emissions and energy costs.
- The use of renewable energy sources, such as solar or wind power, to power smoke detector circuit can also have further positive environmental impacts.

4.3 Considerations to Cultural, and Societal Needs

- Our cost-effective smoke detector design are essential to ensure that everyone has access to fire safety equipment. These detectors should be

affordable, and the cost should not prevent individuals or building owners from installing them.

- Our smart design makes it accessible to individuals with disabilities, including those with hearing or vision impairments.
- Our smoke detector is user-friendly and easy to install, regardless of an individual's technical ability.

5 Reflection on Individual and Team work

5.1 Individual Contribution of Each Member

- ID 1806051 and ID 1806053 have done the ADC circuit and implemented it on the hardware.
- ID 1806040 has done the seven-segment display circuit and implemented it.
- ID 1806047 has done the comparator circuit and Timer block and implemented it.

5.2 Mode of TeamWork and diversity Statement of Team

Having diversity in a team is crucial to achieving success in any workplace. Our team of three males and one female personnel which brings a range of different perspectives, experiences, and skills to the table. The diversity in our team allows us to approach problem-solving and decision making from various angles and consider different viewpoints. This led to more creative solutions and better outcomes. Additionally, having a mix of genders in our team can help promote a more inclusive work environment and ensure that all team members feel heard and valued. By recognizing and celebrating our differences, we can learn from each other and work collaboratively towards achieving our goals.

6 References and Acknowledgement

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