ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

This is to certify that the mini-project report titled **"FIRE DETECTION USING IMAGE PROCESSING"** is the authentic work of **VIBISH V A (822721106047), SUJIL M (822721106042), LAKSMI KANDAN L (822721106026), and JASHPIN BOSE(822721106019)**, who conducted the project under my supervision.

DATE:

Signature of Staff in-charge   Signature of Head of the Department

Internal Examiner   External Examiner

ABSTRACT

Fire detection is the main objective of this project besides surveillance. The aim of the project is to early detection of fire apart from preventive measures to reduce the losses due to hazardous fire. The project mainly is based on image processing and arduino serial communication. In this project, at the user end, the fire images will be feeded in the form of video frames.

These images will be further processed by using the software, MATLAB. The proposed system uses RGB and YCbCr color space. The advantage of using YCbCr color space is that it can separate the luminance from the chrominance more effectively than RGB color space. along with this smoke, motion, area detection is also performed using its color characteristics. The proposed system consist of hardware such as arduino, DHT 11 to monitor the Humidity and Temperature.

There is a camera for the surveillance. This camera will give a realtime video output to the user on the laptop or computer via a small GUI graphic user interface which is to be built in MATLAB. Thus the fire will be detected using this model.

This project can also be served for security and surveillance applications.

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CHAPTER 1

Introduction

Fires represent a constant threat to ecological systems, infrastructure and lives. Past has witnessed multiple instances of fires. With the faster and faster urbanization process, more and more high-rise buildings appear around us. This also can make the frequency of fire increase and bring great losses to people's lives and property. In areas where fire would pose an unreasonable threat to property, human life or important biological communities, efforts should be made to reduce dangers of fire. As the damage caused by fires is so tremendous that the early fire detection is becoming more and more important. Recently, some fire detectors have been used in many places, they used the smoke, temperature and photosensitive characteristics to detect fires. But they are too worse to meet the needs in a large space, harsh environment or the outdoor environment etc.

Traditional fire protection methods use mechanical devices or humans to monitor the surroundings

The most frequently used fire smoke detection techniques are usually based on particle sampling, temperature sampling, and air transparency testing. An alarm is not raised unless the particles reach the sensors and activate them.

Some of the methods are mentioned below:

A. Fire Watch Tower

In watch towers human are made to observe the location throughout. If any fire occurs he reports it. However, accurate human observation may be limited by operator fatigue, time of day, time of year, and geographic location.

B. Wireless Sensor Networks

In a wireless sensor-based fire detection system, coverage of large areas in forest is impractical due to the requirement of regular distribution of sensors in close proximity and also battery charge is a big challenge.

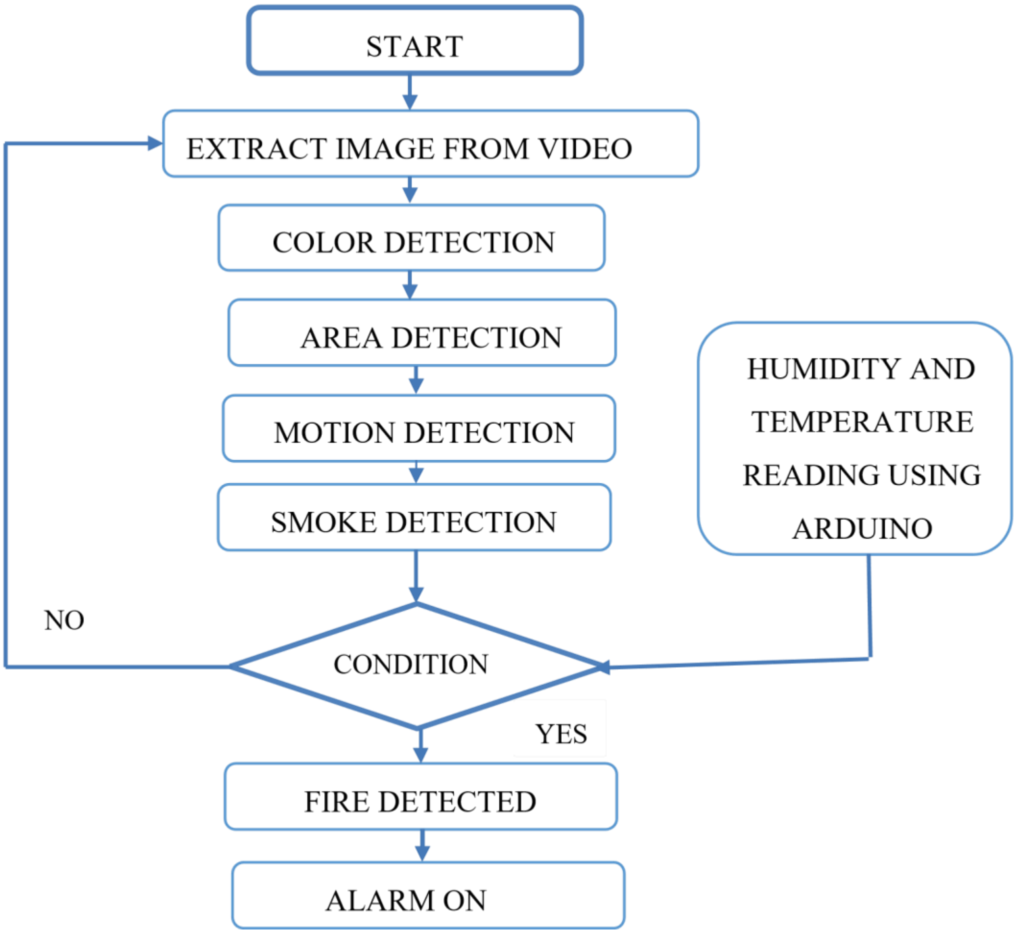
The motivation for an image processing based approach is due to rapid growth the electronics. Fire detection systems are one of the most important components in surveillance systems used to monitor buildings and environment as part of an early warning mechanism that reports preferably the start of fire. Currently, almost all fire detection systems use built-in sensors that primarily depend on the reliability and the positional distribution of the sensors. The sensors should be distributed densely for a high precision fire detector system. In a sensor-based fire detection system, coverage of large areas in outdoor applications is impractical due to the requirement of regular distribution of sensors in close proximity. Due to the rapid developments in digital camera technology and video processing techniques, there is a big trend to replace conventional fire detection techniques with computer vision-based systems. In our project different characteristic parameters of fire i.e Color, smoke, Area and motion using image processing in MATLAB are analyzed. Along with this monitoring of temperature and Humidity of fire is done for more precision. Motion detection is used to detect any occurrence of movement in a video. It i done by analyzing difference in images of video frames. There are three main parts in moving pixel detection: frame/background subtraction, background registration, and moving pixel detection Similar to the fire detection. We are also modeling smoke pixels. The smoke pixels do not show chrominance

characteristics like fire pixels. At the beginning, when the temperature of the smoke is low, it is expected that the smoke will show color from the range of white-bluish to white.

Toward the start of the fire, the smoke's temperature increases and it gets color from the range of black-grayish to black. Area detection method is used to detect dispersion of fire pixel area in the sequential frames.

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. As the fire increases humidity decreases and temperature increases, for this threshold is set. So after analyzing all above parameters fire will be detected and it will give pop-up on the screen of a fire image as well as buzzer as an indication for person present at the location to take a quick action to suppress fire and to avoid losses of human lives and their valuable properties.

1.1 FLOW CHART

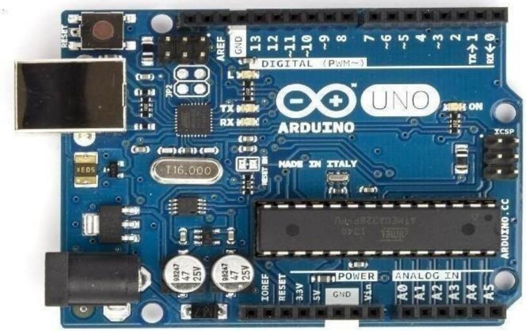


In our proposed Fire Detection System, we detect the fire based on the various parameters and condition as shown in above Fig. 3.1. Flowchart. Firstly, our system extracts images of the environment on a real-time basis, in every 2 seconds. These images then go through the detection techniques of : Area detection, Color detection, Motion detection and Smoke detection. Also, continuous monitoring of environmental Humidity and Temperature is done alongside using DHT11 sensor and Arduino.

CHAPTER 2

HARDWARE AND SYSTEM DESIGN

2.1 ARDUINO UNO

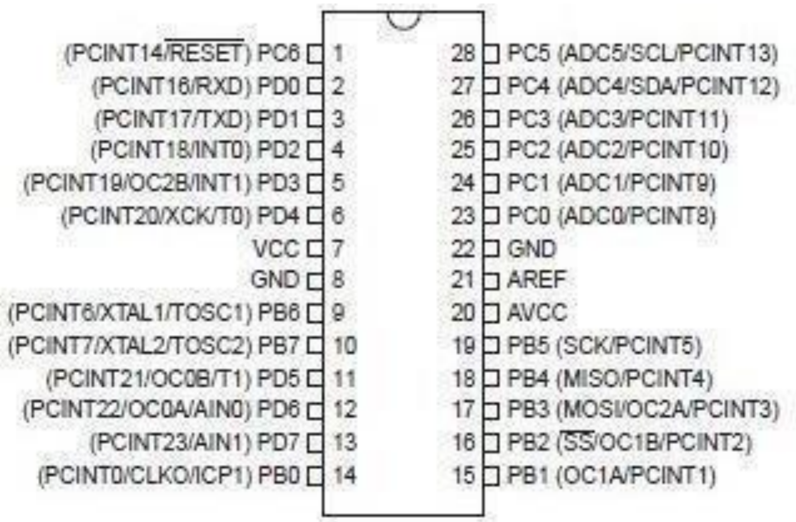


The Arduino Uno is a microcontroller board based on the ATmega328. It

Has14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started

Microcontroller	**ATmega328**
Operating Voltage	5V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader

Pin diagram of Arduino IC.



. Pin Descriptions:

VCC: Digital supply voltage.

GND: Ground.

Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2:

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source,

PB7…6 is used as TOSC2…1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

Port C (PC5:0):

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5…0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tristated when a reset condition becomes active, even if the clock is not running.

PC6/RESET:

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port
C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given
.Shorter pulses are not guaranteed to generate a Reset.

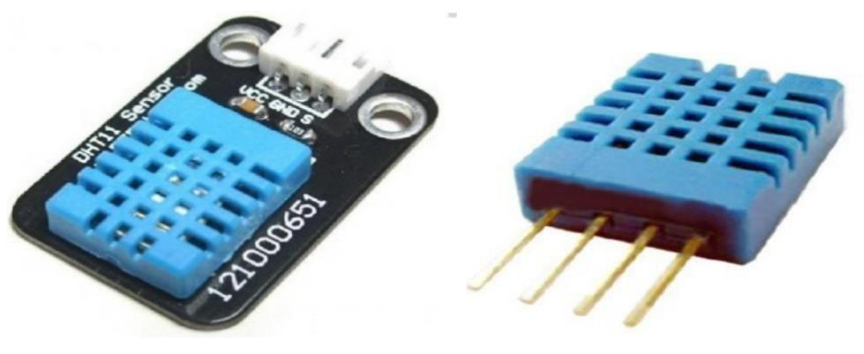
Port D (PD7:0):
Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tristated when a reset condition becomes active, even if the clock is not running.
AVCC

AVCC is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: AREF is the analog reference pin for the A/D Converter.

ADC7: 6 (TQFP and QFN/MLF Package Only):
In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

2.2DHT 11 Humidity & Temperature Sensor



Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor’s internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

. Technical Specifications:

Overview:

Item	Measurement Range	Humidity accuracy	Temperature accuracy	Resolution	Package
DHT11	20-90% RH 0-50 ºC	±5%RH	±2ºC	1	4 Pin Single

Table Overview of DHT11 Detailed Specifications:

Parameters	**Conditions**	**Minimum**	**Typical**	**Maximum**
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25ºC		±4%RH	
	0-50ºC			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0ºC	30%RH		90%RH
	25ºC	20%RH		90%RH
	50ºC	20%RH		80%RH

Response Time (Seconds)	1/e(63%)25 ºC, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1ºC	1ºC	1ºC
		8 Bit	8 Bit	8 Bit
Repeatability			±1ºC	
Accuracy		±1ºC		±2ºC
Measurement Range		0ºC		50ºC
Time Response (Seconds)	1/e (63%)	6 S		30 S

2.3 LCD DISPLAY

A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels; for example, a 4K display is made up of 3840 x2160 or 4096x2160 pixels. A pixel is made up of three subpixels; a red, blue and green—commonly called RGB. When the subpixels in a pixel change color combinations, a different color can be produced. With all the pixels on a display working together, the display can make millions of different colors.

2.4 GAS SENSOR

Gas sensors are devices that help us understand the amount of gas in the environment and the natural state of its movement. Gas sensors reveal the amount of gas in the environment and the nature of the gas composition with electrical signals and can provide its change

2.5 BUZZER

Sound can be produced using buzzers close buzzer An output device that produces a buzzing sound when current flows through it. or speakers close speaker An output device that produces sound using electromagnetism

2.6 POTENTIOMETER

The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.
Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment

2.7 JUMPER WIRE

jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. By attaching a jumper wire on the circuit, it can be short-circuited and short-cut (jump) to the electric circuit

2.8 MATLAB SYSTEM

The heart of MATLAB is the MATLAB language, a matrix-based language allowing the most natural expression of computational mathematics.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to *learn* and *apply* specialized technology.

Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The MATLAB system consists of five main parts:

***The MATLAB language*.**

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

The MATLAB working environment.

This is the set of tools and facilities that you work with as the MATLAB user or programmer. It includes facilities for managing the variables in your workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications.

Handle Graphics.

This is the MATLAB graphics system. It includes high-level commands for twodimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete Graphical User Interfaces on your MATLAB applications.

The MATLAB mathematical function library.

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

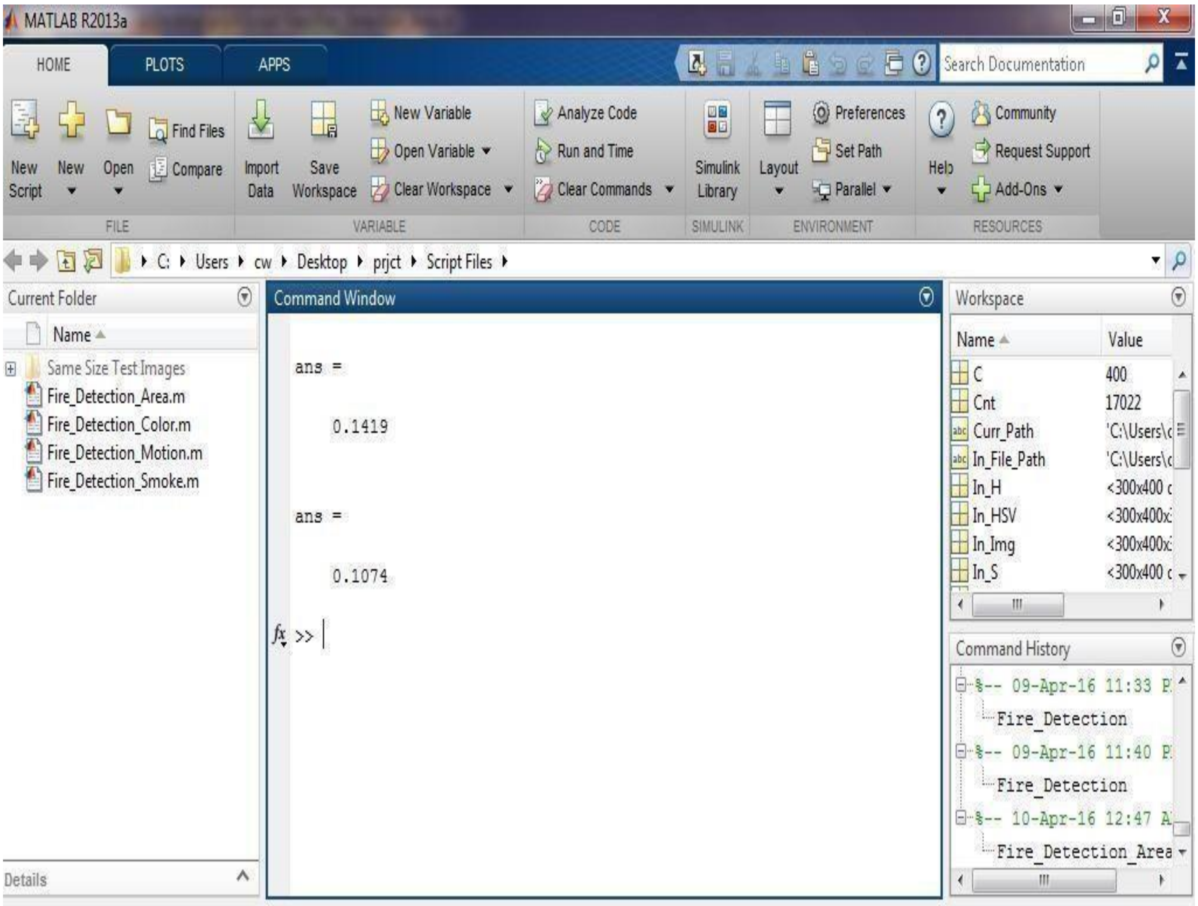
The MATLAB Application Program Interface (API).

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

CHAPTER 3

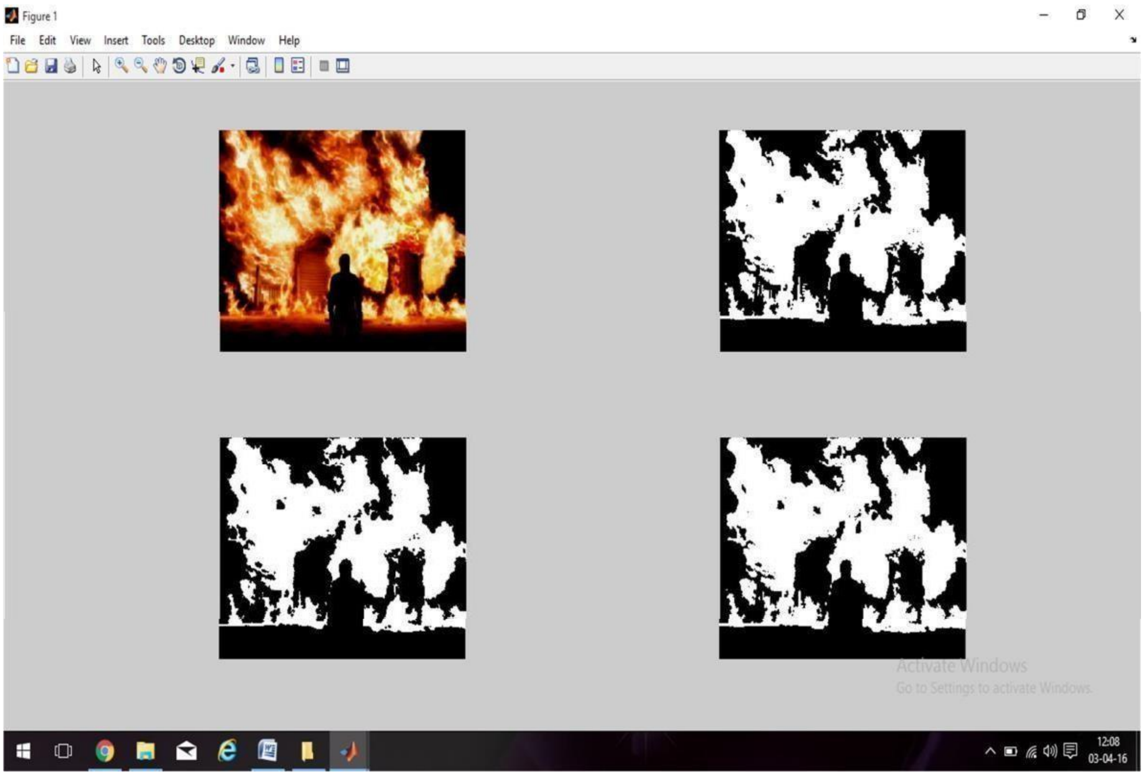
RESULT AND CONCLUSION

Here, we have shown the actual snapshots of our program output for each evaluating parameter and for all conditions together



Mean value and standard deviation value

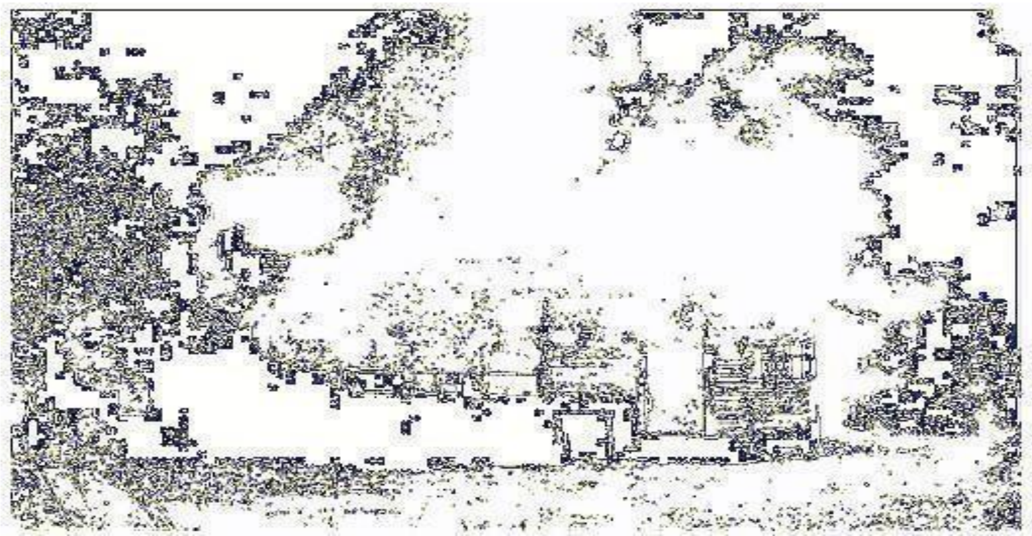
Original image with eroded and dilated image



Color detection:

. Image before color detection

Image after color detection



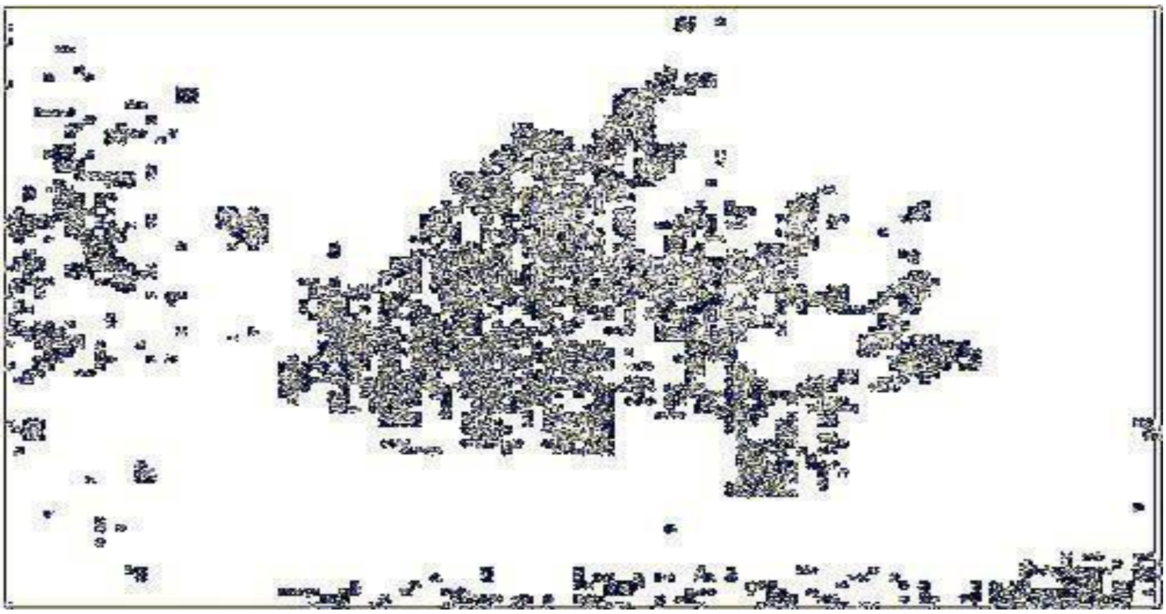
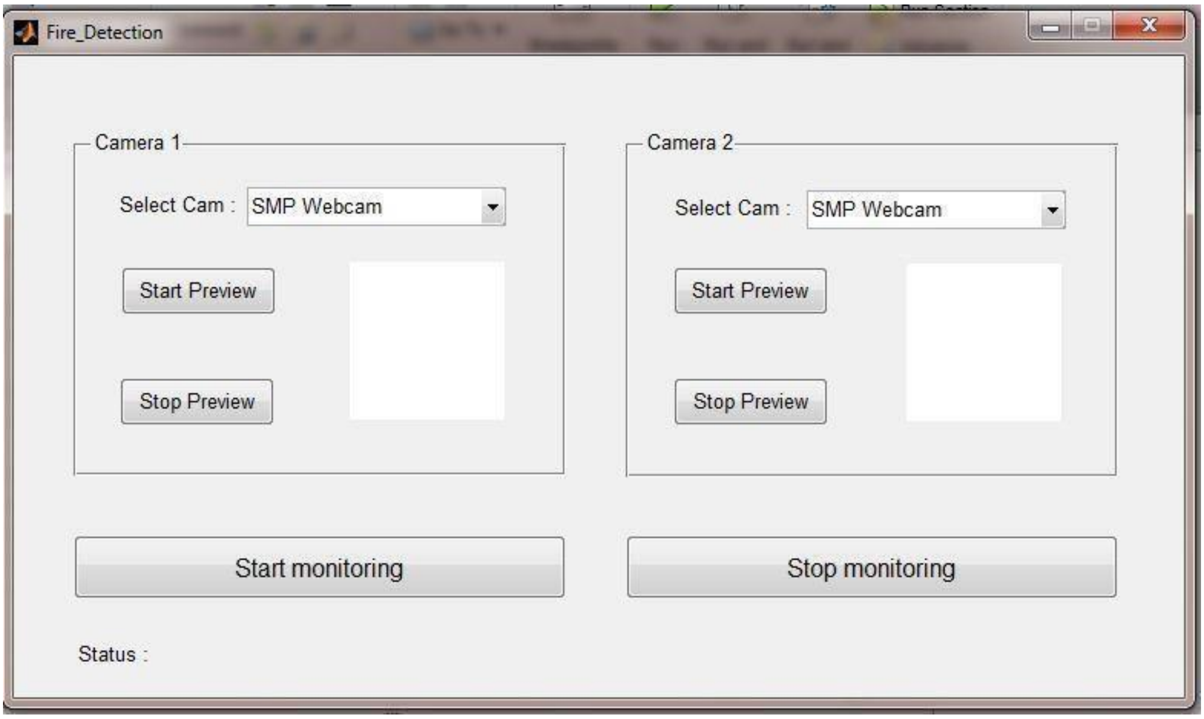


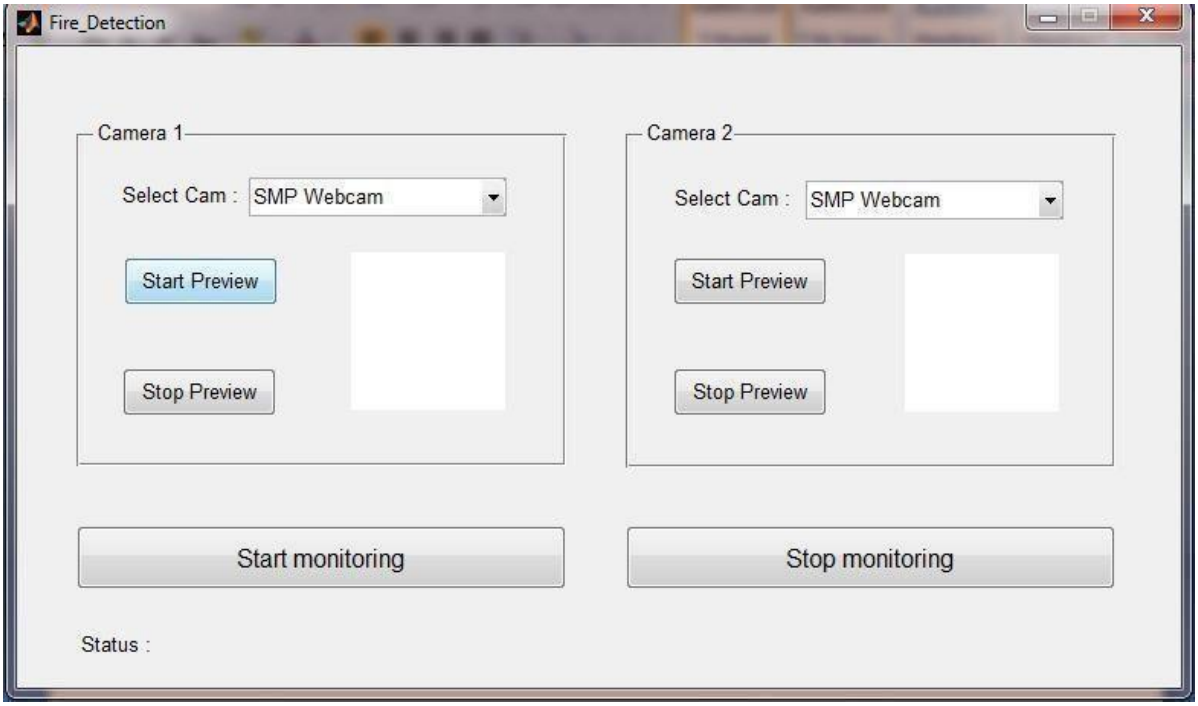
Image after color detection

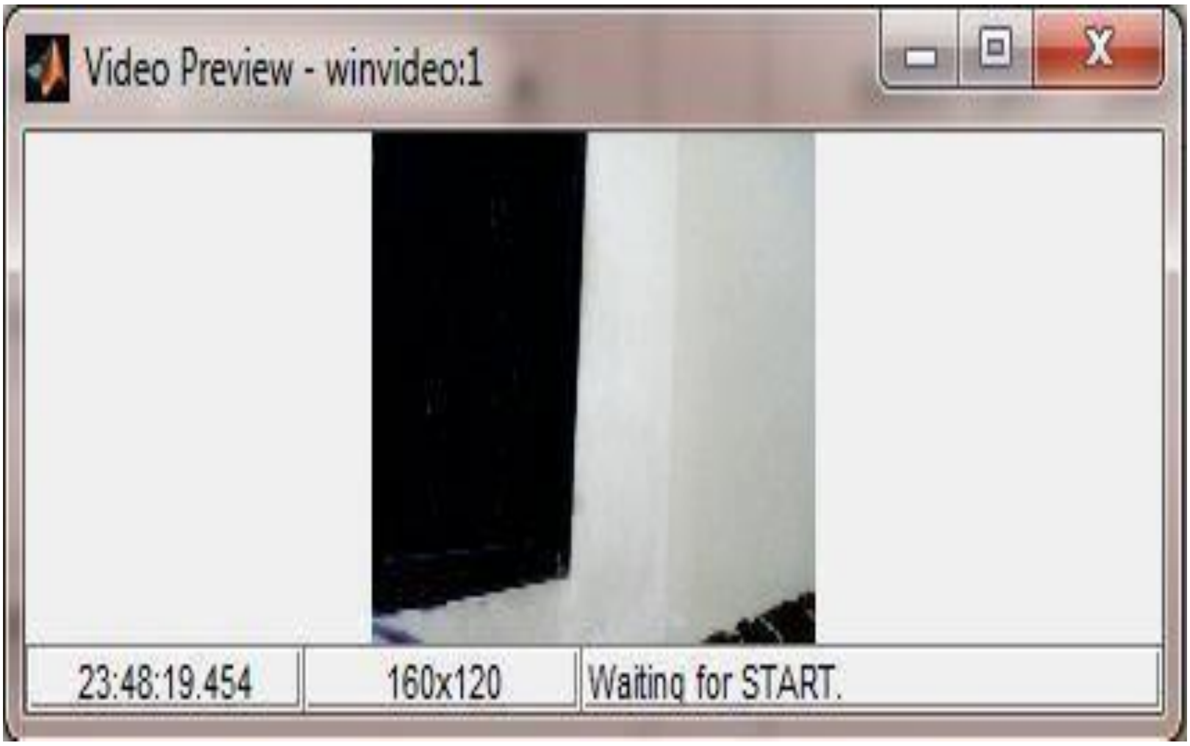
Image after color detection

Steps of fire detection

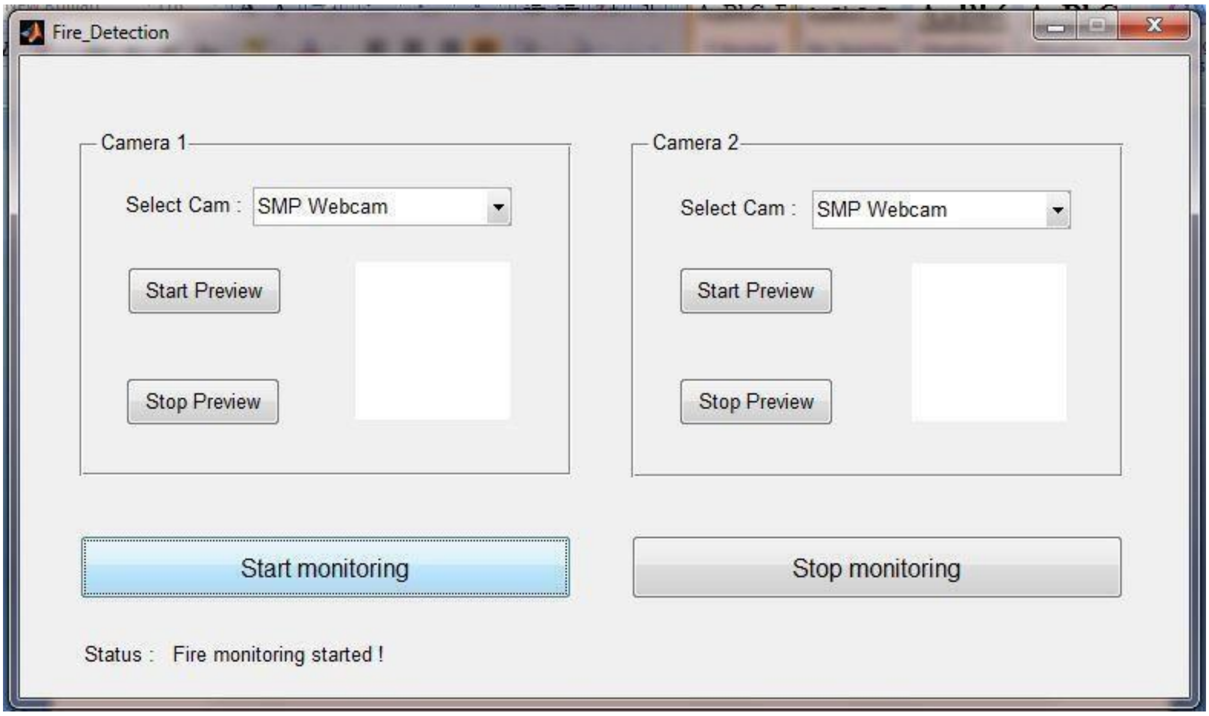


UI after selecting Run option



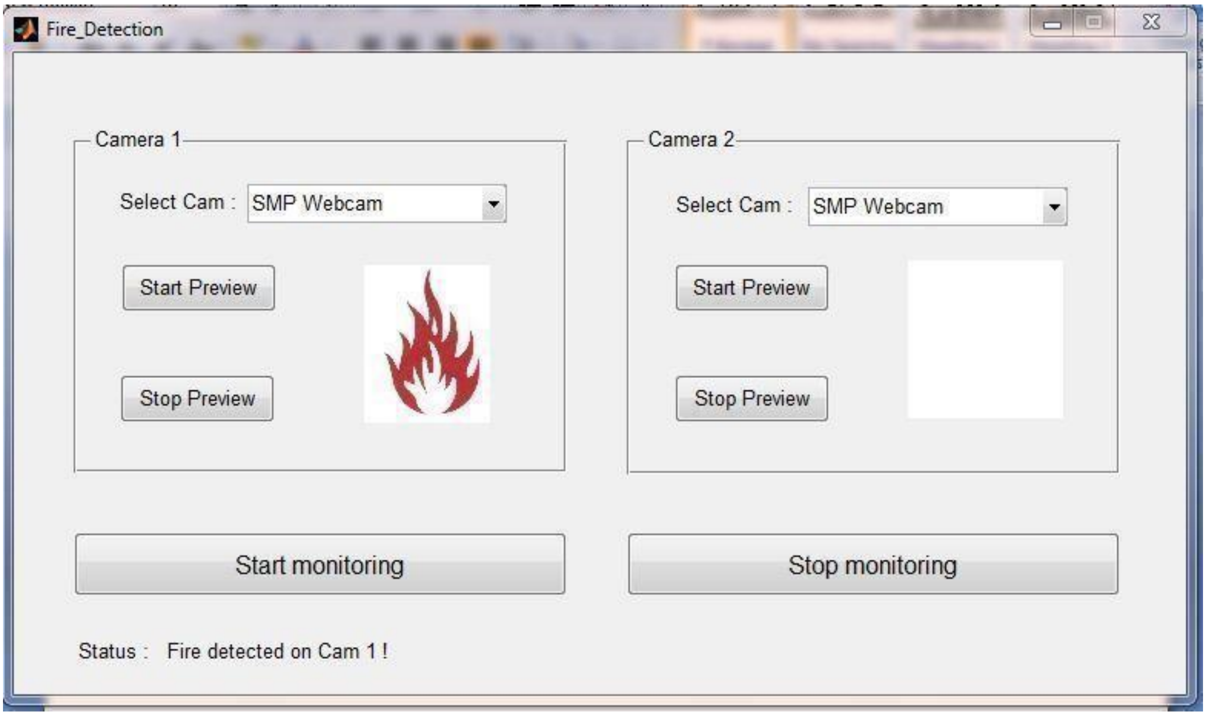


Video preview

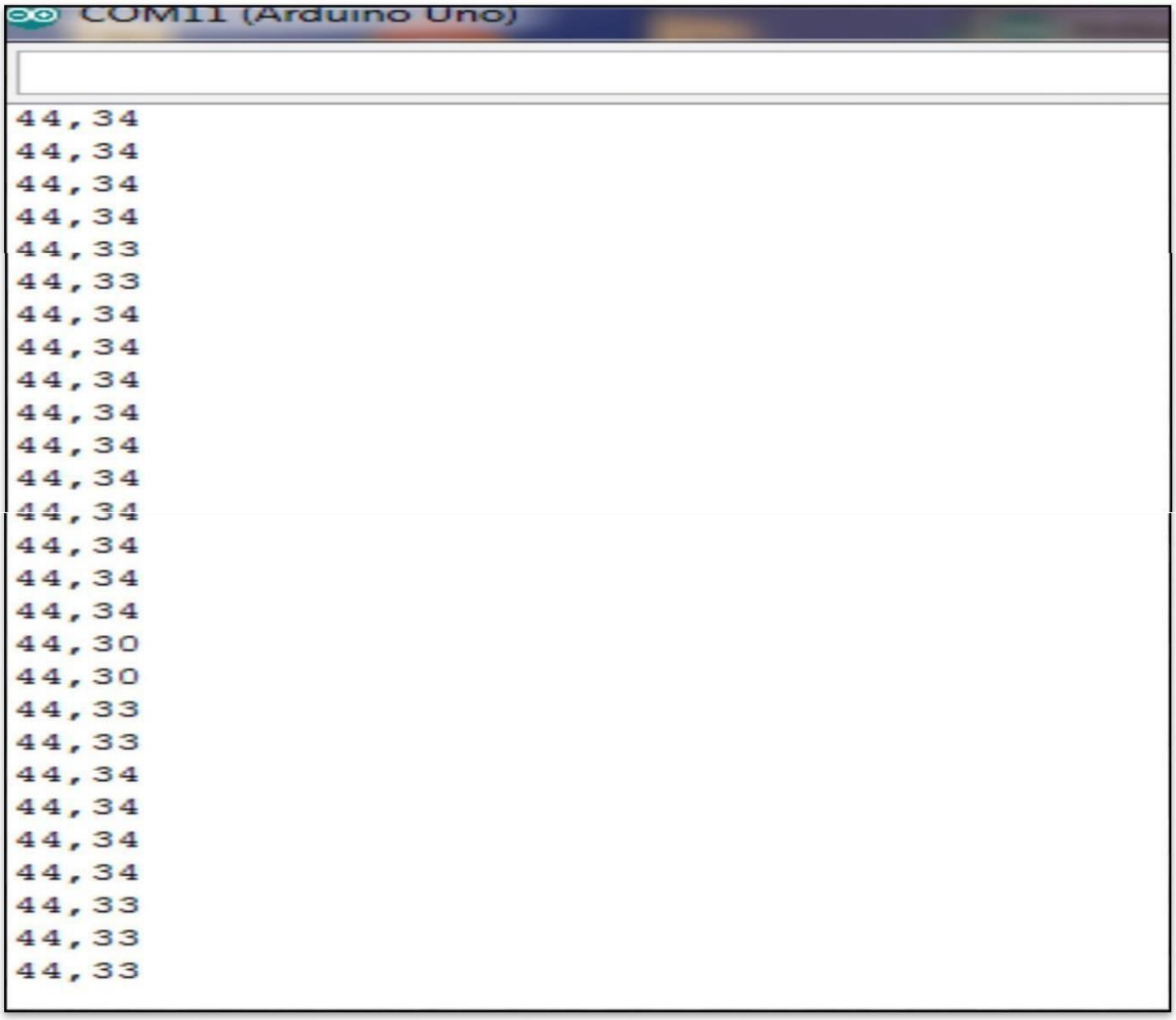


Start of monitoring

Capturing of fire frames



Detection of Fire on Cam1



Monitoring of Humidity and Temperature using Arduino

Matlab result:

For practical results, we have experimented the proposed system for fire detection. The experimentation was performed to check for efficiency of the proposed system to detect actual fire and faulty detection. In the experimentation

have taken 20 trails of fire before the webcam. Among these 20 trials our system

2 faulty detections and 18 correct detections were made. Based on these we have following table 6.1

No. of trails	Correct Detection	Faulty Detection	Efficiency
20	18	2	90%

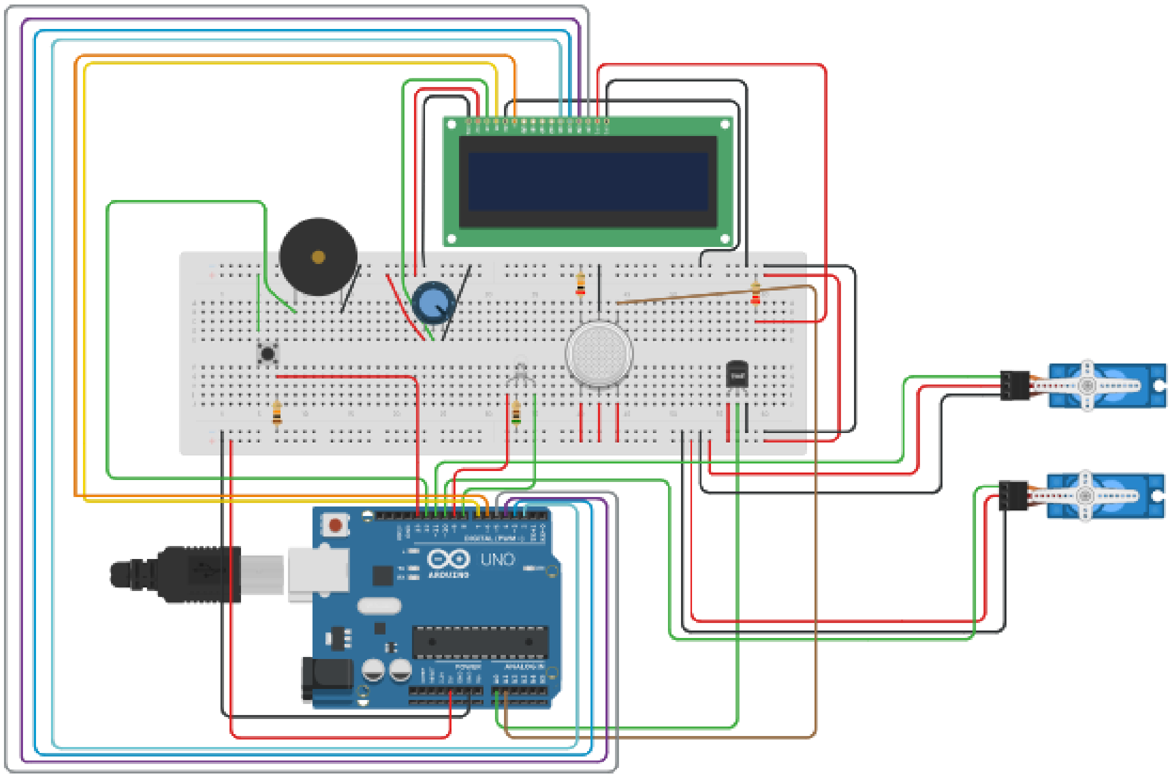
Experimental values of correct detection, faulty detection and efficiency

For the comparison purposes, two sets of images are collected from Internet. set is composed of images that consist of fire. Fire set consists of 332 images. The images in fire set show diversity in fire-color, and environmental Illuminations. The other set does not contain any fire but contains fire-like colored regions such as sun and other reddish objects. Two types of comparisons are carried out; one is for the evaluation of the correct fire detection rate and the other is for the false alarm rate. The following criterion is used for declaring a fire region: if the model achieves to detect at least 10 pixels of a fire region in a given image, then it is assumed as a correct detection, where images are in the size of 320x240. For the false alarm rate the same detection criterion is used with the non-fire image set. In Table 6.2, we have tabulated fire detection results with false alarm rates. It is clear from Table 6.2 that the new method shows better performance with respect to the technique defined, because it eliminates the colors which are similar to firecolor but it is not a fire.

Model	Detection Rate (%)	False Alarm Rate (%)
RGB, Chen et al. [3]	93.90	66.42
RGB, Celik et al. [1]	78.50	28.21
rgb, Celik et al. [2]	97.00	9.50
YCbCr, Celik et al. [10]	99.00	9.50
Proposed	99.00	4.5

Performance comparisons of the models with respect detection rates, and false alarm rates

STIMULATION USING TINKERKARD RESULT



CONCLUSION

This project, Fire Detection System has been developed using Image Processing and Matlab software. This system has the ability to apply image processing techniques to detect fire. This system can be used to monitor fire and has achieved 90% accuracy for single webcam. The system works on real time, as it extracts frames in every 2 seconds, it provides continuous monitoring. This system has high efficiency as it has incorporated techniques of Area detection, Color detection, Motion detection, and Smoke detection as well as Humidity and Temperature detection. For better performance outcomes use of RGB, HSV and YCbCr color space is made in the detection techniques, as per their suitability, efficiency and properties. The different parameters like threshold value, blind-spots will be handled properly in our future research. Thus application of proposed fire detection system gives us a better system performance in term of less false alarm and thus a higher system performance is achieved.

Future Scope

For further accuracy use of Neural Networks for decision making can be made and GSM module can also be implemented for sending SMS to nearby fire station in case of severe fire. Water sprinklers can also be incorporated. By research and analysis, the efficiency of the proposed Fire detection system can be increased. The margin of false alarms can be reduced even further by developing algorithms to eliminate the detection of red colored cloth as fire. By proper analysis, suitable location height and length for camera installment can be decided, in order to remove blind-spot areas.

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8. Abitha T.E., Paul P Mathai, Reducing False Alarm in Vision Based Fire Detection with NB Classifier In EADF, International Journal of Scientific and Research Publications , Volume 3, Issue 3, August 2013
9. Surya T.S., Suchitra M.S., Survey on Different Smoke Detection Technique using Image Processing, International Journal of Research in Computer and Communication Technology,2014

APPENDIX

```
#include<Servo.h>//header file for servo #include

<LiquidCrystal.h>//header file for LCD const int

temperaturePin = 0;

const int buzzer = 12; / int

gasSensorPin=A1; int sensorval;

Servo servo1,servo2;

int servo1Pin=11; int

servo2Pin=10; int

red_led=9; int

green_led=8;
```

```
LiquidCrystal lcd(7, 6, 2, 3, 4, 5); int
buttonstate = 0; const int resetbtn =
13; int repeat = 0; void setup()
{ pinMode(buzzer, OUTPUT);
  servo1.attach(servo1Pin); servo2.attach(servo2Pin);
  servo1.write(90); servo2.write(90);
  pinMode(red_led,OUTPUT);
  pinMode(green_led,OUTPUT);
  pinMode(resetbtn,INPUT);
  lcd.begin(16,2);
}

void loop()
{     float     voltage,     degreesC;     voltage     =
        getVoltage(temperaturePin); degreesC
        = (voltage - 0.5) * 100.0; sensorval=analogRead(gasSensorPin);
        buttonstate = digitalRead(resetbtn);

  if(buttonstate == HIGH) { repeat =
        0;
  } if(degreesC>37 || sensorval>700 || repeat == 1)
        {
     repeat = 1;

     tone(buzzer, 800, 800);

     servo1.write(0);
     servo2.write(0);
```

```
lcd.clear();
        lcd.setCursor(0,0);
            lcd.print("DANGER!!");
        lcd.setCursor(0,1);
        lcd.print("VACATE Building!");


        digitalWrite(red_led,HIGH);
        digitalWrite(green_led,LOW);
        delay(1000);
        tone(buzzer,600,800);
        digitalWrite(red_led,LOW);
        delay(400); } else{
        servo1.write(90);
        servo2.write(90); delay(1000);
        digitalWrite(green_led,HIGH);
        digitalWrite(red_led,LOW);
        lcd.clear(); lcd.setCursor(0,0);
        lcd.print("SAFE");
        lcd.setCursor(6,0);
        lcd.print(degreesC);
        lcd.print("C"); lcd.setCursor(0,1);
        lcd.print("Gas
        Conc.:"); lcd.print(sensorval);
      } } float
    getVoltage(int pin)
    {
      return (analogRead(pin) * 0.004882814);
```

}