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Computer vision for fire detection and controlling

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Abstract— Fire increases producing bright light, heat, and smoke. It can be hazardous and catastrophic at times leading to loss of life and property. In such case, there is a need for detection at the correct time and act immediately. So, we are proposing a model that uses computer vision technology to detect and send alert notification to mobile device. Along with sensors, camera is used to provide input information and the power supply is cut-off if leakage of gaseous material found. Automatic water sprinkling systems and use of renewable energy sources increases efficiency of this model.

Keywords—Computer Vision Technology, fire and gas sensors, camera, OpenCV, PyCharm, Sprinklers, IOT Application, Renewable energy.

I. INTRODUCTION

Early fire detection is supreme for the safety of people and assets. Although fires can be detected indoors with modern smoke detectors and related sensing modalities, this is not the case outdoors. Furthermore, these sensing technologies cannot provide adequate information for a proper estimation of the fire's size, location, and dynamics. This paper addresses the problem of early fire detection from a computer vision perspective, exploiting the ubiquity of surveillance cameras and helps to overcome limitations that were faced earlier.

Computer vision is an interdisciplinary field that is useful in various applications like robotics to recognize advanced pictures or recordings. From the point of view of designing, it tries to computerize errands that the human visual framework can do. It helps to integrate tactics for gaining, preparing, examining and understanding computerized pictures, and extraction of high-dimensional information from this present reality keeping in mind the end goal to deliver numerical or representative data.

Fig 1: Uncontrollable fire outburst.

The proposed system uses OpenCV and sensors to detect fire and automatically turn on water sprinklers. Gas sensors identify if any leakage

of flammable materials found. All the updates are done using Wi-Fi module to Thing Speak platform. System uses Solar panels which boosts the efficiency of the system.

II. METHODOLOGY

1. Having a fire detection system can significantly reduce damages and maximize the fire control efforts.
2. The fire is detected using various sensors like flame and gas. Along with the sensors we have an USB camera installed which is used for monitoring.
3. The sensors are connected to the microcontroller which gathers the data from input devices and then transfers it to wi-fi module as well as various other output components like buzzer and sprinkler.
4. The USB camera is connected to laptop with OpenCV which acts as our library. This live camera input detects if there is any fire and alerts the person in-charge. In case, if fire is detected a series of serial data is sent to microcontroller to turn on the water sprinkler.
5. Water will be sprinkled automatically at the area where fire is detected.
6. The input information collected will be sent via wi-fi module and stored in an online platform called Thing speak.
7. All the alert notifications can be received by Thing speak platform in graphical and statistical form.
8. To increase efficiency, we have used solar panels which acts as source of power supply along with a battery.

Fig 2: Automatic fire extinguishing sprinkler.

III. BLOCK DIAGRAM

Fig. 3 explains the block diagram which shows that the fire and gas sensors collect data from surrounding environment and forward it to the Microcontroller (In this case Arduino UNO). The Updated readings are sent into the Wi-Fi module (Node MCU) that translates the data into a graphical and statistical manner. A Webpage is created to analyse the data and a corresponding response is extracted. This data helps to determine the area and the amount of water to be used to extinguish the fire, if detected via sprinklers.

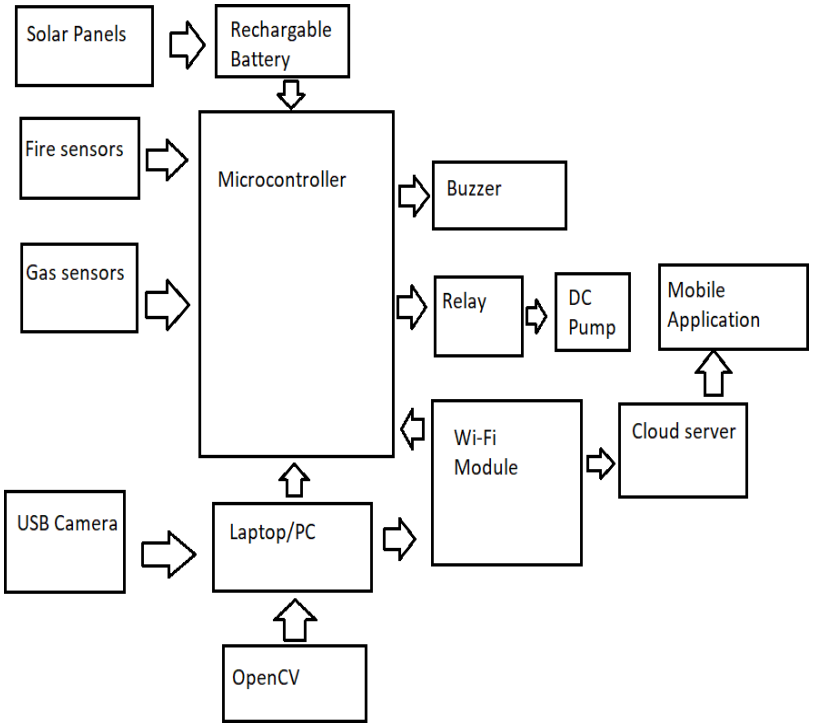

Fig 3: Block diagram

This model simultaneously sends the alert SMS to the user and also trigger the fire extinguisher system. The alert message helps the person in charge to gain information via camera and also control the sprinklers manually. Besides that Buzzers are used to alert the neighbours about the danger. The Wi-fi module stores data and displays the readings on smart devices via the mobile application. The relay is mainly used for switching purpose as it acts as an electromagnetic switch. To make this model more efficient Solar panels are used to convert the renewable solar energy and utilize it as a source of power supply.

IV. HARDWARE AND SOFTWARE SPECIFICATIONS

A. Arduino Mega 2560:

Arduino Mega board which resembles microcontroller board and depends on the ATmega2560 microcontroller. It comprises digital input/output pins-54, with 16 pins as analog inputs, 14 used like PWM outputs hardware serial ports, a crystal oscillator of 16 MHz, an ICSP header, a power jack, a USB connection, in addition to RST button.

B. Node MCU (Wi-Fi Module):

Node MCU is an open source-based firmware for the ESP8266 Wi-Fi SOC from Espressif. The software was primarily manufactured as a companion in project. It also has 128 KB RAM and 4MB of Flash memory just enough to cope with the large strings that make up web pages, JSON/XML data.

C. Relay:

Relay acts as an electromagnetic switch, which is used in applications to turn ON and OFF a circuit by a low power signal. Here several circuit signal must be controlled by one signal. It works on the principle of an electromagnetic attraction. When the circuit sense fault, it energizes the electromagnetic field and produces a temporary magnetic field. This magnetic field moves the relay armature for opening or closing the connections.

D. DC mini pump:

It is a high quality made, CE passed, Mini DC submersible water pump. It is built by brushless motor which is quieter and last longer. Easy to maintain with fish tank, solar water pump, accelerating water circulation, miniature garden, indoor fountain, toys, and other water circulation system.

E. Solar panel:

Solar panel that is an assembly of photo voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity. Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

F. Gas Sensor (MQ-xx):

Gas sensor device notices the existence or concentration of gases in the atmosphere. Based on concentration the sensor produces a corresponding potential difference by varying the resistance of the material inside the sensor, which can be measured as output voltage.

G. Flame Sensor:

Fire detector sensor designed to sense and respond to the existence of fire. Detection of flame depend on the installation, but can include sounding an alarm, deactivating a fuel line, and activating a fire suppression system. There are different types of flame detection approaches, some are: Ultraviolet detector, near IR array detector, Infrared thermal cameras, UV/IR detector etc.

H. Buzzer:

A buzzer will only generate sound when it is electrified. It creates sound at only one frequency. This buzzer functions at an audible frequency of 2 KHz. The specifications are as follows: It operates at a voltage range of 3.3-5V and a frequency of near 2 KHz.

I. Open CV:

OpenCV is a cross-platform library via which real-time computer vision applications can be developed. It mainly focuses on image processing, video capture and analysis including. Computer Vision can be defined as a discipline that explains how to recreate, interrupt, and understand a 3D scene from its 2D images, in terms of the assets present in the scene. It deals with modelling and replicating human vision using computer software and hardware.

J. USB Camera:

Full HD widescreen video calling: Logitech C270 lets you make widescreen video call. The lenses cover a 60-degree field of view. Streaming over wi-fi with noise reducing mic.

K. PyCharm IDE:

PyCharm offers some of the best features to its users and developers in Code compilation, inspection and Advanced debugging. Supports for web programming and frameworks such as Django and Flask. You can run .py files outside PyCharm Editor as well.

L. Arduino IDE:

Arduino IDE is an open-source software which mainly helps for writing and compiling of code. It is an official making code compilation too easy. Even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, and Linux.

M. Thing Speak

Describes an IoT analytics platform service that allows to aggregate, visualize as well as analyze live stream data in the cloud platform known as Thing Speak. The ability to execute MATLAB code in Thing Speak helps in online analysis and processing of the data as it comes in. Thing Speak is often used for prototyping and proof of concept IoT systems that require analytics.

V. CIRCUIT DIAGRAM

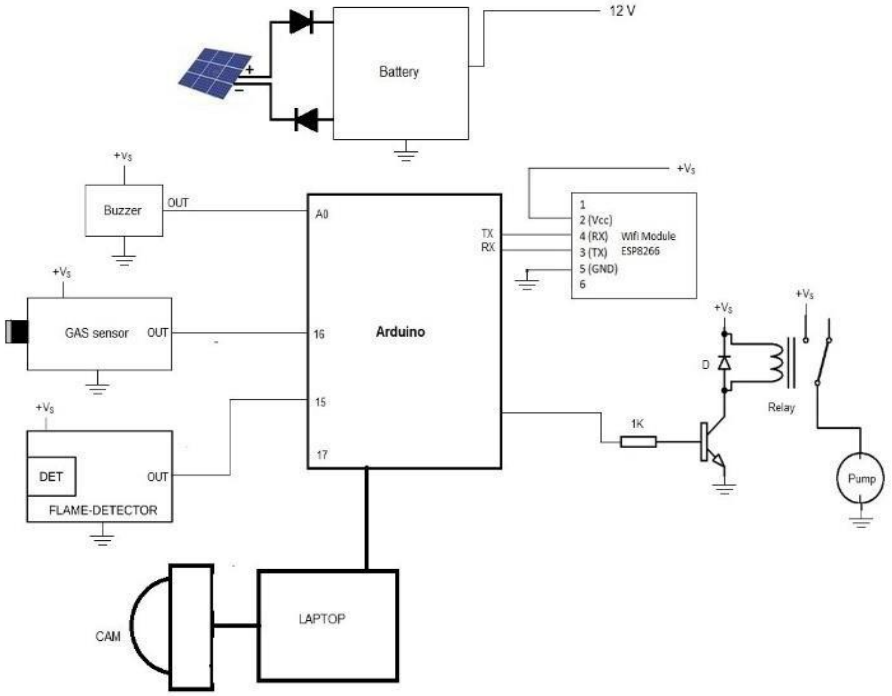

Fig 4: Circuit diagram of the system.

The above fig 4 shows Circuit diagram of computer vision for fire detection and controlling which performs the below operations

- Fire Alarm Circuit is a simple circuit that detects the fire and activates the pump as well as the Buzzer.
- Gas and Flame detector are connected to the Arduino 15 and 16 pin respectively.
- Buzzer is connected to the A0 pin of the Arduino.
- From arduino the data is sent to wifi module.
- Arduino is also connected to relay, which helps to convert high variable voltage to a lower voltage.
- Microcontroller is a conneted to the laptop which in turn has camera to detect the fire.

VI. APPLICATIONS

1. It Can be used in Museums & Industries.
2. Can be extended to identify Forest Fires.
3. Helps to alert inhabitants, allowing them to escape the building safely in time.
4. To take charge and controlling the fire as quickly as possible.
5. To initiate automatic fire suppression as well as control systems.
6. To assist and supervise fire regulator and suppression system.

VII. ADVANTAGES

1. The most important goal is perhaps that this process can save the life of anyone in the building or surroundings at that instant of time.
2. This is particularly crucial at night time, in alerting anyone who is sleeping, when the fire starts.
3. Early and primary detection.
4. Helps to avoid major damage or even worse, the complete destruction of the home.
5. A home fire alarm system gives the homeowner protection 24 hours a day, every day of the week.
6. Avoid Smoke Inhalation & Multiple fire Detection.
7. Easy, Affordable & 24/7 Monitoring.

VIII. RESULTS

It is seen that Initially fire and gas sensors are always in ready state, continuously collecting surrounding data. If Gas sensor detects flammable gases, then entire power supply is cut-off within few seconds. The microcontroller collects data from

sensors and process data based upon the compilation code. Then it executes the specified operation and transfers the data to Node MCU. The Node MCU acts as a Wi-Fi module for storing and updating the data in cloud.

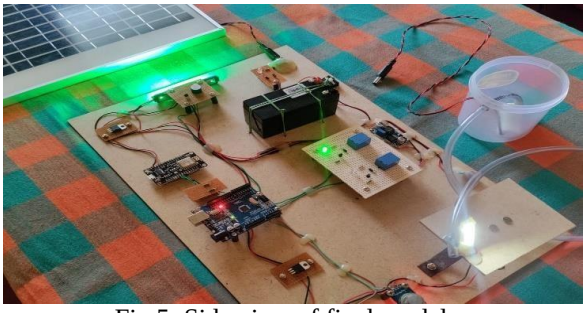

Fig 5: Side view of final model

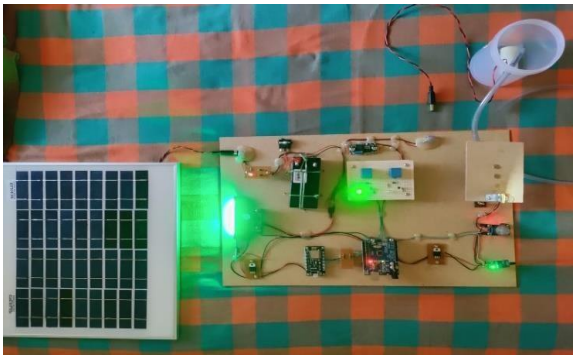

Fig 6: Top view of final model

If fire sensor detects flame, then buzzer goes off and pump is turned ON immediately. Automatic sprinkling of water takes place until the fire is extinguished. The collected data readings are sent into a Wi-fi module and updated in Thing Speak platform. This process takes place with a time interval of 5 seconds. Then it translates the data into graphical and statistical manner, which is easily understandable by any individual. Batteries feed the system as a back-up source while the solar panel acts as main source of power.

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