Fire Fighting System Powered By Solar Energy

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Abstract:- *A fire alarm system has a number of devices working together to detect and warn people through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present. These alarms maybe activated automatically from smoke detectors and heat detectors or may also be activated via manual fire alarm activation devices such as manual call points or pull stations. Generally, these fire alarm systems work on AC power supply from the socket. As the fire alarm system must be kept running 24/7, a lot of power is used. This project is about saving that power by using a solar panel for a lastingly long period by replacing smoke detectors with infrared flame sensor as used in conventional systems.*

The project is designed and built to provide a reliable and cost-efficient fire security system. This project overcomes the drawbacks of the conventional system. When tested the project provided a very quick and satisfying results. The system is not dependent on the main regular supply and has its own working power supply. Taking this into account the project can be applied in various zones reaching from residential, commercial and as well as in industrial applications. It is most applicable in zones where it is very likely to catch fire and where conventional smoke detectors and fire extinguishing system fall short.

Key words: Microcontroller, Solar Panel, Sensors, Motors, Pumps, *Arduino IDE*

I. INTRODUCTION

Today, fire system has become a part of our everyday life. Every Residential or Commercial structure has its own fire security system. Things will get really bad if there were no fire alarm system as an uncompensated loss will occur, whereas when we use a fire alarm system, it will alert us with the detected smoke or fire. It will help us to react quickly and extinguish the fire. The world's first fire alarm system was made in 1852, since then with the advancement of technology; the system has become more and more advanced.

Automatic fire detection systems, when combined with other elements of an emergency response and evacuation plan, can significantly reduce property damage, personal injuries, and loss of life from fire in the workplace. Their main function is to quickly identify a developing fire and alert building occupants and emergency response personnel before extensive damage occurs. Automatic fire detection systems do this by using electronic sensors to detect the smoke, heat, or flames from a fire and providing an early warning.

Using a private fire system can be proved to be a lot helpful while the city's fire security arrives. It can be used to prevent the fire from rising to the point where it might be too late to extinguish and may save many lives of the people by the time help is received.

For example, if a Factory catches a fire at night time when there aren't any workers, it can cause a tremendous havoc if the fires aren't seen by someone early enough. In situations like these the smart fire detecting system would be a lot more helpful in saving huge goods from burning in that Factory. Fire systems which are now generally used work on the metered AC supply.

As we all know that fire system rarely turns on and yet it is supplied power 24*7. Or there is different type of fire security which does not use electricity which completely works on water pressure. This project aims to save the power by using renewable energy and making the fire system smarter and convenient for more reliable use.

Fire detection equipment can be as crucial as sprinkler systems when it comes to saving lives. The fire detection equipment sounding will warn occupants to escape when there is fire detected. The fire protection community's objective is to reduce reaction time, evacuation time, response time, and suppression time. Past fire events have shown that codes and standards-complying fire alarm systems can provide the window of safety needed to meet fire protection goals. Coupled with automatic suppression systems, tools exist to significantly reduce life and property loss from fire.

Fire alarm systems will give warning to those located inside of a building but will only help them if they react to the sounding alarm by leaving the premises. These fire alarms are primarily used to protect lives and secondly to protect property. Fire alarms are activated by initiating devices such as smoke detectors, manual fire alarm box, or a supervisory switch. Detectors are activated when the environment changes indicating a fire signature. These fire signatures consist of heat, smoke (aerosol particulates), and radiant energy.

II. BLOCK DIAGRAM

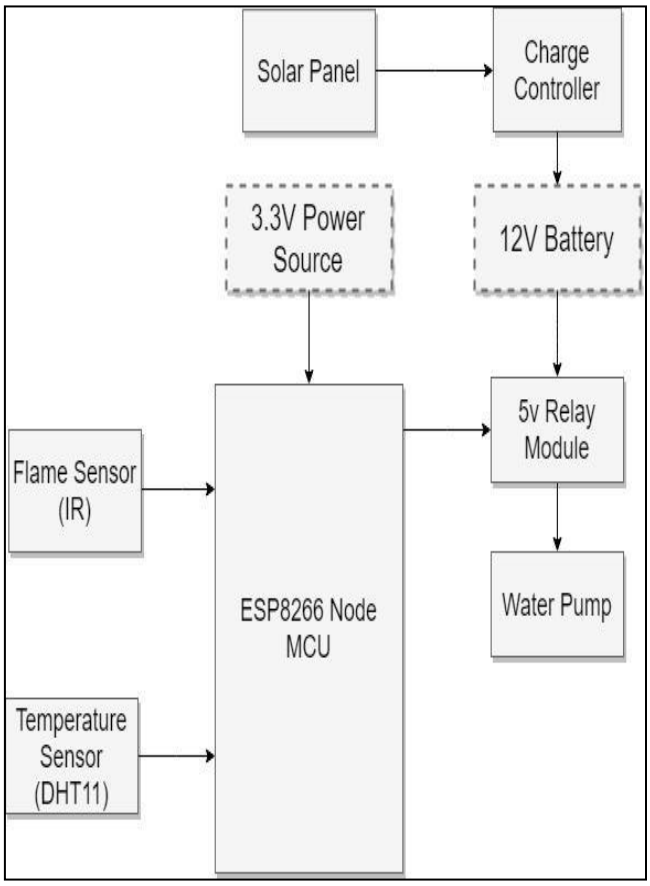

Fig.1. Block Diagram of the Project

III. SYSTEM DESIGN

1. Solar Panel

As green energy is to be used for power conservation, solar energy is being used here. To harvest the solar energy, a 7W Solar Panel is used here. The equation that solves for charge time is as follows: charge time (hours) = (Amp-hours removed x 1.15)/charge rate; where Amp-hours removed equals the load being placed on the battery in amp-hours (think of this as how much battery capacity is being used by appliances), 1.15 is 115 percent of capacity, and the charge rate is equal to Amps = Watts/Volts. Keep in mind that this is a somewhat simplified equation because other components in the system may have to be taken into account, like the charge controller and inverter.

Now let's plug in some numbers. We'll be using a 12 Volt battery and a 7 Watt Solar panel, with the battery at 50% capacity. This battery is a 7.2 Amp-hour battery, so if it's at 50% capacity then amp-hours removed equals 3.6 Amp-hours. The product of 3.6 and 1.15 is 4.14. To find the charge rate, divide the wattage of the panel by the voltage of the battery (Amps = Watts/Volts), which is 7 Watts/12 Volts, which equals 0.59 Amps. So, the equation now reads 3.6 Amp-hours/0.59 Amps, which equals about 6.1 hours.

2. Solar Charge Controller

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery charger. Here a stand-alone charge controller is used in this project so as to control the power charging the battery.

3. Microcontroller

ESP8266 NodeMCU

The microcontroller is the brain of the whole system. The microcontroller controls all the functions of the circuit. In this project, we use ESP8266 NodeMCU. It operates on a 3.3V power supply. It is a microcontroller with 13 Digital pins and 1 Analog pin this microcontroller is used in this project because of its high number of digital pins. The microcontroller works on the C programming principle.

ESP8266 NodeMCU is programmed by the software Arduino IDE which is Open Source software for developers around the world. The ESP8266 NodeMCU is manufactured by the organization called ESP.

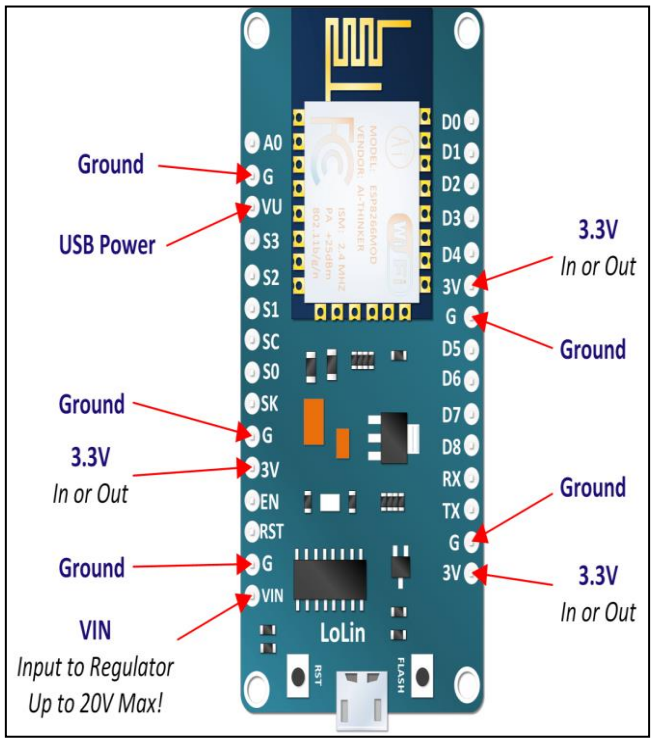

Fig.2. ESP8266 NodeMCU Microcontroller

4. Flame Sensor (IR)

Flame sensor is the most sensitive to ordinary light that is why its reaction is generally used as flame alarm purposes. This module can detect flame or wavelength in 760 nm to 1100 nm range of light source. The sensor and flame should keep a certain distance to avoid high temperature damage to the sensor. If the flame is bigger, test it with farther distance. The detection distance is up to 100 cm. The detection angle is 60 degrees so the flame spectrum is especially sensitive. The Flame sensor can output digital or analog signal. It can be used as a flame alarm or in firefighting systems.

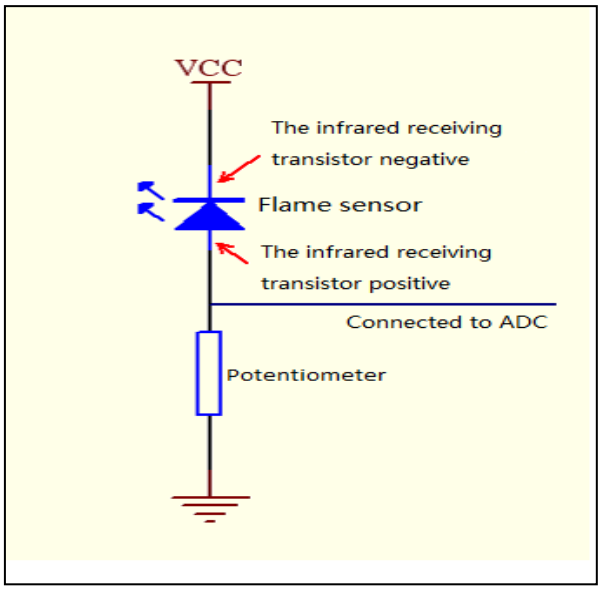

Fig.3. Flame Sensor

5. Temperature sensor

DHT 11

This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor complex. Its technology ensures the high reliability and excellent long-term stability. This sensor includes a resistive element and a sense of wet NTC (Negative Temperature Coefficient) temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high cost performance advantages.

Each DHT11 sensors features extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the program memory, internal sensors detect signals in the process, and we should call these calibration coefficients. The single-wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 10 meters, making it a variety of applications and even the most demanding applications. The product is 4-pin single row pin package. Convenient connection, special packages can be provided according to users need.

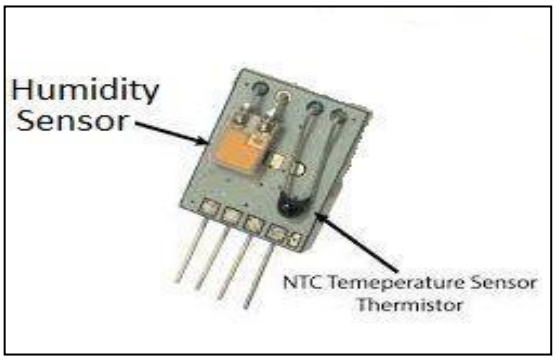

Fig.4 DHT 11 Sensor

6. Relay Module

This is a 5V 2-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.

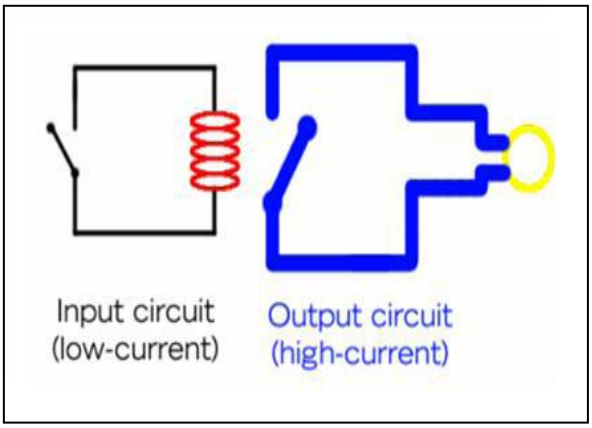

Fig. 5 Relay Module

7. Water Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism typically reciprocating or rotary, and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. The rating of pump used is 12V DC 80W Micro Electric Diaphragm Water Pump 5.5L/min capacity.

IV. ARDUINO IDE

Arduino is an open source computer hardware and software company, project, and user community that

designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environmentusing sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The source code for the IDE is released under the GNU General Public License, version 2. [56]

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

V. CIRCUIT CONNECTION DIAGRAM

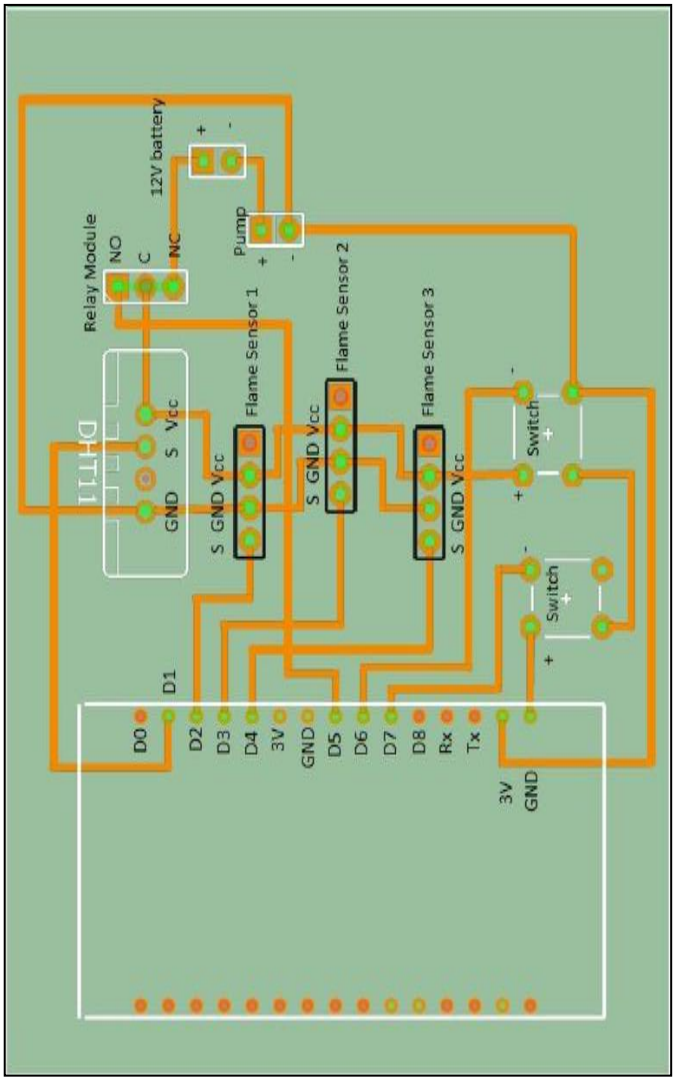

Fig.6. Circuit Connection Diagram

VI. WORKING

When photons hit a solar cell, they knock electrons loose from their atoms. If conductors are attached to the positive and negative sides of a cell, it forms an electrical circuit. When electrons flow through such a circuit, they generate electricity. Multiple cells make up a solar panel, and multiple panels (modules) can be wired together to form a solar array. The more panels you can deploy, the more energy you can expect to generate.

A charge controller or charge regulator is basically a voltage and/or current regulator to keep batteries from overcharging. It regulates the voltage and current coming from the solar panels going to the battery. Most "12 volt" panels put out about 16 to 20 volts, so if there is no regulation the batteries will be damaged from

overcharging. Most batteries need around 14 to 14.5 volts to get fully charged.

Infrared flame sensors are designed to work within the infrared spectral band. When an explosion occurs, certain hot gasses will emit patterns in the infrared region, which can then be analyzed using a specialized thermal imaging camera. Infrared flame sensors are somewhat prone to false alarms, so generally feature an inbuilt time delay.

The project works on detection and execution-based principle. The project starts from the power supply of the system. Being a power conserving project, a 7-Watt solar panel is used. This solar panel charges, a 12V dc battery by the rate of (time required=amp-hour removed x1.15), with the help of a charge controller which protects the system from overcharging and damaging itself. Further this 12 V is supplied to the relay unit. An external source of power supply is provided for the microcontroller. As each unit gets supply it starts working.

The project works with the combination of two sensors, the first infrared flame sensor and the secondary DHT 11 sensor which is a Temperature and Humidity sensor. Both the sensors have pre-registered values of triggering, at which the microcontroller executes the operation. These values can be set by the operator as required. The infrared detector works on wavelength of the fire and DHT 11 on temperature respectively. As soon as there is a fire taken place in the room or even if the temperature of the room exceeds above the pre-set limits the sensors detects and provide an output signal to the microcontroller (pin D1, D2, D3, D4). This is done in a jiffy.

The microcontroller works on the principle of HIGH and LOW. As soon as any sensor detects the fire, it will supply a HIGH command to the microcontroller. The HIGH command of the sensor is carried by the "signal" pin of the sensor to the specified pin on the microcontroller. So as to explain, If the flame sensor detects fire, then it will send a HIGH command to the specified pin (here D2). The microcontroller will act according to the programming code uploaded to it and it will make the pin D5 (output) as HIGH. This supplying a power of 3.3v to the relay and the relay will complete the circuit of battery and water pump.

Alternatively, this can also be done by a manual switch, which will also trigger the alarm circuit. (Considering the probability that if the sensor fails to detect any fire or any malfunction in the system, the user should be able to turn on the system manually.) Then further the microcontroller provides an output voltage of 3V directly to the relay unit. This voltage charges the relay primary exciting coil and it attracts the coil of the secondary circuit by magnetization, which completes the supply circuit for the pump.

As soon as the pump gets provided with a 12V DC supply from the relay unit the pump starts to supply water from the storage to the fire extinguishing valves of the water circulating system. This will continue till the fire is extinguished by the water or manually halted.

VII. RESULT

After installation of the system in the property, the fire detection system will work without any human interface. The following steps will occur.

Step1. Fire detection:

As soon as the fire ignites and increases, the IR flame sensor or the DHT11 will detect and send a HIGH signal to the microcontroller in the specified pin.

Step2. Action:

The microcontroller will then send a HIGH command to the pin assigned for the output. Thus, giving supply to the relay circuit and powering the water pump.

Step 3. Extinguishing:

If the fire is not detected by the system, a manual button is added to the system to make it easy for manually triggering the alarm circuit

Step 4. End:

When the fire is extinguished, the system can be stopped by another manual button in the system. This button will disconnect the supply to the relay module thus open circuiting the battery supply to the water pump

VIII. APPLICATIONS

The project is designed and built to provide a reliable and cost-efficient fire security system. This project overcomes the drawbacks of the conventional system. When tested the project provided a very quick and satisfying results. The system is not dependent on the main regular supply and has its own working power supply. Taking this into account the project can be applied in various zones reaching from residential, commercial and as well as in industrial applications. It is most applicable in zones where it is very likely to catch fire and where conventional smoke detectors and fire extinguishing system fall short.

Also, in places like go down or multilevel complex, this system is very feasible and easy to operate. The project's low cost of operation, it can be used even in low space areas like small shops and offices.

IX. CONCLUSIONS

The design of the system is simple and easy to implement. Stable and quick-fire extinguishing is obtained. The system circuit is very compact and makes is very easy to place. The system requires a DC supply provided through a solar panel. The system is extremely user friendly due to the well programmed. The components

used are relatively cheap which reduces the system cost. Due to use of comprehensive programming the complexity of the system is reduced. Some of the drawbacks of the design is the falling short of sensor angle and cannot be detected if the fire is out of the range.

Ruling out the smoke detector is both, a positive and a negative scheme. As this project puts forward the use of infrared based system, the system won't be triggered by any smoke which will make sure that the property isn't being sprayed by water just because of some minor smoke (as there are times when a minor short circuit produces a quite big smoke). In the case of smoke, the system will wait for the IR flame sensor or temperature sensor or manual triggering to spray the water.

ACKNOWLEDGMENT

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