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Design & Development of Smart Fire Safety System for Vehicles Using IOT

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Abstract: ***Today, fire accidents often occur in homes and industrial environments, where climate change and human negligence can be predicted. The proposed prototype is designed to detect such fire accidents and remotely extinguish the fire from the user, thus reducing the risk to firefighters. The main idea of this concept is to propose a model that focuses on the cost-effective design and implementation of an automatic fire protection system for electric vehicles. In this system, the fire extinguisher is activated when it detects flame/smoke in the vehicle fire area and extinguishes the fire automatically. There are many reasons for an electric vehicle that can cause fire accidents. The main cause of electric car fires is the battery used in them. There have been many cases of cars catching fire for the reasons mentioned above and ending with the entire vehicle reduced to ashes. The installation of an automatic extinguishing system allows to minimize the financial losses that can arise from a fire and to increase the safety level of the vehicle, passengers and other road users.***

Keywords: Fire Situation, Controller, Emergency Alert, Accident Prevention, IOT Technology etc.

I. INTRODUCTION

Fire accident is a very common phenomenon in our country. Many fortunes and lives are at stake. As a developing country, we do not have modern technology to solve this problem. The core sector of firefighting has limits to overcome. Sometimes the police, army comes to help them in the shooting. But that is not enough. Electric vehicle batteries introduce new safety challenges to the vehicle development process, and rigorous testing must be performed to ensure minimal fire risk. Research has shown that electrical systems are among the top four causes of car fires. The purpose of the proposed system is to build a controllable vehicle that can be installed in a domestic or industrial environment and that alerts the user in case of fire. The user can drive this vehicle by controlling the mobile phone to the designated place where there is a fire accident and spray water to extinguish the fire by controlling the mobile phone. The user can also control the speed, amount and direction of the water while spraying. The developed vehicle can be remotely monitored from the mobile screen to control the movement of the vehicle and thus the user can interact with it to extinguish the fire effectively. IoT (Internet of Things) integration allows the guided vehicle to organize, analyze and process data, allowing the user to make optimal decisions in real time. In this way, possible damages caused by fire can be significantly reduced before the arrival of the extinguishing unit, and the risk of the participation of the extinguishing team can also be minimized. The probability of human loss and/or injury in a typical car fire accident can be reduced by an automatic door opening system. However, firefighters are people who dedicate themselves to extinguishing fires even at the cost of their lives. So this research aims to minimize human involvement to prevent fire accidents.



Fig.1. Electric Vehicle on Fire situation

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II. PROBLEM DEFINITION

1) Studies have shown that electrical systems are among the top four causes of car fires. Many people think that only full electric and hybrid vehicle batteries are problematic and can cause fires.
2) A few years ago, at the end of 2013, the Tesla Model S, recognized by the media as the safest car in the world, caught fire
3) The concerns and risks related to electric or hybrid cars are by no means over. Every new design or model comes with even more risks. It may take some time for these high profile events to fade from many people's minds.

a) Battery overcharging
b) Battery electrolyte leakage
c) Short circuit in electric components
d) Road crash



Fig. 1. Busses caught fire and totally buried

III. OBJECTIVES

1) To study the available literature and study the automatic fire safety system with IOT communication.
2) The main goal of our project is to detect fire accidents and inform the nearest authorities, who will reach you faster.
3) All sensors are connected to the central controller, whenever fire is detected, the controller activates water sprinklers, alarms.
4) An IOT module is integrated into the system, through which data is sent to the cloud and is available to all authorities. departments Things speech cloud is used in the prototype.
5) Developing the experimental organization of the study
6) Analysing the result.

IV. LITERATURE SURVEY

Vehicle motion is dictated by a combination of sensor-based inputs and user control. When the fire detection sensor detects a fire, the signal is immediately transmitted to the controller. The IOT modules are activated to notify the user of a fire accident. Once the alarm is received, the user can direct the vehicle to the desired location to extinguish the fire using the Blynk software and built-in camera module. A servo motor connected to the extinguishing hose can control the direction and amount of sprayed water. The controls for the servo motors are included with the user. The proposed fire truck is designed to run on the Internet of Things (IoT), allowing the user to control the fire from anywhere.

1) Anij Joseph John et al. [01] conducted an experimental study on "Automatic Fire Fighting Robot Vehicle". This robot is defined as a mechanical structure capable of performing human tasks or behaving like a human. Building a robot requires expertise and complex programming. It's all about building the system and connecting the motors, sensors, wires and other important components. A firefighter robot is a robot with a small fire extinguisher attached. By attaching a small fire extinguisher to the robot, the automation extinguished the fire under human control. Firefighters face dangerous situations while fighting fires and rescuing victims, it is an inevitable part of being a firefighter. In contrast, a robot can operate autonomously or be remotely controlled, meaning that extinguishing and rescue operations can be carried out without endangering firefighters, using robotic technology instead.

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2) Choton Kanti Das and others. [02] conducted a study on the design and implementation of a "failure multi-detector based automatic fire extinguishing system". The main objective of this article was to propose an automatic fire extinguishing system that eliminates the shortcomings of the prior art and allows easy installation or removal of the system in the area where automatic extinguishing should occur and ignite. flexible arrangement of gas jet nozzles according to the size and shape of the area. However, since such conventional automatic fire extinguishing systems require a complex gas piping system from the gas bomb to the gas jet nozzles, piping costs and installation are expensive.

3) Andrzej Łebkowski [03] did an experimental research on "Fire extinguishing system of electric vehicles". The presented electric vehicle fire extinguishing system, based on the information available from temperature, flame and shock sensors, can warn the driver about a fire in the vehicle and take immediate preventive measures. The advantage of the fire suppression system over other solutions that are limited to disconnecting the battery is that it can continue to respond in an attempt to extinguish an active fire. The fire extinguishing system of an electric vehicle can communicate with other diagnostic and monitoring systems, including remote notification of emergency services and remote diagnosis of electric vehicles.

4) Swetha Sampath [04] conducted a study on hardware based "Automatic Fire Extinguisher Robot". The robot in this article detects a temperature of approximately 300°C in an oven using a thermocouple. IC 71 was used as both comparator and amplifier. The amplified direct voltage is converted to alternating current by means of a DC-AC transformer. The alternating voltage generated in this way supplies the water pump with power. In general, water or other substitutes such as foam and carbon dioxide can also be used to extinguish the fire. Obstacle avoiders and motion sensors were used to avoid obstacles and move in all directions depending on the intensity of the fire. The robot is protected by calcium silicate plates to withstand very high temperatures.

5) Rafat Shams et al. [05] developed a model "Automated fire extinguishing system with GSM alarm". This article presents requirements, specifications, design issues and solutions for a compliant fire suppression system project. Firefighting is an important and dangerous job. A firefighter can extinguish a fire quickly, preventing damage and reducing losses. Technology has bridged the gap between firefighting and machinery with some effective methods. The aim of this thesis was to create a system that can detect and extinguish a fire in the shortest possible time with some effective factors. In this case, the purpose of the system is to extinguish the fire before it spreads, increasing the safety of the home, laboratory, office, factory and building important for human life.

V. BLOCK DIAGRAM

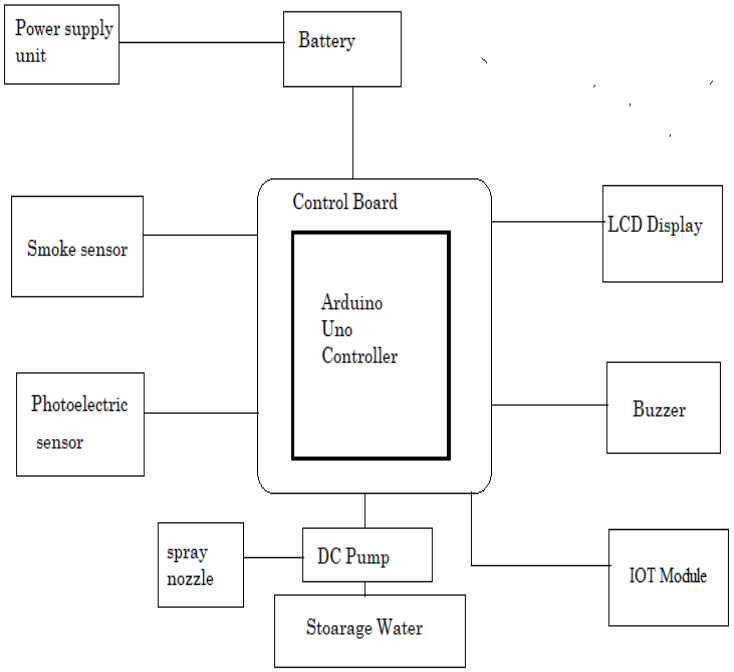


Fig. 2. Block Diagram

VI. WORKING

1) When a fire starts, the sensors on the top of the model detect the fire. The smoke sensor and photo sensor detect fire smoke, and the flame sensor detects the actual fire by determining the temperature of the environment and its operating range.
2) The sensors then send a signal to the Arduino (microprocessor). The microprocessor then reads the data transmitted by the sensors and processes it.
3) With the help of a program given to the microprocessor, the microprocessor controls various actuators according to the information taken from the sensors.
4) When the data is taken from the smoke detector, the microprocessor only controls the buzzer, IOT module and LCD screen. And after the data is taken from the sensor, the microprocessor controls the buzzer, the LCD screen, the IOT module and also the DC pump.
5) When the DC pump starts, its pump starts drawing water from the storage water tank device. And the spray of water falls into the fire zone of the electric car.

VII. COMPONENTS

- Arduino Uno Controller
- LCD Display
- Buzzer
- Power supply unit
- Battery
- DC Pump
- Smoke sensor
- Water Tabj
- Photoelectric sensor
- Nozzle
- Development Board
- Relay Board
- IOT Module
- Others

A. *Arduino Uno*



- The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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.

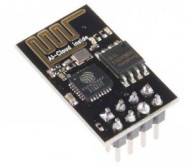
B. *Liquid Crystal Display*



LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

- The declining prices of LCDs.
- The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.

C. IOT Module



IoT, or Internet of Things, refers to connected machines and devices that can communicate remotely via one or more, wireless communication media. IDC defines it as "endpoints of specific identities (or" content "networks) that communicate without human interaction using ID connectivity - so “locally” or globally”

D. Brushless DC Pump



1) Brushless DC pump series have 4.5V,5V, 6V, 9V, 12V, 13.8V, 24V.
2) All series can be based on customers’ specifications, pressure / flow and matched with the required electrical design plus required In / out water pipe.
3) General application can refer to standard parts.

E. Relay

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). The main operation of a relay comes in places where only a low-power signal can be used to control a circuit.



F. Smoke Sensor (MQ2)

MQ2 gas/smoke sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide.

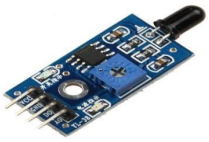
MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas.



G. Flame Sensor

Flame Detection Sensor Module is sensitive to the flame, but also can detect ordinary light. Usually used as a flame alarm.
It detects a flame or a light source of a wavelength in the range of 760nm-1100 nm.

1) Detection point of about 60 degrees, particularly sensitive to the flame spectrum.
2) Sensitivity is adjustable, stable performance
3) Operating voltage 3.3V-5V



VIII. DESIGN OF SYSTEM

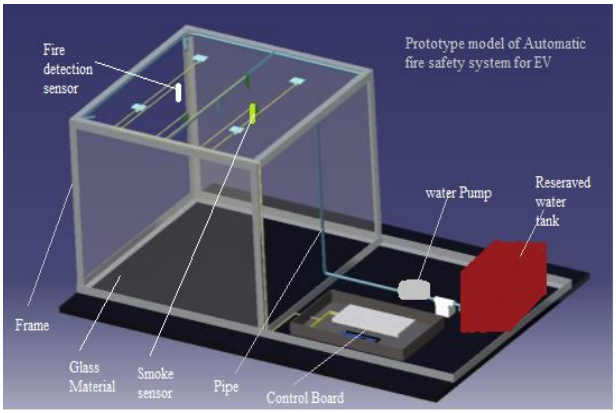


Fig.3. Design of structure

IX. CALCULATION

The main aim of the fire fighting robotic arm is to facilitate the function of fire man. The fire fighting robot is capable of providing forward and backward, left and right side motions when the operator presses the key via a zigbee communication system. And the jib also provides left, right, up and down motion to aim the water to the fire source to extinguish it. Its movement is also connected by remote control.

The support which resists the back pressure and provides stability for the robot system.

The following equations are used to find out the back pressure, effective height of jet of water, and water discharge rate. The reaction force due to water hammer is given by

$R = (1.57 \times P \times d2)/10$ (1)

Where P is the pressure in bar at the nozzle and d is the diameter of the nozzle in mm

The theoretical height of jet is find out by,

$H=V2/2g$ (2)

Where , H is Height in meters; V is velocity in m/s and g is the acceleration due to gravity

The effective height of jet of water is given by

$He=2/3(H-0.113H2/d)$ (3)

Where He is the effective jet in meter, d is diameter of nozzle in mm, and H is the theoretical height of water jet

The discharge rate is found out by,

$Q=2/3 \times d2 \times (p)1/2$ (4)

Where Q is the discharge in litre/minute; d is the diameter of nozzle in mm; p is the pressure in bar The fire fighting robotic arm consist of 5mm diameter nozzle; and pressure of 2 bar

By substituting in equation (1)
Reaction force due to water hammer,
R=(1.57×2×52)=7.85 newton
The theoretical height of water jet is found by equation (2)
H= 19.82/(2×9.81)=20 m
The effective height of water jet is found by equation (3)
He=2/3(20-0.113×202/5)=7.3 m
The rate of discharge is found out by equation (4) as
Q=2/3×52×(2)1/2=23.57 litre/hr.

X. RESULTS

As our project is mainly to reduce accidents in Electric vehicles, the whole design is shown above, and as a small prototype we had made bus with sheets. And there is graph showing the values of surroundings that was detected by sensor and this can be seen by using the cloud. Preventive measures are implemented with a minimum amount of time. Human loss and property loss will be reduced.

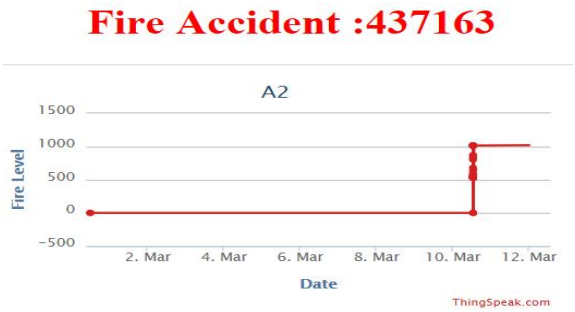


Fig.4. Parameters reading from sensor graph

Internet of thing has several of applications and here we had applied in the field of fire safety and monitoring. Especially in AC buses. IOT has a broad application background in the field of real time applications mainly in security systems. This proposed system mainly focuses on reducing the human loss and property loss when accident had happened. In our proposed system the preventive measures are implemented automatically, So the time to implement them is very less, so the loss can be reduced. We propose this system as a first attempt and compliment to public transportations. Many accidents occurs during night time, and sometimes when driver is in sleepy condition driver cannot control the bus, if there is a drowsiness detection then in that situations a alert is given to driver in the form of buzzer.

XI. CONCLUSION

This invention of Automatic Fire Extinguishing System is effective and it is well within the reach of every person.

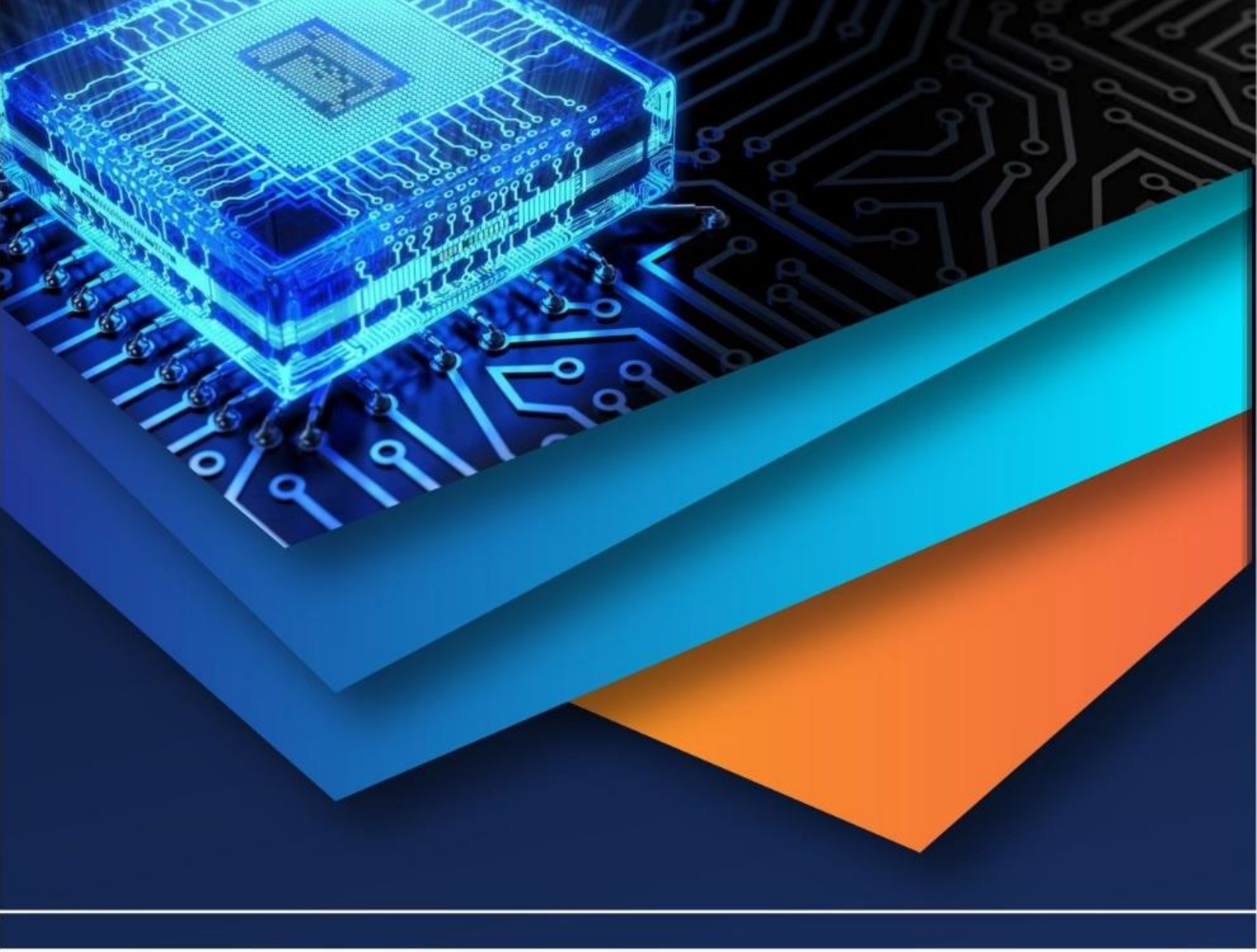
1) If considerable amount of time is spent on its further research and development, it could really prove to be an effective product in the fire safety department.
2) This system is applicable to the different sizes of fire extinguisher and high controlling capability over them.
3) The simple design of it allows minimum of maintenance work.
4) After installation of this system, there will not be any disturbance and uneasiness to the driver and also to the passengers.

Assurance that fire outbreak has no more fatal consequences in the automobile and especially in electric vehicles where the thousands of battery cells powering the vehicle tend to overheat, catch fire and explode brings new quality to road transport safety. System derived from sound reasoning ideas have been implemented and can be tested, using embedded and sensor based technology. Automobile fire can be detected and extinguished effectively without driver's intervention and is devoid of false alarms based on current testing. This multi-sensor fire detection and control is a useful low cost sophisticated system, which can also be tested and deployed on other systems where air-conditioners can be installed. With system's excellent performance under 20 seconds, it is expected that system will pose no threat to human life although more extensive testing might be needed. Moreover, building an incorporated functionality that deals with prognosis of the health of sensors will be beneficial to the real-time detection and control of in-vehicle fires and serve as mode for preventive maintenance.

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