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Review Article

Fire Extinguisher types and Applications

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Abstract

In any environment, fire extinguishers are an essential part of any fire safety strategy. They are a first-aid response to a fire and can assist in preventing severe property damage and even fatalities in homes, businesses, and even automobiles. The selection of an extinguisher device, which incorporates both passive and active fire safety procedures, offers the right intervention in the event of a potential fire outbreak. In the past and in the present, fire has been a major source of property loss and fatalities. If the appropriate steps are not done, they may result in significant property damage, process interruptions, death, and injury. The density of flammable, explosive, and dangerous substances, chimneys, hot surfaces, static electricity, and electrical dangers, particularly in industrial buildings, increases the risk of fire. Therefore, the appropriate safety measures should be performed.

Keywords: Extinguisher device, Fire Outbreak, Fire Safety.

I. Introduction

The first hand pump to provide water to a fire was created by Ctesibius of Alexandria circa 200 BC. Captain George William Manby created the first pressurized fire extinguisher in a copper container with three gallons of potassium carbonate inside. Since then, fire extinguishers have advanced significantly. Different fire extinguishers are required for each sort of fire since it might start from a variety of sources. There isn't a single kind of fire extinguisher that can put out every fire. One of the most harmful problems in our life is fire disasters [1]. The spread of fire has accelerated and grown to worrisome proportions [2]. resulting losses to human life, the environment, buildings, infrastructure, businesses, and commercials [3]. Buildings are now experiencing a domino effect due to the frequency and severity of fire occurrences, which has become a major problem in recent years [3]. When there is no timely response for the early phases of the fire, a fire disaster offers a serious threat to both civilians and fire fighters [4]. Additionally, combating fires is a very risky task [5-7]. And is challenging [8]. especially when interacting with unfamiliar situations. The purpose of the study is to create a model of an autonomous mobile robot that can recognize classes of fire and non-fire in images. then automatically goes in that direction to put out the fire. A mobile robot equipped with a motion control algorithm serves as the secondary controller for the created system, which is controlled by a primary controller PC for image processing. The system comes with a 1-megapixel webcam to record the fire image, and the PC displays the frames and ground from the reference frame. The temperature increment is checked using a temperature sensor, and wireless communication is accomplished using a Bluetooth module [45]. The [46] receives the necessary current from the L298N driver module to power the movement of the mobile robot. In a space of 3 square meters, the robot operates. For improved operation, this space needs to be clutter-free and clean [47–55]. The various approaches and theories that earlier researchers used to create a mobile fire-extinguishing robot In the study, the developed system is referred to as AFFMP [9]. For fire detection, the device contains a flame sensor [56]. It also follows a leading path to steer clear of obstructions that restrict the robot's progress. The microcontroller receives the detecting commands to begin utilizing a water pump to put out the fire. The autonomous firefighting robot system that is suggested in the study [10] The device was created to assist firefighting robots that have trouble spotting fire in a smoke-filled environment. Enhancing system stability for real-time processing is the goal. For fire detection, the suggested system is equipped with two stereo thermal infrared (IR) views, and for determining location, it is equipped with a frequency modulated continuous wave (FMCW). The clever fire extinguisher robot with voice control described in the article [11] Human vocal instructions, including those that entail direction movement, are used to operate the system. A PIC16F77A microcontroller, an IR sensor, a camera to display video of the fire on an LCD screen, a buzzer to sound an alarm, a CO2 blower to put out the fire, and other components make up the system. The flame sensor in the system will detect fire flames. A web server is utilized in the firefighting robot in the study [12] to handle the robot from a web page and can be used to monitor various web server characteristics. For fire detection, the system made use of traditional detectors. The Android phone is used to control the motion. The autonomous firefighting robot was created in the paper [13] with self-power management. The paper [14] built a mobile robot with a sensor-fusion fire detecting unit. The publication titled Development of Firefighting Robots [15] has a description of the proposed system «Q ROB. It is intended to save firefighters from hazardous circumstances they can come across in small spaces. To avoid obstructions, the robot also contains an ultrasonic transducer. The operator directs the robot to put out the fire while keeping an eye on its movement via the mounted camera. The paper [16] describes the suggested DTMF-centered remotely placed fire extinguishing robot. The robot can be moved by a human operator using a cell phone in reaction to a flame sensor. The user gives the robot instructions by using DTMF tones. The sent signal is converted into binary bits by the embedded system's decoder, and each command is tailored for a specific job. The paper [17] built the firefighting robot based on deep learning for fire detection. After training and validating the model, the system coupled the Alexnet model with Imagenet to detect fires. The classification accuracy reached up to 98.25%. The device uses the PI camera to detect fire and then transmits information to the Raspberry Pi computer to control the movement of the mobile robot. The most popular branch of machine learning algorithms, deep learning (DL), is capable of outperforming more traditional machine learning algorithms [18, 19]. This study uses it because of how much data it can handle [20]. It also performs well and is straightforward to process and analyze datasets, which is important for image classification applications [21, 22]. A function from input to output is created when the output results are mapped to the input data [23, 24]. It is regarded as the foundation and the fundamental area for handling a range of tasks in machine learning [25, 26]. Using convolutional operations, a convolutional neural network (CNN) is one of the deep learning neural networks that is used to process complicated tasks and the content of images [27–29]. Among the other DL neural networks, it is the most widely used network algorithm [30, 31]. The filters that CNN utilizes to automatically create features from a large number of datasets and then train these features to categorize datasets [32, 33] are what set it apart from competing systems. To create a solid performance model for deep learning algorithms, a large number of training datasets are required [34]. Building trials from the ground up thus becomes the norm. Additionally, gathering data from scratch takes a while and ultimately yields too few datasets [35]. Therefore, by utilizing transfer learning approaches in CNN models with a vast amount of data. This technique enables the transfer of knowledge into the newly created desired model while using updated optimum weights and biases for the trainee [36]. In sectors relying on recognition and computer vision, transfer learning approaches increase effectiveness and performance [37, 38]. This paper demonstrates a prototype of a mobile robot that can automatically identify fires and extinguish them using a deep learning model that has been pretrained. The outcome demonstrates that computer vision-based systems perform more effectively than systems using traditional sensors. For training, the CNN model that has already been pretrained performs better for fire detection systems. They are quick at detecting in real time, and the training process takes less time. The CNN model underwent training, and its effectiveness was assessed. The frames were taken into account when converting the transformation matrix of the robot's body frame in relation to the camera's reference frame. The system was put into place and all goals were effectively met [39]. In this study, innovative uses for fire control are looked into. In simulated forest fires, new extinguishing agents made of boron-based compounds as well as thermal camera applications for fire trucks were evaluated. In these tests, it was discovered that the thermal camera quickly identified the fire. The employment of thermal cameras for all different kinds of fire apparatus (foam trucks, water tankers, rescue trucks, etc.) looked logical. The ability of the thermal camera program to identify and monitor the fire while the firefighters were putting it out was observed. In the studies, water had a worse extinguishing and cooling impact than the boron-based fire suppressor. The liquid boron-based extinguisher offered 22% faster suppression and cooling than the conventional approach, which used water, while the solid boron-based extinguisher offered 42% faster suppression and cooling. The use of thermal camera applications and boron-based extinguishers in fire trucks is expected to result in an efficient and beneficial change in the upcoming years, according to three distinct trials [40]. The most widely utilized realistic safety education material in Korea, the "simulator fire extinguisher," was used four times in this study's safety education program for 34 elementary school children. Tests of safety-related knowledge and problem-solving skills were utilized as measuring instruments, and statistical significance was confirmed using paired sample t-tests. This study proved that the "simulator fire extinguisher" safety education program was successful in enhancing safety knowledge and problem-solving skills. In tests of safety knowledge, students' average scores climbed from 8.47 to 9.23, and in tests of safety problem-solving skills, they went from 4.26 to 4.64. The statistical significance of these findings was high ($p < 0.001$) [41]. When a fire starts unintentionally, it is extinguished with an automatic fire extinguisher, a hardware-based variation. The shield is covered with boards composed of calcium silicate, which can withstand very high temperatures. To alter the robot's sensitivity to temperature, thermocouple ends are heated to a cut-off temperature, above which the robot starts reacting to the fire. The major benefit of this is that it automatically turns on and goes in that direction to try to put out a fire when it detects one nearby using a thermocouple. The temperature sensor backs up the thermocouple in extreme circumstances; when it senses heat or fire, the extinguishing chemical is released and runs via the solenoid valve to put out the fire. In the same instant, both life and property. By putting out the fire right away, our technology lowers the risks associated with saving lives and protecting property. The occurrence occurs first and foremost, and the DAF EXTINGUISHER immediately extinguishes the fire [42]. In this work, a robot that can autonomously put out fires after fire incidents is shown. The robot uses calcium silicate protected boards that can resist extremely high temperatures to travel in the direction of the fire's intensity and prevent self-destruction. At 300 °C, the design and testing of the employed principle took place. Thermocouple ends are heated to a cut-off temperature, over which the robot begins responding to the fire, to change the robot's sensitivity to temperature. In tight loops like hospitals and shopping malls, where the likelihood of servicemen entering fire-prone regions is quite low, as well as during wars to undertake rescue tasks, the robot finds use in rescue operations during fire incidents. The main bonus of this robot is that it turns on automatically as soon as it uses a thermocouple to detect a fire between 5 and 10 cm away and tries to put it out by traveling in the direction of the fire's intensity. In many situations, the temperature sensor serves as a backup to the thermocouple [43]. Negotiations with supplier businesses for the selection of appropriate fire extinguishers were used in this study to develop successful criteria. The DEMATEL method was used to calculate the weights of the criterion once the criteria had been scored. The TODIM approach was used to choose and sequence fire extinguishing agents appropriately [44].

II. Types of extinguishers and their uses

Extinguishers come in a variety of varieties, and each one has a different purpose. Typical household fire extinguisher types include:

1. Class A fire extinguisher:
   Typically, this type is used for ordinary combustibles like wood, paper, cloth, and some plastics. It works by coating the fire with water or a dry chemical.
2. Class B fire extinguisher:
   This type can be used for flammable liquids such as gasoline, grease, and oil.
3. Class C fire extinguisher.
   This type of extinguisher works on electrical, lightning, or energized fires from live wires, panels, and circuit breakers.
4. Class A-B-C fire extinguisher.
   Dry powder extinguishers (also known as ABC fire extinguishers) are suitable for Class A, B, and C fires involving solids, liquids, and gases [57–60, 64]. The A-B-C extinguisher will do the work of a Class A, B, or C fire extinguisher. It is the most versatile of all the home options and is usually sold at most home improvement stores.
5. Element fire extinguisher.
   This is a small handheld fire extinguisher that is highly portable and can be kept in a car or carried when needed. It is typically used for fighting fires on the molecular level. Its gas chemically interrupts the chain of combustion, effectively extinguishing a fire without making any mess or removing surrounding oxygen.
6. Class D and K fire extinguisher:
   These types of extinguishers are usually found in commercial settings. Class D fire extinguishers work on flammable metals, and Class K fire extinguishers are used for oil fires in cooking appliances [65].

Conclusion

In any environment, fire extinguishers are an essential part of any fire safety strategy. They serve as a first-aid response to fires and can assist avert severe property damage and even fatalities in homes, businesses, and even automobiles [61–63]. Numerous studies on fire extinguishers have been evaluated in this study, and the effects have also been covered.

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