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Artificial Intelligence Based Fire Fighting Robot

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ABSTRACT— Fire-fighting robots are utilized in indoor environments to detect fire and extinguish them. Sensors like flame sensors are currently used to detect fire in firefighting robots. The major disadvantage of using these sensors is there restriction of usage for fireplaces beyond a threshold distance. Using AI technique, fire is often detected during a wider range. Hence, this paper describes a fireplace extinguishing model by AI Robots supported with Arduino Uno and also the advantages and disadvantages of using deep learning for object detection over machine learning is highlighted. The algorithm used to obtain target location and the robot must move to use bounding box coordinates are additionally discussed during this paper.

Keywords—Robots of Artificial Intelligence, Firedetection, Location finding

I. INTRODUCTION

Fire accidents cost lives and damage property. Having an autonomous fire-fighting robot that can detect fire and extinguish it will be extremely helpful in such situations. Most of the fire-fighting robots constructed in the past used sensors such as flame sensors [1] to detect fire. Fire-fighting robots also had ultrasonic sensors to detect obstacles in its path. The time taken for the pulse emitted by the sensor to travel from the object back to the sensor was used to determine the distance of the obstacle from the robot [1]. This distance was compared to a threshold value. If the distance was less than the threshold value, the robot turned in the direction of the least obstacle path and continued to move forward towards the fire. IOT has been included in these robots [2] to communicate to the authorities about the incident. A water-based extinguisher is used for ordinary combustible material such as paper or wood and a carbon-dioxide based extinguisher is used for fires in flammable liquids such as petrol. Fire - fighting robots have been designed to have both types of extinguishers so that an appropriate type of extinguisher can beused. Whether the sensors detect fire or not depends upon the distance between the sensor and the fire. Sensors cannot detect fire when it is beyond a certain threshold distance. Using artificial intelligence techniques, fire can be detected at a wider range which is the motivation behind exploring object detection using machine learning and deep learning techniques for fire detection. Object detection is used to find whether the object of interest is present, the location of the object, the number of objects of interest detected and the relative size of the objects. In this article, the extinguishing model is established based on Arduino Uno. The main purpose is to study whether obstacle avoidance will affect the efficiency of fire-fighting under different conditions.

Artificial Intelligence is an approach to make a computer, a robot, or a product to think how smart a human can think. AI may be a study of how the human brain thinks, learns, decides and works, when it tries to unravel problems. And finally this study outputs intelligent software systems**.**

In order to realize this, we must come up with a thought which may detect a flame, locate it and extinguish the hearth immediately before it possess a threat to anything around it. For risky situations, it might be idealistic to send a firefighting robot which can quickly and efficiently find the fireside and suppress it. Effective monitoring, high speed recognition, and extinguishing of hearth are problems to be addressed immediately. To reduce the risk of losing life in such situations, fire fighting robots can be used.

The automatic robot is meant to avoid further spreading of the hearth that would cause possible human causalities or damage to property. Firefighting robot will help the hearth fighters to try to do their job effectively. The robot immediately calculates its path towards the hearth,moves towards it avoiding obstacles, and ultimately finds the hearth. When the hearth is out, the robot returns to its original root**.**

II. LITERATURE REVIEW

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This design was successfully implemented on a four-wheel drive robot. The 3D printed mount was mounted in front of the robot's chassis to discharge the CO2 gas for extinguishing flame with the arrival of technology, humans are replaced with robots in life-threatening situations. By designing and implementing an autonomous robot capable of detecting and extinguishing flames, disasters can be avoided with minimal risk to human life [1]

One of the foremost efficient tools for early extinguishment of fire is a fire fighter robot. A new method is used to detect gas and to extinguish the fire. This is considerably needed for all types of industries. In most of the Industries fire sensing is extremely essential to prevent heavy losses.

This particular design is developed using cyber security,which is very helpful in saving Engineers lives working at industrial sites with dangerous conditions.

The robot can be controlled by computer or mobile application through wireless application for safe distance. [2]

The mechanism is intended and made ready to extinguish the fireplace. this can be a totally autonomous mechanism. It examines and leverages the potential of automation in unsafe however necessary occupation as firefighting. Robots are designed to seek out the placement of fireside, before it goes out of management. It may well be wont to work with fireplace fighters to cut back the chance of injury to victims.

The mechanism has its own limitations as mentioned more thanhowever, within the acceptable conditions it operates well with none flaw and snag. It implements the thought like environmental sensing. The mechanism processes data from its sensors and hardware parts. unbearable device are wont to seek out the weather of surroundings fireplace find or sensors or used to detect fireplace**.**

Once the fireplace is detected, mechanisms sounds Associate in Nursing alarm. Then the mechanism activates the Associate in Nursing electronic valve that unleash sprinkles of water on the flame. elaborate thought of mechanism is explained that mechanically detects a fireplace and extinguishes it brieflyby time by the employment of sensors, microcontroller etc. therefore we'll be developing a mechanism which can be used for fireplace fighting purposes. This proposes an excellent probability for automation and can be helpful at places wherever human cannot reach.[3]

This style may be a totally machine-controlled fireplace fighting automaton The automaton is activated by victimization DTMF transmitter and receiver.

The firefighting automaton is integrated with an embedded system model system intended to sight and extinguish fireplace. It aims to scale back pollution caused by the fireplace. The automaton is intended to sight fireplace in tiny plan

The task of extinction fireplace is split into smaller tasks every task is meted out in most acceptable means. The automaton navigates in each area step by step, finds the hearth during a area, approaches fireplace from fastened distance so extinguishes fireplace. [4]

This automaton relies on IOT primarily based fireplace Fighting automation which might crop up in everybody home, each look and malls and alternative common however thronged areas simply with the advancement within the field of mechanical technology,human interruption has subsided and robots are being utilized for varied works and for welfare of beings.

This model is Associate in Nursing IOT primarily based fireplacefighting automaton that detects fire. when being abreast of the authorities will begin visualizing the hearth location and might communicate with folks curst a facility of Associate in Nursing automatic receiver put in. directions will be given to the automaton concerning its movement, turning on its pump or carbon-dioxide pump betting on a fireplace sort through long distances. The hearth sort and carbon-monoxide level is thought victimization the sensors put in that offer a graph to form the analysis.

But conjointly presents addition of higher options that produces it a lot of much usable.

Robots in real time situations wherever acknowledging fireplace sort is vital so as to avoid increasing the fireplace with spilling of the wrong fireplace extinction agent within the method of extinction.[5]

III. MODEL ESTABLISHMENT

After the basic background is briefly introduced, we will formulate a model to describe and analyse the problem. In this problem, the group of fire-fighting robots is required to accomplish the fire extinguishing task together. The goal of this task is that robots (arrows) with the sensors need to put out the fire (red squares) which are distributed in the environments in the presence of obstacle avoidance and non-obstacle avoidance situations respectively.

3.1 PURPOSE OF THE MODEL

In contrast with pure mathematical models, the objective of agent based model is not usually to obtain analytic solutions to specific questions. Therefore, in this paper, we take the robots of artificial intelligence as a prototype, respectively,

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researching the changes of the fire fighting speed under different conditions.

1. When the number of robots is fixed, how does the speed of extinguishing change in different degrees of fire scale and obstacle avoidance.
2. When the allocation number of robots is altered according to the fire situation, that is, the average task for each robot is almost equal, how does the speed of extinguishing change in different fire scales.
3. Because the robot of artificial intelligence is expensive, we need to add the separation rules in order to avoid the collision between robots, and then observe whether the separation rules will affect the speed of fire extinguishing or not.

3.2 STRATEGY DESIGN

In this model, agents may execute various behaviors appropriate for the system they represent. Fire points are distributed in clusters (not randomly or regularly) in the interface like the real world. Robots want to put out fire points. What the best search strategy might be? We design the strategy in the presence of obstacle avoidance and non-obstacle avoidance situations respectively.

I. In the non-obstacle avoidance situation in this case, robots only have one action, that is, research. Because the fire points are distributed in clusters, so when robot meets the red patch on behalf of the fire point in each time executes, the red patch change to yellow to show that it has been putted out, then it turns a small angle and step ahead one patch with a small scale movement to search fire point nearby. When robot meets the black patch on behalf of there is no fire point, it turns a large angle sharply and step forward one patch distance to search fire point in other place.

II.. In the presence of obstacle avoidance situation In this case, besides above strategy we need to add separation rules to avoid collision between robots. Robot has limited sensing radius to find its neighbors. If the distance between the nearest neighbor and itself is smaller than the minimum separation, the robot execute the separate action, that is, turn the max separate angle to different direction respectively. In the presence of obstacle avoidance situation, vision is the distance that each robot can see 360 degrees around it. The separation rules mean that a robot will turn to avoid another robot which gets too close.

IV. HARDWARE IMPLEMENTATION

4.1 ANALYSIS

The main purpose was to create a prototype robot. Wehave made some slight changes in the design andimprovised the code as and when necessary to have theoutput as determined by us. Based on the distance, trials were conducted in the robot. As the distance increases, the ability of the sensors to detect the fire dims. Thus it is best suitable for a plain terrain. Upon further improvisation, this very robot can operate in its capacity in difficult and rough terrain too.

4.2 HARDWARE REQUIREMENTS

I. MATERIALS USED

1. Arduino Uno board
2. IR based Flame Sensors (Three units)
3. (SG90) Servo Motor
4. Motor Driver L293D
5. Robot Chasis of Metal
6. Breadboard
7. DC Motors (Two units)
8. Wheels (Two units)
9. Castor Wheel
10. 12V DC Pump
11. 5V Relay
12. 4V 1.5Ah Lead Acid Battery
13. Switch and Connecting wires
14. Container for keeping Water
15. Silicon pipe for water delivery

In order to get the specified mobility and speed, a four wheeled differential drive robot is employed for this application. Arduino UNO is employed to read the Analog and digital values from the sensors and also to send control signals to the motor controller board. The Arduino UNO generates a PWM signal to regulate a servo motor attached to the bike tire inflator so as to discharge a CO2 this will be achieved by mounting an appropriate servo motor’s arm to regulate the inflator. This unit can then be mounted on the existing differential drive robot. By turning the servo motor, the CO2 are often discharged from the cartridge it's to be noted that a high torque servo motor like HS-5685 should be wont to discharge the C02The flame sensor outputs a digital and an Analog signal. For higher accuracy, we use the ADC on the Arduino to read Analog signals rather than the digital values. The flame detector sensor features a detection angle of 60°, hence three sensors are wont to obtain a detection angle of 180°. The flame sensor operates between the range of 3.3 and 5 Volts. The detection range varies from 20 to 100 cm. And the distance increases with the increase in flame intensity. The output from the Ping))) ultrasonic sensor is employed to work out the space between the robot and therefore the obstacle by interfacing it with the Arduino UNO. This also provides us with sufficient data to not only avoid obstacles but also to take care of a secure distance between the hearth sourcethen extinguish the Fire.

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V. SOFTWARE IMPLEMENTATION

The Arduino UNO is programmed using the Arduino IDE.Once the robot is powered ON, the Arduino will initialize a digital I/O pin as an output so as to send control signals to the Ping))) ultrasonic distance sensor. The ultrasonic sensor returns a pulse whose duration is adequate to the time taken for the ultrasonic pulse to travel from the sensor to the thing and back. This pulse is shipped back to the I/O pin of the sensor. Hence the Arduino digital I/O pin should be made as input in order to read the pulses. The 'pulseIn()' function of the Arduino library provides us the pulse duration on the digital pin. We know that the heart beat duration received is for the wave to propagate from the sensor to the thing and back again. Hence, we divide the pulse duration by 2. In order to calculate the space, we use the speed of sound and therefore the pulse duration.

Once the distance is computed, we can compare it to a pre-set threshold value. The pre-set threshold value may be a safe distance the robot maintains from an object. This value can be obtained from practical testing. If the measured distance is quite the edge the robot continues to maneuver forward. If the measured distance is less, then the servo motor to which the Ping))) ultrasonic sensor is mounted is controlled by sending PWM signals using the 'servoh' library functions. The sensor is moved left to right to live the smallest amount obstacle path. Once that's determined, the robot makes a turn therein direction and continues to maneuver forward.

There are three flame sensors which are mounted on this robot. The analog values from these sensors are read continuously to detect any fire source. Once the flame sensor is detected, by comparing the output analog values of every sensor, the direction of flame are often established. Once the direction is established, the robot is formed to show in small increments for the center sensor to aim at the hearth source. Then the CO2 cartridge is discharged and thus the robot makes a turn and continues to maneuver around the building.

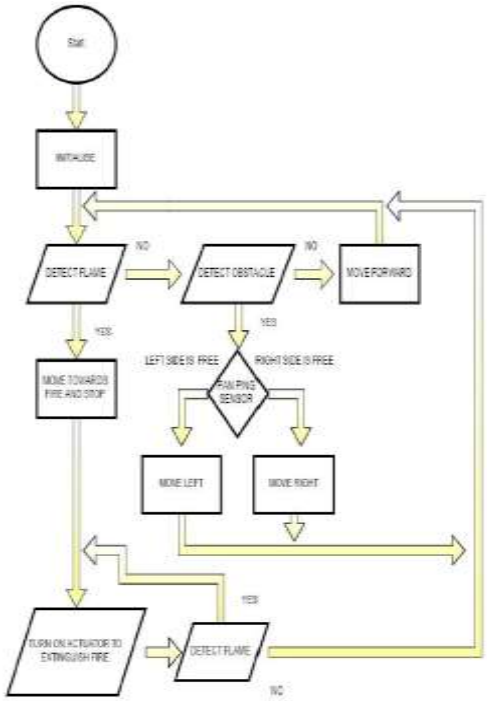

Fig. Program Flow Chart

VI. SIMULATION

The flame sensor is sensitive at the wavelength of 760nm to 1100nm. Hence any source of sunshine therein bandwidth are often used for testing. Considering safety, a daily lighter or a candle are often wont to mimic as a source of the hearth. A candle of suitable dimension are often kept lit during a room, the robot functioning as an obstacle avoidance robot will detect the flame while maneuvering across the space. Once the flame is detected, the robot positions itself facing the flame source and stopping at a secure distance and extinguishes the hearth. It then automatically makes a turn so as to avoid going over the flame source.

VII. RESULTS

The Fire-Fighting robot is capable of detecting the flames and extinguishing them successfully. The motor controller and Arduino code work together to regulate the movement of the robot with obstacle avoidance. It can detect the flame more effectively within the buildings and glued lighting conditions. The robot is meant for the indoor application. Since the ambient daylight varies throughout the day, a dynamic threshold value is important to catch up on the change in ambient light. Use of the high torque servo motor is necessary to discharge the CO2 Cartridge.

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VIII. SCOPE AND LIMITATIONS

This study focuses on creating prototype fire detectingand extinguishing robot. There exists large scope of improvisation by interfacing GSM modules with the G.P.Sto the Arduino UNO board. G.S.M. module will alert thenearest fire station by sending the text through the locationtraced by the G.P.S. The capabilities of flame sensors are limited. The distance limited for water delivery action is up to 50 to 60 cm. Another limitation is the terrain and topography. This prototype is more suitable for residential purposes due to its structure and design.

IX. CONCLUSION

Based on the prototype the objectives were successfully achieved. However the robot has its own limitations asmentioned above. But in the suitable conditions it operateswell without any glitch and snag. After the furtherimprovisations like adding the ultrasonic sensor, gas sensor, led display, smoke sensor, it is possible to use this robot inpractical real time situations.

X. FUTURE SCOPE

IOT are often implemented onto the robot to send an E-mail to the user when the robot detects a flame. More sensors can be mounted, to achieve a 360º view of field. This will reduce the reaction time to the fire source. The addition of a camera to the robot in order to distinguish between ambient sun light orfire source. This will help set a variable threshold for comparing the sensor value to make a decision whether there's a fireplace or not. By adding wheel encoders, we will make the robot maneuver with precision and independent of battery voltage fluctuation. Replacing the 16g canister with a transportable extinguisher would help suppress larger flame source. The motion of the robot can my mode smooth by implementing PID control.

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