

## Fire Fighting Robot using LEGO Mindstorm

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### Abstract

**Background/Objectives:** In this paper a prototype of Fire Fighting Robot (FFR) using LEGO Mindstorm is proposed for disaster management, which has the functionality of quick movement inside a building, detecting obstacles and locating the fire on its way. Simulation of the prototype is accomplished by two modulus Fire detection and message alert. FFR uses the ultrasonic sensor to move around the obstacles and light sensor to find out the fire origin. When the fire is detected it will send messages alert to the people in, building regarding fire disaster and extinguish the fire. Simulation of the robot is tested under various scenarios with different test cases and the result is discussed in result and analysis.

**Conclusion/Application:** The simulation designed is proved to safeguard the human life and property from the fire accident. FFR can be considered as the useful simulation for the real time application.

**Keywords:** Firefighting robot, Lego Mindstorm, ultrasonic and light sensor, NXT programming.

## 1. Introduction

In today's world we live with a technology in various forms, which will help us to speed up work in our daily life. Every system has its own pros and cons. There are many industries working with chemicals such as acetone, potassium permanganate, sulfuric acid and machinery such as computer, sewing machine. It may lead to fire accidents in terms of wire short circuit, sudden loss of power and bad contact of chemicals it may cause loss of life and property. At present humans are employed to save life and property of others in such fire accidents by risking their own life. Robots are the interesting and intelligent invention of the human where now a days it is being used for many purpose in variety of fields. Robot that is made will save the life and property of people from the major fire accidents automatically without any human interaction.

Lego Mindstorm [1][3][5][7] contains software and hardware that helps to create customized, programmable robots. The hardware part includes an intelligent brick computer that controls the system and is considered the brain of the system, a set of modular sensors like ultrasonic, touch, light, heat and color and motors(A,B,C).The best part of using Lego Mindstorm[8,9 10] is that ,it's easy to model and code. The programs [2][4][6] are downloaded into the NXT brick using USB or through Bluetooth settings present in the NXT brick.

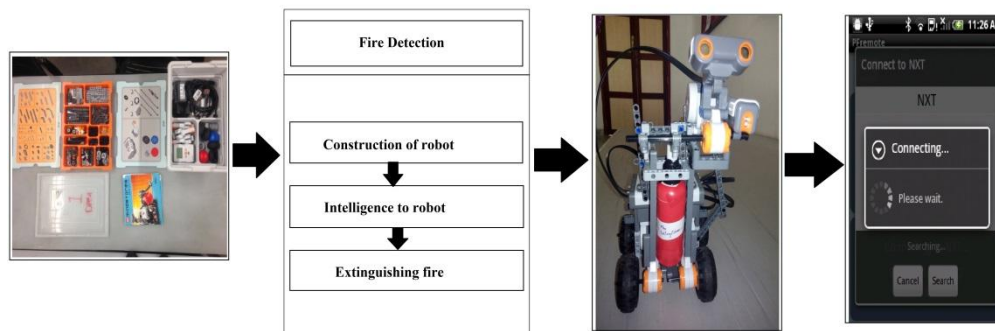
In this paper we propose of simulating a Fire Fighting Robot (FFR), which will move around the building for detecting fire with the help of sensors such as ultrasonic and light sensor. The sensors play an important role in simulation of the robot. The two sensors used are ultrasonic and light sensor. The ultrasonic sensor is responsible of detecting obstacles and the light sensor detects the light variations of the fire. When the fire is detected it will send message to the people in the building and start to move around to reach the fire origin and extinguish the fire. In case if the fire is large and cannot be controlled by the FFR then the message will be sent to the fire department server asking for help.

## 2. PROPOSED WORK

In this paper we propose the simulation of Fire Fighting Robot (FFR), which consists two phases, fire detection and message sending. With the accomplishment of the two phases, FFR is capable of maneuverer effectively through a multiple rooms in floor plan. FFR will have standalone control without any connections which will be easy for mobility through the building. FFR is designed like a vehicle with wheels and sensors. FFR will sense the fire send message to the people in the building and extinguish the fire.

### 2.1 Fire Detection

The proposed prototype of FFR will detect the fire by completing modules such as construction of robot, intelligence to robot and extinguishing fire as described in Fig 1.

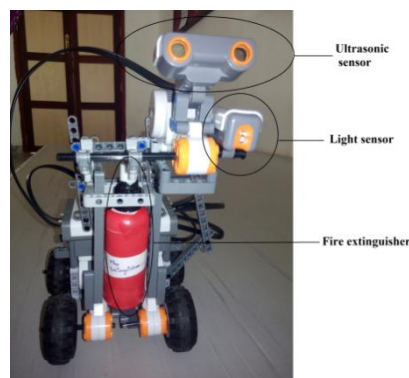


**Fig 1 . Architecture diagram of robot FFR**

**2.1.a Construction of robot**

LEGO Mindstorm kit is used for the construction of the robot. It is a programmable robotics kit. It is called as Robotics Invention System. It comes with the NXT-G programming software. The main component in the kit is a brick-shaped computer called the NXT Intelligent brick. It can take input from up to four sensors and control up to three motors. The other parts such as connectors, beams, wheels etc. are components of kit. The final constructed model is presented in Fig 1.a.

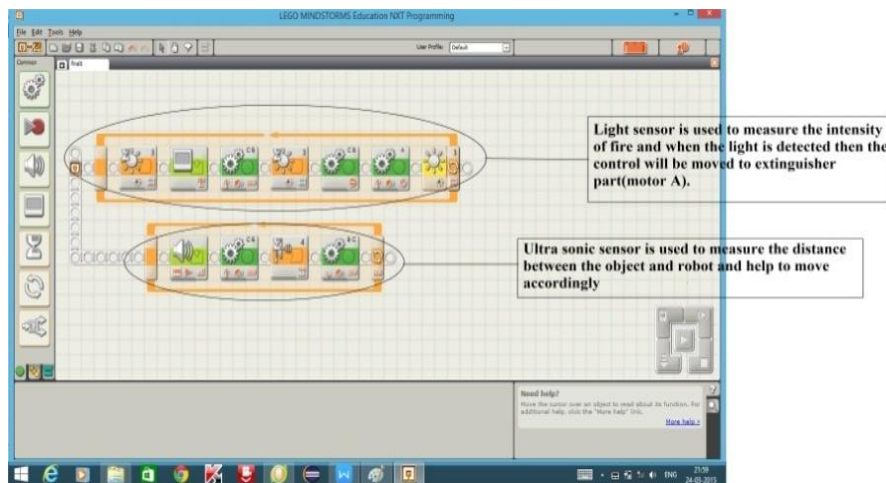
FFR is constructed like a vehicle with four wheels, three motors and two sensors. Two wheels were placed in front and connected to the motor whereas other two wheels were placed at the backside for the easy movement and rotations where wheels are controlled by motor A and B. Ultrasonic sensor is placed at the top, it will measure the distance between the robot and the object by reflecting back the light intensity. Light sensor is placed at the side and used to find the fire source. FFR will carry a pint/ spray which will contain Co2 will be controlled by motor A in it to extinguish the fire before spreading further.



**Fig 1.a Construction of FFR**

### 2.1.b. Intelligence to robot

Lego Mindstorm provides software named NXT which is used to program the NXT brick. NXT software is used to program the FFR. When there is a fire accident in the building FFR will detect the fire, message will be sent to owner of the building and alert people in building with alarm sound. FFR will measure the distance between object and stop when distance is less the 10 cm it will stop and turn left or right. When the fire is at less than 5 cm FFR will pass the control to motor A where the extinguisher will be operated in 60 degree rotation to press the nozzle of Co2 spray to blow out the flame.



**Fig 1.b Intelligence to FFR**

### 2.1.c Extinguishing Fire

Carbon dioxide extinguishes fire by attacking fire triangle, when CO<sub>2</sub> is sprinkled on fire zone it will displace the sufficient oxygen in the atmosphere to extinguish the open burning and CO<sub>2</sub> is a cool substance which will automatically cool down the fuel or object on which fire is caught. When the fire is detected then motor A will rotate 45 degree to give pressure to the nozzle of the extinguisher to put off the fire.



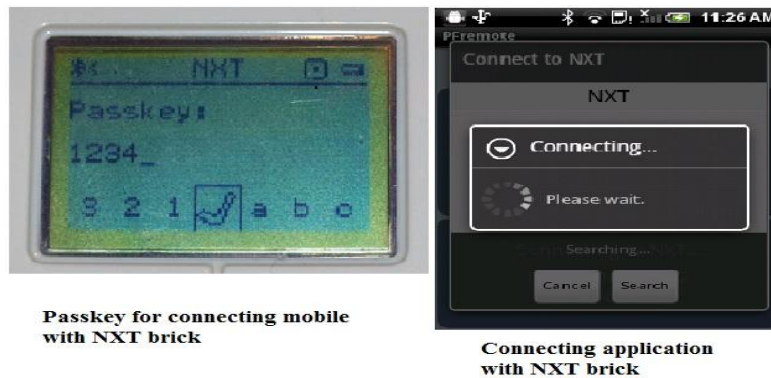
**Fig 1.c Extinguisher contains Co2**

## 2.2 Message Alert

When the fire is detected FFR will send message to the owner's mobile phone. Message can be sent using Bluetooth connection and as we know it is not reliable for longer distance. Android application is created for the communication of robot to mobile phone.

Steps to connect mobile with NXT brick

1. NXT brick has to be configured with the mobile phone using Bluetooth for connection. Turn on Lego NXT brick - press side arrow - click on Bluetooth - turn on visibility - search for mobile device - enter the passkey shown in NXT brick - press connect to add the mobile number into my contact.
2. Create an android application to connect mobile with NXT brick using eclipse.
3. Install app in the mobile phone which supports android application.
4. Then the NXT brick can be connected mobile application by searching.



**Fig 1.2 Message sending from NXT brick to mobile phone**

## ALGORITHM

### **Step 1:**

*Input: Fire intensity greater than certain degree*

*Output: will move around and shut down fire*

### **Step 2:**

*Lego mindstorm is used to create Fire Fighting Robot.*

### **Step 3:**

*FFR is programmed using NXT technology. It consist of different modules*

*A) Detecting the candle light using the light sensor*

*If light < 10 cm*

*SendMsg*

*B) Sending message*

*When fire = on*

*Then SendMsg("fire alert")*  
*PlayTone("watch out")*  
*C) Avoid obstacles using the Ultra sonic sensor while driving*  
*If dist < 5 cm*  
*Move left or right*  
*If fire (10) = stop*  
*D) Extinguish fire*  
*If fire dist = < 5cm*  
*Extinguisher = motor A turn 100 degree*  
**Step 4:**  
*FFR will shut down the fire and move to the starting place.*  
**Step 5:**  
*FFR will move back to the starting place.*

### 3. RESULT ANALYSIS

Simulation of robot is tested in three different conditions

#### 3.1) Case 1: No fire



**Fig 3.No fire is detected**

In case where there is no fire in area of the robot, light sensor will not measure any value ranges greater than 50 degree hence FFR will stay static in its position.

**3.2) Case2: Fire along its path with no obstacles**



**Fig 3.1.a Fire detected**



**Fig 3.1.b Fire extinguished**

In this case if FFR detect the value of light ranges from 50 to 100 degree then it will go to the fire origin, send fire alert message to the people in the area and extinguish the fire.

**3.3) Case 3: Fire along its path with obstacles**

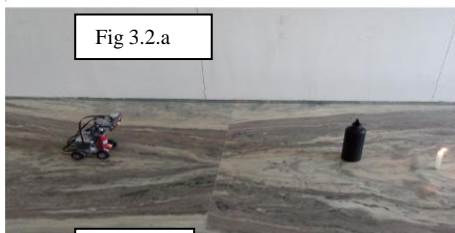


Fig 3.2.a

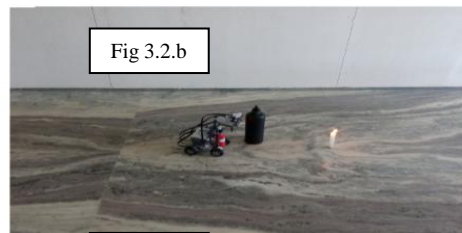


Fig 3.2.b

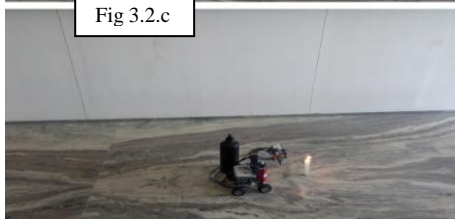


Fig 3.2.c

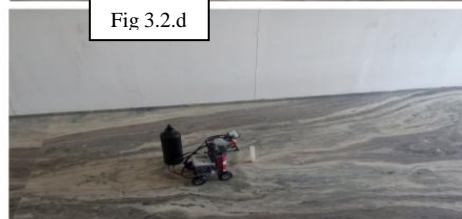
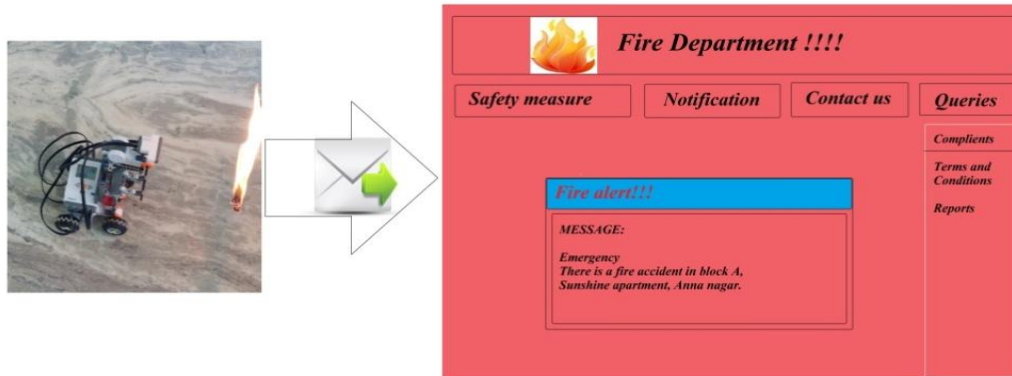


Fig 3.2.d

**Fig 3.2 Sequence of actions when fire is detected with obstacles**

In this case FFR will detect the object in the front using ultrasonic sensor and when range of light goes beyond 50 degree it will call the extinguishing function. Motor B and C will stop the robot whereas motor A will be operated automatically to extinguish the fire.

### 3.4) Case 4: Fire is large and cannot control by robot



**Fig 3.3 When large fire is detected**

In case if the light sensor in FFR senses the light range greater than 200 degree it will send message to the fire department in that area and move away from the fire and return to the starting place.

## CONCLUSION

The simulation designed is proved to safeguard the human life and property from the fire accident. Hence it is a simulation we have used candle bed to test it. FFR can be considered as the useful simulation for the real time application. Thus the project can be enhanced in such a way to reach the fire origin easily by storing the floor plan in the NXT brick and heat sensor can be used for the exact measurement of heat intensity. Hence FFR is the prototype it will face problem in moving through the staircase. If there is a fire accident in a closed area where many buildings are nearby then FFR can be placed in one building can communicate by sending message regarding fire accident to the FFR placed in other buildings.

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