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Design and Development of Fire Extinguisher Action Robot (F.E.A.R.)

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Abstract: **The aim of this paper is to discuss the design and prototyping of a reconnaissance type fireproof rescue robot (codename F.E.A.R.) for detecting and extinguishing fire. In recent years there has been a surge in usage of Unmanned Ground Vehicle (UGV) technology, but even with current technological advances, very few platforms have been created that aim to provide RC robots that can be inserted into high risk areas at a low cost for extended periods of time. The robot is designed and fabricated to enter the core region of fire, extinguish it and provide a live feed from incident area by using a camera to increase knowledge about fire behaviour. This will reduce the risk of injury and number of casualties for firefighters as well as for possible victims. The robot also decreases the monetary losses which increases considerably as fire duration increases. The user can achieve controllable motion by a suitable tethered, ground based remote control interface to control a multi-purpose robot that can be used in extreme terrain, and can douse different classes of fires. The prototype robot is maneuvered with the help of four geared motors each attached to one wheel and its movement will be controlled using Bluetooth remote control, where the transmitter will be a smart phone.**

Keywords*: *Bluetooth Controlled Robot, Fire-fighting robot, Geared and Servo Motor, Creo, ANSYS.

I. INTRODUCTION

There are basically four components that are required to start and sustain a fire and/or flame. They consist of fuel, heat and oxygen, which together undergo a chemical reaction to form fire. By taking away any of these four elements, a fire can be extinguished. The F.E.A.R. prototype is designed such a way that it can carry up to 1.5 litres of an Extinguishing Agent (EA) in a closed chamber.

With the help of mini-pump the extinguishing agent is sprayed precisely from the nozzle which creates a mist at the target location. This reduces the amount of extinguishing agent required to douse the flame which decreases the time required [1]. It is also outfitted with a camera to provide live feedback of the affected area to the operator. F.E.A.R. will automate dangerous tasks of fire-fighters, allowing them to focus more on saving victims.

CLASSES OF FIRES	TYPES OF FIRES	PICTURE SYMBOL
A	Wood, paper, cloth, trash & other ordinary materials.	
B	Gasoline, oil, paint and other flammable liquids.	
C	May be used on fires involving live electrical equipment without danger to the operator.	
D	Combustible metals and combustible metal alloys.	
K	Cooking media (Vegetable or Animal Oils and Fats)	

Fig 1. Classification of fires

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II. OBJECTIVES

Since the robots available in the market are currently limited by their high initial and maintenance cost, an alternative low-cost product is necessary.

With the view of the above scenario, the current work focuses on the research and development of a robot spraying platform powered by four motorized wheels. Remote operation of the robot platform is achieved by the user through a suitable interface. Our objectives are as follows:

- To perform reconnaissance duties and thereby reduce the workload of a manual firefighter.
- To transverse areas that cannot be easily accessed manually.
- The robot can directly enter into the area of the source of a domestic fire burning at an approximate temperature of 800°C (107K).
- The robot can be used to analyse the spread of the fire as it can stay is the region of fire for a prolonged period of time.

III. CAD MODELLING

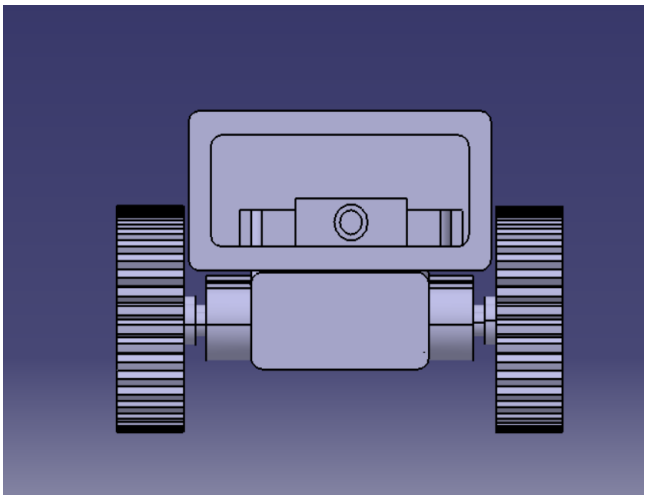

Fig 2. Front view of robot

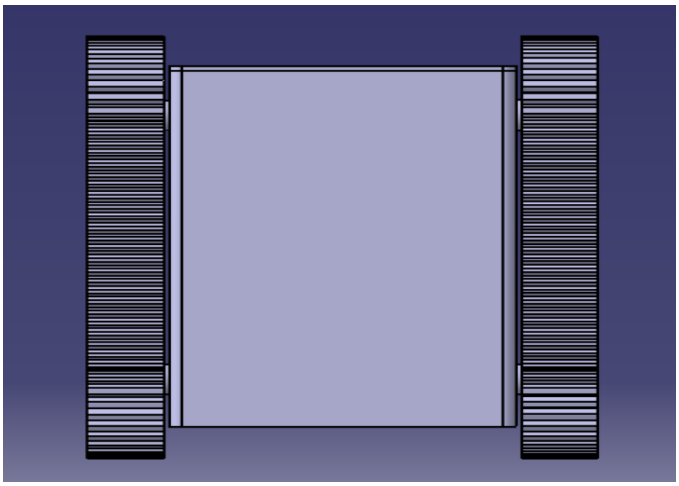

Fig 4. Top view of robot

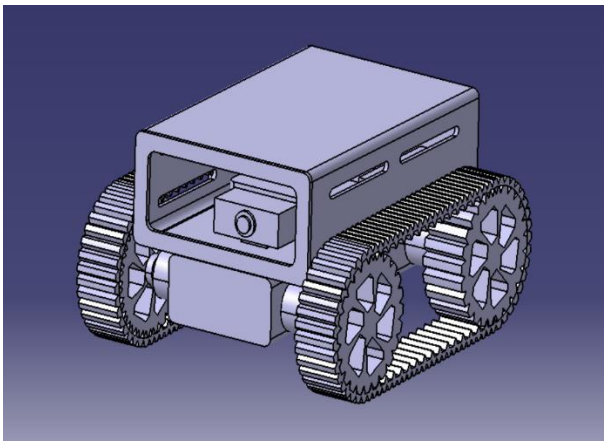

Fig 3: Isometric view of robot

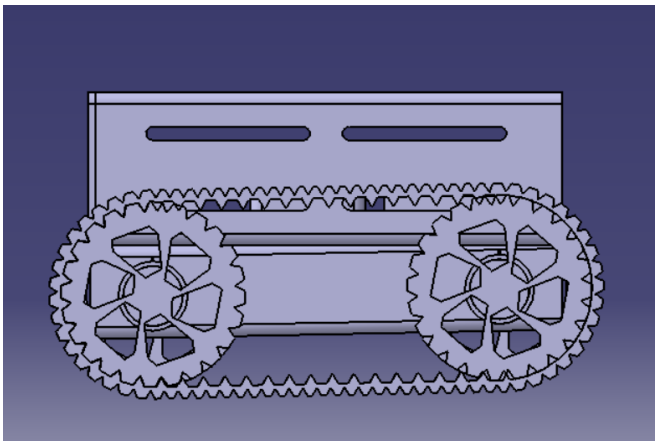

Fig 5. Side view of robot

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IV. SYSTEM OVERVIEW

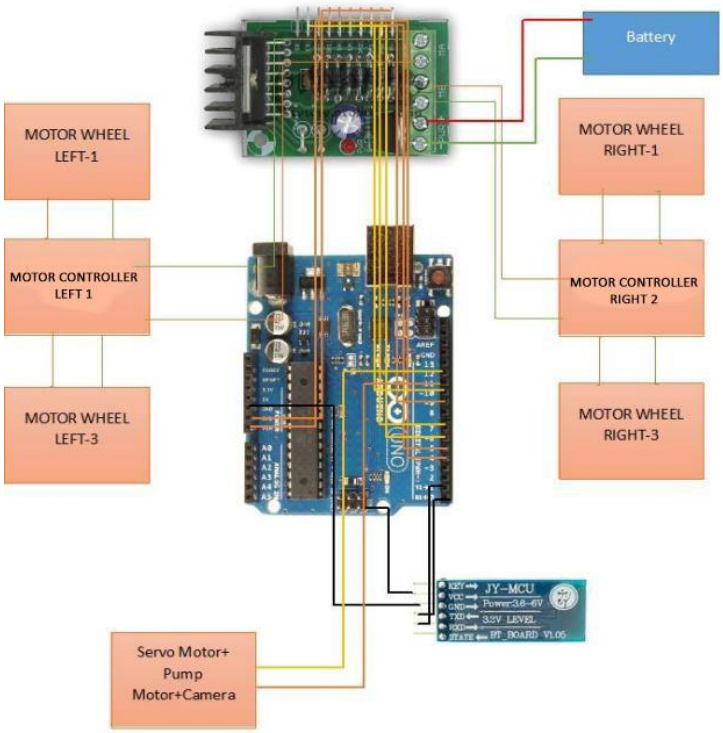

Fig 6. System overview

From the proposed system overview given in Fig. 5, we can see that the robot is controlled by a smartphone running on an Android application. The robot's control unit is developed using Arduino UNO controller. It is equipped with a camera, a Bluetooth receiver, two servo motor (for controlling the direction of spraying), one pump motor (to spray the pesticide), a Li-ion battery, three 2-channel relay boards, LED lights, an active cooling system and four 12V 30RPM DC motors. Each one of the first two relay boards commands the movement and direction of the robot while the third controls the spraying of EA along with lighting. The Arduino solves the data received from the Bluetooth module sent by the android phone application. The Android operating system has an application which allows the mobile's inbuilt gyroscopic sensor to control the movement in four directions (forward, backward, left and right) as instructed by the user, hence rotating the mobile phone in any particular directions results into the corresponding propulsion of the robot There is also an option present within the for only direction control using arrows on the android application. The directional control commands are communicated to the robot through Bluetooth (BT) communication via the BT module. Some characteristics of the Arduino board are:

1. Digital I/O pins: These are numbers 0-13 on the Arduino board and is used to take input and output based on the software flashed and returns a 0 or 1 that is low or high signals

2. Analog Input signal: These are numbered (A0- to A5) and are used to scan for analog signals from the sensors.

3. 3. AT mega 328: Arduino are built on the ATMEL's AT Mega 328 microcontroller.

This prevents overheating of electronics and system failure. The outer casing for the robot is made out of Mild Steel which is known to have a melting point in the range of 1350°C to 1530°C. The robot is fireproofed using a ceramic fibre blanket which is able to withstand temperatures in excess of 800°C, and reduces the temperature to around 100°C to 150°C. The ceramic blanket is sandwiched between the Mild steel plate and a Mylar sheet that acts as a final defence barrier against the heat. Mylar, is also known as BoPET (Biaxially-oriented polyethylene terephthalate) is a polymer film and acts as an insulating material which further decrease the temperature to around 30°C, which is the optimal temperature for electronics. These materials provide passive cooling that allows the robot to operate at a relatively cooler temperature compared to surroundings. Since the internal electronics generate heat during operation, an Active Cooling System (ACS) is provided which cools down the temperature to well below 15°C while venting out hot gases though the rear vents that might have leaked in. The ACS can work automatically or manually through the app, by taking real time temperature measurements using a thermocouple present within the robot.

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V. APPLICATION

1. The android application that is used for controlling this Robot is “Bluetooth RC” and is available on the Play Store.

2. The application connects to the HC-05 Bluetooth module in the car and controlled either by the directional keys or the gyroscopic method.

Fig 7. Controlling using Directional Keys

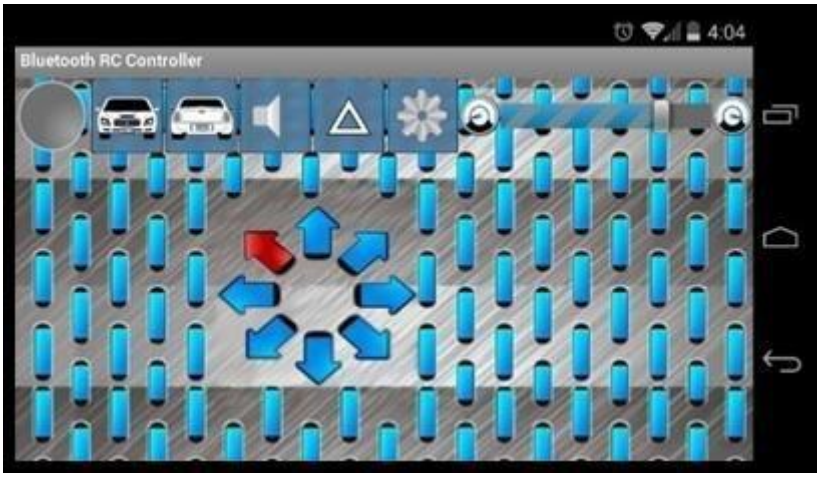

Fig 8. Controlling using gyroscopic method

VI. CONCLUSION

This paper has presented a unique vision of the concepts which are used in this particular field. As we can see, using an integrated system provides us with better product as it reduces weight and improves efficiency. It also provides greater flexibility to the robot and the user as a digital platform is used. Currently the robot is only able to extinguish class A fires but further work might provide us with a robot that can handle all classes of fires by employing a variety of techniques. In the near future, these robots may also be embedded with artificial intelligence technology which could help extinguish fires faster by running simulations and choosing the best method of action. Better materials maybe available that could help to decrease the weight and size of the robot whilst also withstanding higher temperatures and allowing to be used in more extreme environments.

Although we have tried to achieve most of the proposed framework and vision, a deeper and clearer understanding along with better R&D is required to fully visualize and implement through collaboration with various entities.

VII. ACKNOWLEDGMENT

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