

Gesture Controlled Fire Extinguishing Equipment

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Abstract- Robots are usually used to speed up the process, accuracy and places where humans are liable to injury or loss of life. Firefighting is one such profession where fire fighters are more vulnerable to injury or loss of life. Everyday firemen fight with fire risking their lives. Considering this fact we planned to do a project on firefighting bots which can aid the fire fighters during their rescue or firefighting operation. Gesture controlled fire extinguisher project employs the gesture control technology to put off fire in confined and hazardous environment where firemen can't enter. The robot has a a lilypad arduino for controlling the actuation of the wheels, fire extinguisher and its hose direction. The wireless control is controlled by the user at a considerable distance from the target. A Bluetooth camera is used to locate the fire through a display carried by the controller. The robot is capable of transmitting the signals. It is sure that it would be of a great support for the fire fighters. It can reduce the number of fire fighter accidents to a greater extent. To work in automatic mode, we have used image processing technology that can detect the fire itself and extinguish fire without human assistance.

Keywords- Wireless Gesture Control Technology, Dry powder fire extinguisher, Bluetooth camera, Arduino, DC motor, Encoder and Decoder and RF module, and image processing

I. INTRODUCTION

Robotics has a greater contribution in most of developing technologies. Robots have replaced humans to extensively and are highly efficient for hazardous applications like fighting fire. Robots can be adopted for such hazardous tasks thereby saving many human lives. This problem has given thirst in order to protect firemen from greater risks of fire in confined areas. We have come up with the idea of designing a hand gesture controlled firefighting robot so as to serve this purpose. Everybody the fire firemen death rate is getting increased because of the increase in risks in industries using hazardous chemicals. They need a more secured way of extinguishing the fire to decrease the casualties. This robot is coated with a fire resistant coating which can handle high temperatures. The wireless interfacing of the robot helps to control it from a considerable distance. The transmission system has a lilypad arduino and an accelerometer to sense the

gestures and send the signals accordingly to the receiver through RF module. It comprises of a three axis movement mechanism to control the direction of the fire extinguisher hose.

II. EXPERIMENTAL PROCEDURE

A. METHODOLOGY:

The robot is controlled manually by hand gestures using a lilypad arduino and accelerometer. The location of the robot is identified using a wireless camera fixed in the front of the robot by the controller. The fire extinguisher is actuated by a high torque motor and the wheels are operated by the 200rpm DC gear motors. The hose targeting position is controlled by a low rpm gear motor.

B. COMPONENTS:

1. Accelerometer:

An analog accelerometer is used in the robot that can measure 3 orthogonal axis of motion. The 3 axis accelerometer consists of three accelerometers mounted on one block. It works with 5volt DC supply and 30mA current. It detects the pitching motion of hand carrying the receiver and sends the analog input to the lilypad arduino. Four motions are detected by the accelerometer -forward, backward and turning towards left and right.

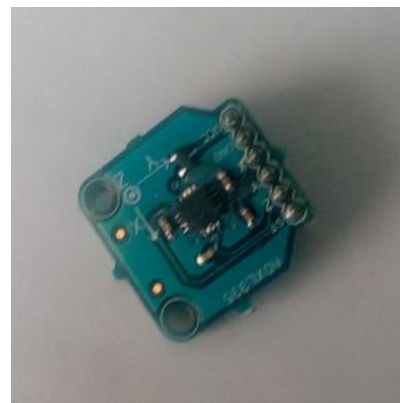


Fig 1: Accelerometer

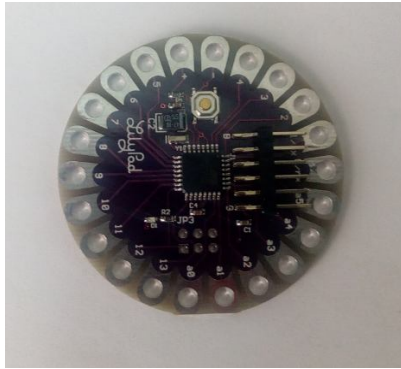


Fig 2: Lilypad arduino

2. Lilypad arduino:

It is the controlling unit to which all main components such as accelerometer, encoder, RF modules are interfaced. It offers a handy control in a light weight round package design. It can be powered by an external power supply between 2.7-5.5V. It is programmed with Arduino software (IDE). It has 14 digital I/O pins and 6 analog input channels with a clock speed of 8MHz.

3. DC gear motor:

It has steel gears and pinions to ensure longer life, better wear and tear properties. The output shaft rotates in a plastic bushing. The motor is screwed to gear box from inside. Motor runs smoothly from 4V-12V. It gives wide range of speed of rpm and torque. The relationship between torque vs. speed and current is linear; as the load on the motor increases, speed will decrease. Load torque can be determined by measuring the current drawn when the motor is attached to a machine whose actual load value is known. Here 12V DC motor is used and expected speed is 150rpm.

4. High torque motor:

A high torque gear motor is used for the actuation of the fire extinguisher handle since a higher force is required for operating the fire extinguisher. It has a base motor of 18000rpm and can achieve a maximum torque of 21kgcm at 12V input. Maximum load current is up to 7.5A while no load current is 800mA.

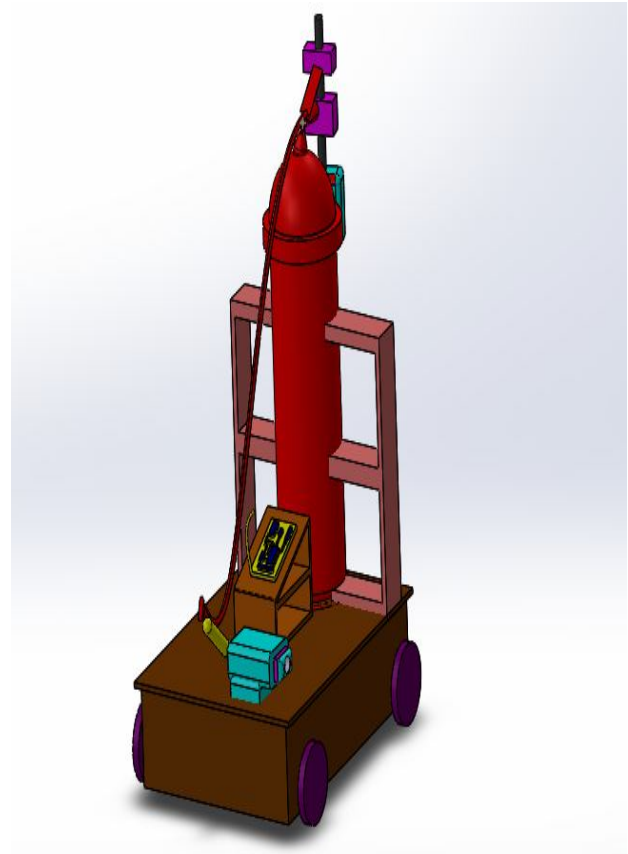


Fig 3: Solidworks model of firefighting equipment

5. RF module:

Wireless communication is all about transmission of data wirelessly so that there is no hassle of any wires and no direct contact with device itself. RF module comprises of a transmitter and a receiver that operates at a radio frequency range, usually it operates at 315MHz. The RF transmitter has 4pins-Vcc, Gnd, Data and antenna. Vcc is connected to 5V and Gnd to ground respectively. The data pin is connected to any of the digital I/O pin of the lilypad arduino through an encoder. The receiver part consists of a 315MHz receiver module. It has 8pins: 2Vcc, 3Gnd, 2DATA and an antenna. DATA pin is connected to decoder HT12D that decodes the signals received by the RF receiver module.

6. ENCODER AND DECODER:

HT12E (Encoder) and HT12D (Decoder) are used for encoding and decoding respectively in this project. HT12E is a 2¹² series encoder IC for remote control applications especially in RF transmission. These encoder and decoder can transmit and receive 12 bits of parallel data serially. It includes 8 Address bits and 4 Data bits. A0-A7 are the input address pins. Using these pins we provide a security code for the data.

D8-D11 are the inbuilt metal gears for building up the torque required at the output shaft.

C.Architecture:

(i)Hand Gesture unit:

This includes accelerometer, lilypad arduino, HT12E and RF transmitter. This unit acts as the controlling unit accessed by the hand gesture signals created by the fireman. The entire hand gesture unit is mounted on a hand gloves worn by the controller .The hand gestures unit is mounted on a hand gloves worn by the controller .The hand gesture signals are recognized by the accelerometer and the data is sent to a lilypad arduino followed by HT12E encoder that encodes and sends the radio frequency through a RF transmitter connected to load of 20N.Four motor combined together has capacity to carry 80N of weight.

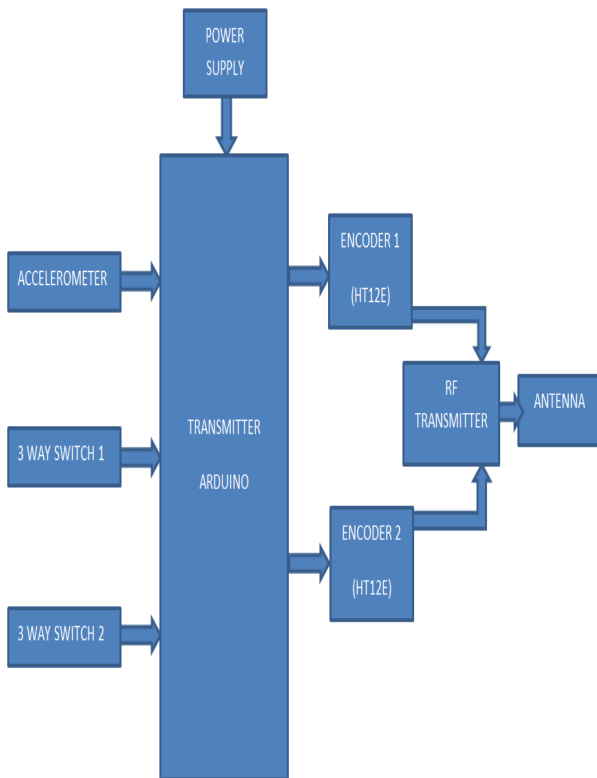


Fig 4: Systematic Architecture of transmitter circuit

ii) Receiver unit:

It comprises of a HT12D decoder, motor drives, RF receivers with a 12v power supply. The signal from transmitter in radio frequency is received by the RF receiver and this signal is decoded by Ht12D. These analog signals are sent to respective motors through motor drives .A regulator is

used to reduce the voltage for RF module ,decoder to 5v.The HT12d receives 12 bits of parallel data serially that includes 8 address bits and 4 data bits and decodes them for further processing.

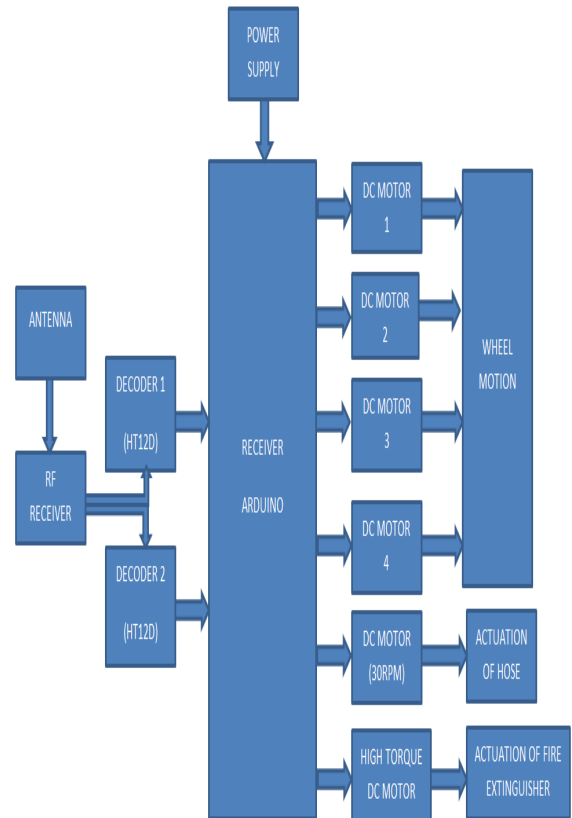


Fig 5: Systematic Architecture of receiver circuit

iii) Wheel actuation unit:

Four 200 rpm DC gear motors are used for actuation of the wheels. A 12v battery supply is given for these motors through a motor drive. The four primary motions that are involved in the robot movement are forward, backward motion and left, right turning motions. The signals for these motions are obtained from the respective hand gestures. Each motor has a capacity to pull a input data pins. These pins are connected to VSS for sending LOW or HIGH respectively .HT12E starts a 4 word transmission enable signals on TE input .when TE signal switches to HIGH, the encoder output completes the current cycle and stops. The remote gives approximately 150 meter coverage.

iv) Fire extinguisher actuation unit :

High torque motor of 30rpm and a DC gear motor of 30rpm to actuate the fire extinguisher handle and the hose respectively. Since very high force is required to actuate fire

extinguisher high torque motor is used to get signals from their motor drive. Signals for the actuation are given 2 way switches operated by the controller. A pulley and rope mechanism is used to pull the handle of the fire extinguisher. A link is connected with the DC gear motor has the fire extinguisher hose mounted on it. The rotation of this link provides up and down movement of hose. It facilitates the ease of fire extinguisher operation.

D. Calculations:

1. Reaction force due to friction:

$$\begin{aligned} R &= W/4 \\ &= 8/4 \\ &= 2\text{kg} \\ &= 19.6\text{N}. \end{aligned}$$

2. Friction force:

$F = 0.4R$ (source: Serway, Raymond A. and Robert J. Beichner. *Physics for Scientists and Engineers with Modern Physics 5th edition*. New York: Saunders, 133.)

$$\begin{aligned} \Sigma F &= ma = 0.4R \\ F &= 7.84\text{N} \end{aligned}$$

3. Torque = $F \times r$

$$\begin{aligned} &= 7.84 \times 0.035 \\ &= 0.55\text{Nm (per motor)}. \end{aligned}$$

E. Applications:

The firefighting robot can be used in places which are more likeable to catch fire often. In those cases these robots can be used so that there won't be a need for manual fire extinguishing every time. It can also be used to extinguish fire in a more confined areas and some poisonous gas leaked areas. These are the cases where our firefighting robot becomes handy and purposeful.

F. Upcoming trends:

The upcoming trends are extinguishing of fire using flying drones which are otherwise called as quad copters. They carry fire extinguishers or water pipes near the burning flames and puts them off. The other one is the high temperature detecting sensor extinguishing robot. These robots immediately reaches the place where the temperature is high and extinguishes fire.

G. Conclusion:

Our firefighting equipment will be of a great support for the fire fighters during their firefighting and rescue

operation. It thus helps to decrease the casualties during the fire extinguishing process in the hazardous areas. It increases the confidence among the firemen during rescue missions to work safely and thus extinguishing the fire in more effective manner.

III. ACKNOWLEDGEMENT

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