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RF Control Based Mobile Robotic System for Search Mission with GPS Tracker

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Abstract

Background/Objectives: Robot can do a work with ease, which seems to be impossible for a man and it becomes more helpful if one can control it remotely. **Methods/Statistical Analysis:**The concept of employing a robotic system for search mission has been proposed for searching of survivors in case of natural disaster like earthquake, hurricane, tsunami and it can also be used as a GPS tracking device as it also has inbuilt GPS device which can give the exact current location of the robot. **Findings:** There are certain features of the robotic system which makes a complete and versatile system for search mission like it can be controlled wirelessly using RF technique which is considered to be the best with respect to range and interference, this system can also sense the environment with the help of different sensors, it has inbuilt camera which can send the live videos wirelessly to remote device, GPS is also attached with the system which can send the current location to remote device at any point of the time. **Conclusion/Improvements:** All these features make this robotic system capable of doing things which seems very difficult for the human.

Keywords: Android Devices, ISM Band, RF Communication, Ultrasonic Sensor, Zig Bee Communication

1. Introduction

Robots have become a vital part of the society Mobile robots have a great potential and can be used in variety of applications like exploring the dangerous areas, driving assistance for disabled and it is also used in industries for performing task with greater Ongoing research and development of mobile robots draws the interest of researchers in the areas like medical field where they are used to assist in surgery, Unnamed Aerial Vehicles (UAV), military applications, bomb disposal and many more numerous applications.

Autonomous robots is considered to be more intelligent and can able to take the self-decision based on the environment, most of the robots are autonomous to some extent and has the feature like it can switch on the light in case of darkness, able to detect the obstacle and move accordingly by designing the map and navigate itself, can send the data to remote device if it crosses a particular threshold value. The main advantage of using autonomous robot is that the task can be accomplished by the robot without human interaction so in the meantime one can handle the emergency situation and robot will send the data when needed so no need to continuously monitor the situation, robot will handle the situation in much better way than a human cannow a day smart phone is also using in research because of the availability and the inbuilt sensors like orientation sensor, acceleration sensor, and gyroscopic sensor and ultrasonic sensor. Jognil Lim and SeokJu Lee proposed a strategy where smart phone in built sensor and ultrasonic sensor is used to steer the robot in enclosed environment, the main purpose of smart phone is to calculate the rotation angle and finally result shows that orientation sensor of smart phone gives better performance than encoder[3]. One has to admit that Smart phone is penetrating deep into the individual's life and it is estimated that by 2016 the number of smart phone user will exceed 2 billion and till 2018[4], half of the phone user will have smart phone.

Mainly robot comes in picture in case of emergency situations only, one important reason behind that is the cost for buying and maintaining the system but that cost

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is nothing as compared to its usefulness like it is relatively cheap to buy drones instead of helicopter for a specific task. Cost can be easily justified if the bot can able to prove its versatility. There are various wireless technologies available which can be used to control the robot but out of all these technologies, RF serves the purpose as it has higher range, can penetrate the walls, no line of sight required and also have less interference than others. In[5] proposed a remote device controlling robot using RF technology; it gives command from laptop to controller. It also has a camera unit which is used for tracking and image can be seen on laptop using window media encoder and the sole purpose of the robot is to explore the places where human cannot reach.

There are lot of situations where robot can handle the situation in better way like in case of any natural disaster many people lost their lives by falling of skyscrapers and many people trapped inside the buildings so human cannot manually search for survivors due to the surrounding like leakage of some gases, temperature condition and many more so in that case robot plays an important role it can penetrate all the difficulties very easily and can show the live scenario of building and can send the current latitude and longitude of the victims which are trapped inside the building. In [6] proposed low cost system based on GPS signal coming from GPS shield attached with arduino, this method is useful for getting the live traffic information and it seems that this method is more accurate than the conventional[6].

2. System Architecture

Figure 1 shows the overview of complete system with different input and output modules which are present in the system and how it is connected to the brain of the system and show interdependency on each other. The heart of the robot is the base unit which is solely responsible for every action of the robot. The base units are arduino UNO[7] and MEGA 2560. The eyes and ear of the robot are sensors which sense the environment and take suitable action according to the pre defined instructions. There are two types of communication modules used; they are RF module and Zigbee module. Zigbee module is use to transmit back the data from receiver unit to control room like the GPS co-ordinates, Temperature sensor reading. The problem with transmitting the data back to the control room via RF is that some signals are delayed while communicate with full duplex communication with the RF system and also it creates lots of interference while transmitting and receiving simultaneously, so to avoid these situations Zigbee module is used as another source of transmitting the data back to the control room wirelessly.

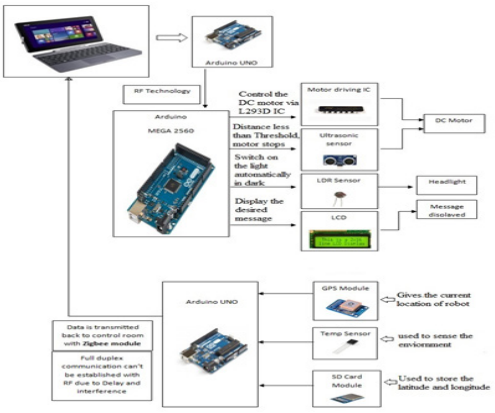

Figure 1. System architecture.

Arduino MEGA takes the command from control room via RF module and control the different unit. There are different sensors which are attached to MEGA like ultrasonic sensor LCD Module, LDR sensor and DC motor via L293D. ultrasonic sensor also controls the output of GPS, when ultrasonic sensor detect any motion then only it fetches the current co-ordinates from the satellites and send it to the control room, and also it can sense the temperature with the help of temperature sensor and send the temperature to the control room so that the control room can able to know the exact situation inside the building and plan the rescue team accordingly, it also has SD card attached, the purpose of using the SD card is to save the latitude and longitudes of the robot for the future use so later on if anyone wants to track the path of the robot which it follows can easily track with the help of the co-ordinates stored in SD card.

2.1 Controlling Mechanism

The mechanism which is used for controlling the robot is RF technology, RF module is the most popular and frequently used electronic circuit which is used to transmit or receive the radio signals[8] and has numerous advantages:-

- Line of sight is not required for communication which is one of the critical features in case of the search mis-

sion because it is impossible to maintain the line of sight between the robot and the control room so RF technology best fits the situation.

- The communication which occurs between the transmitter and receiver is at ISM band, than main advantage of using the ISM band is that one need not to take permission from the government, anyone can transmit in that band. There are different frequencies on which RF module works like 434 MHz, 315 MHz, 915 MHz
- Range plays a major role in any wireless technology, it is the distance where data can be received successfully by the receiver without any interference, RF provides the best range among the different technologies around 1 Km.
- The system do not get affected by any other RF devices present nearby hence provides a better range of communication.

2.2 Display Unit

Figure 2 shows the complete flow of display section from transmitter to receiver unit, It is the unique feature which is not present in the other robot which is designed for the search mission, in this research the 16x2 LCD is mounted on the top of the robot and it has the capability to show 16 characters at a time, the purpose of using the LCD in this research is that if the control room wants to transmit any message to the victims so it can transmit via the LCD because it might be possible that the mobile phone and other communicating device may not work so at that time this concept is very useful for sending any information about the neighbor areas or the situation inside the building so that the victim which are trapped inside the building can take the right action and can save their lives.

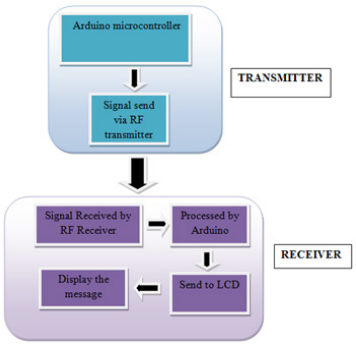

Figure 2. Flow of displaying the desired message.

2.3 Locomotion of the Robotic System

The Locomotion of the robot is accomplished by the combination of the Base unit, motor driving IC (L293D) and DC motor. Here, Locomotion refers to the process that robot carries to transport themselves from one place to another. Figure 3 shows the overall flow of the signal from the control room to the movement of the robot. The command is sent by the control room to the robotic system which processes the information and controls the different units according to the input like movement of the robot which is accomplished by sending a high pulse to motor via motor driving IC.

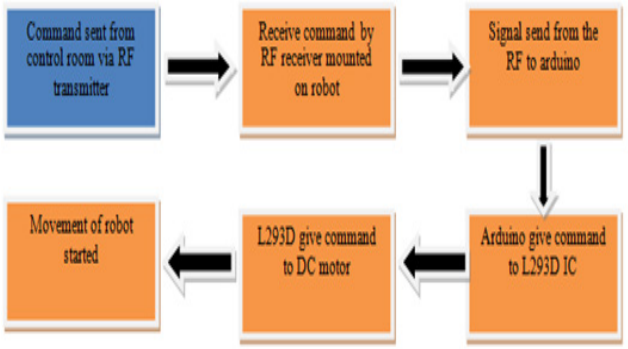

Figure 3. Flow of controlling the robotic system.

Robot is controlled wirelessly by system from control room, when key "w" is pressed signal transmitted from the RF transmitter to RF receiver through the IC L293D it goes to motor and rotate both the motor in forward direction as a result robot will move forward, when key "x" is pressed both motor moves in the backward direction hence robot moves backward similarly when key "d" is pressed so left motor moves forward and right motor moves backward so robot moves right and when key "a" is pressed so right motor moves forward and left motor moves backward so robot moves left and when key "s" is pressed so both motor stops both the motor hence robot stops. There are 2 inputs, 2 outputs and 1 enable pin for each motor and one can control the motor by giving high or low voltage to these pins as shown in Table 1.

Table 1. Motor behavior for different inputs

ENABLE	1A	2A	FUNC TION
H	L	H	Turn right
H	H	L	Turn left
H	L	L	Fast motor stop
H	H	H	Fast motor stop
L	**X**	**X**	**Fast motor stop**

Ultrasonic sensor is used to detect obstacle which comes in between, Time is considered to be important factor which is used in measuring the distance between the

system and obstacle by calculating the difference between the incoming and outgoing signal[9]. The distance which it calculates is twice the distance between the object and the sensor. The calculated distance needs to be divided by 2 to get the actual distance between the object and the sensor. The maximum distance which it can measure is 233cm with the precision of 3 Cm and detect object within the range of 15 degree. Figure 4 gives the better explanation of the movement of the bot that which motor should move forward and which motor should move backward for the particular motion.

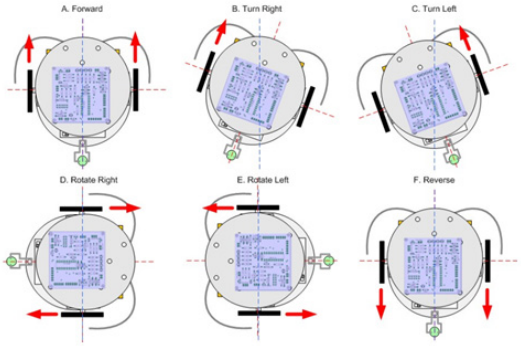

Figure 4. Movements of motor for different motions.

3. Implementation

The proposed system is illustrated in Figure 5. The figure shows the different sensors module, display module, GPS module and camera module, which are explained in further sections.

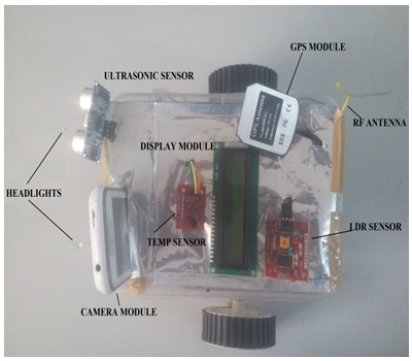

Figure 5. Proposed RF controlled robotic system.

3.1 Camera Module

Camera module plays a very important role in designing of the robot because robot camera is the analogous to the eye of the human, camera allows the user to explore the dangerous environment without being physically present with the help of the robot. The camera which is used in this research is smart phone camera. Figure 6 is showing the images captured by the robot camera module and sent wirelessly via Wi-Fi and generate the URL for the video Once the user gets the URL, open that with the browser and can see the live streaming, it is also secure because one can set the password for that particular URL so whenever one will open that URL server will ask for the Password and then allow the user to see the live streaming.

Figure 6. Image captured by robot and sent to control room.

3.2 Light Dependent Resistor Module

LDR stands for Light dependent resistor which changes its resistance according the light intensity falls on it which makes it suitable for light sensing applications, the resistance values in daylight is around 5000 Ω and 20000000 Ω in dark. The Figure 7 shows the implementation of LDR sensor, when there is dark, robotic system automatically switch on the light, the dark environment is created by putting hand over the sensor.

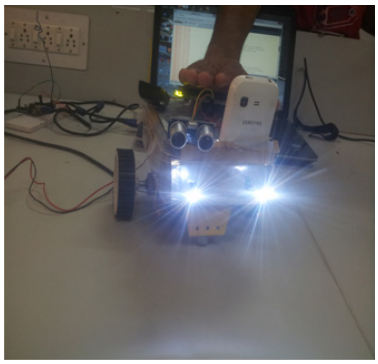

Figure 7. Automatic switch on the light in case of darkness.

3.3 Global Positioning System Module

The GPS module which is used in this research is Sky Labs GPS module which gives the latitude and longitude in National Marine Electronics Association (NMEA)

format, which is an ASCII based protocol[10] and provides the interface among different marine electronics equipments like echo sounder, sonar, anemometer etc. An NMEA standard allows communicating the equipments with other marine equipments and with the computer. NMEA gives the output in following strings[11].

- $GPGGA: Global Positioning System Fix Data
- $GPGSV: GPS satellites in view
- $GPGSA: GPS DOP and active satellites
- $GPRMC: Recommended minimum specific GPS

Out of these 4 strings $GPGGA and $GPRMC are sufficient to find the co-ordinate of the system. The main idea of NMEA is to transmit a line of data as shown below which is self sufficient and independent from other sentences.

- **"$GPRMC,110420.000,A,1244.0941,N,8015.3503 ,E,1.49, 111.57,250215,,,A*54 "**

Every self sufficient sentence starts with the "$" symbol and can have more than 80 character, single line separated by comma[12]. One can easily identified the marine equipment by observing the sentence for ex $GPRMC, here GP stands for GPS and next three words defines the sequence content.110420.000 gives the time in Co-Ordinaed Universal Time (UTC), A stands for active which indicates valid transmission and V stands for void whichindicatesinvalidtransmission.1244.0941,N,8015.3503,E represents the latitude and longitude respectively which is the crucial part of the sentence. Figure 8 shows the path of the robot is tracked at VIT University, Chennai and save the file in .CSV format and opened with Google Map.

Figure 8. Traced path of mobile robotic system.

4. Evaluation

The system which is implemented is tested both qualitatively and quantitatively and to prove the feasibility different tests have been performed and how the different parameters varies with time are recorded and the graph is made to show the variation of the units with the time. Initially temperature sensor reading has been recorded as shown in Figure 9 and plotted a graph which shown variation of temperature with Time.

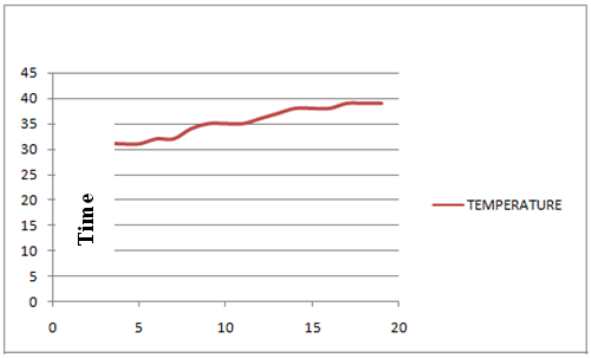

Figure 9. Graph showing the variation of temp with time.

The temperature reading is plotted in graph with respect to the time and it is observed that temperature continuously increases with time. The value is increased significantly from 30⁰ C to 39⁰ C with time as shown in Table 2. The second output which is considered is the GPS module reading which is stored in the SD card, 650 values are recorded and map in the Google map to trace the path of the robotic system.

Table 2. Temperature readings

A	B	C
S.NO	TIME	TEMPERATURE
1	12.53 PM	30
2	12.53 PM	30
3	12.53 PM	31
4	12.53 PM	31
5	12.54PM	31
6	12.54PM	32
7	12.54PM	32
8	12.54PM	34
9	12.54PM	35
10	12.55PM	35
11	12.55PM	35
12	12.55PM	36
13	12.56PM	37
14	12.56PM	38
15	12.56PM	38
16	12.56PM	38
17	12.56PM	39
18	12.56PM	39
19	**12.57PM**	**39**

Values in this table changes after particular time because the frequency of fetching the co-ordinates of GPS module is very fast so it fetches 8-10 co-ordinates per spot and fetches more as robotic system moves further as shown in Table 3.

Table 3. GPS reading of latitude and longitude

	A	B	C
1	Date/Time	Latitude	Longitude
2	04-04-2015 11:04	12.840941	80.153534
3	04-04-2015 11:04	12.840941	80.153534
4	04-04-2015 11:04	12.840941	80.153534
5	04-04-2015 11:04	12.840941	80.153534
6	04-04-2015 11:04	12.840941	80.153534
7	04-04-2015 11:04	12.840941	80.153534
8	04-04-2015 11:04	12.840941	80.153534
9	04-04-2015 11:04	12.840941	80.153534
10	04-04-2015 11:04	12.840941	80.153534
11	04-04-2015 11:04	12.840941	80.153534
12	04-04-2015 11:04	12.841023	80.153558
13	04-04-2015 11:04	12.841023	80.153558
14	04-04-2015 11:04	12.841023	80.153558
15	04-04-2015 11:04	12.841023	80.153558
16	04-04-2015 11:04	12.841023	80.153558
17	04-04-2015 11:04	12.841023	80.153558
18	04-04-2015 11:04	12.841023	80.153558
19	04-04-2015 11:04	12.841023	80.153558
20	04-04-2015 11:04	12.841023	80.153558
21	04-04-2015 11:04	12.841023	80.153558
22	04-04-2015 11:04	12.841023	80.153558
23	04-04-2015 11:04	12.841085	80.153573
24	04-04-2015 11:04	12.841085	80.153573
25	04-04-2015 11:05	12.841085	80.153573
26	04-04-2015 11:05	12.841085	80.153573
27	04-04-2015 11:05	12.841085	80.153573
28	04-04-2015 11:05	12.841085	80.153573
29	04-04-2015 11:05	12.841085	80.153573
30	04-04-2015 11:05	12.841085	80.153573
31	04-04-2015 11:05	12.841085	80.153573
32	04-04-2015 11:05	12.841085	80.153573
33	04-04-2015 11:05	12.841085	80.153573
34	04-04-2015 11:05	12.841085	80.153573
35	04-04-2015 11:05	12.841085	80.153573
36	**04-04-2015 11:05**	**12.841085**	**80.153573**

5. Conclusion

The robot controlled wirelessly using the RF technology for rescue purpose is successfully designed and assembled. Heart of the robot is the microcontroller which interfaces with the transceiver unit and allow the robot to be controlled from the distance with the help of the remote device which is laptop in this case. Different sensor unit makes the robot more versatile and suitable for rescue mission. Their liability of the system can be increased by adding some additional features like GPS tracking so that the robot can be tracked at any point of the time and one can also improve the surveillance system. In the era of industrial revolution where people used to build a huge building but they do not care for the people who live there. After the natural calamities many people lost their life so considering all the situations robot is integrated with different modules which can be used for redemption.

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