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Optimized Rescue Robot Using Fire Bird V

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Abstract- **Our objective is to perform autonomous human detection with the help ofa suitable sensor and also to help the rescue team with the co-ordinates of thevictim which would speed up the process of rescuing. The situations in which the designed robot could be deployed are urban disaster and mining accidents. This aforementionedobjective is achieved by establishing wireless communication between the robotand the control room. Theexisting systems use camera for the purpose of human detection which would beinefficient if the ambient conditions are not conductive. In this paper the detection of human presence is implemented with the help of a PIRsensor along with CCD camera. The hardware modules consist of a wireless CCD camera to assist in robotnavigation and confirmation of human presence which is indicated by the output of PIR sensor, a GPS module to find thevictim's location and a GSM modem to alert the entire rescue team about thelocation and status of the victim. The entire setup reduces the time delay in rescuing the victims. The designed robot provides wirelessdata transferof victim location with a delay of 2 microseconds. The message is sentusing GSM, which contains the coordinates of the victim will assist the rescue team in rescuing the victim.**

Keywords: **CCD Camera, Fire Bird V,Gripper module,PIR sensor,Optimized robot, XBee module**

I. INTRODUCTION

Robotics is the interdisciplinary branch of engineering and science thatincludes electrical, mechanical, electronics, computer science and otherdomains. It deals with the design, construction, operation, and use of robots, aswell as computer systems for control, sensory feedback, and information processing. These technologies are used to develop robots that can perform thejob of humans.

There are 3 components of an embedded System. They are 1) Hardware, 2) Application software and 3) Real Time Operating System (RTOS). RTOS supervises the application software and provide mechanism to letthe processor run a process as per scheduling by following a plan to control thelatencies. RTOS defines the way the system works. It sets the rules during theexecution of application program. A small scale embedded system may nothave RTOS. So we can define an embedded system as a Microcontroller based,software driven, reliable and real-time control system.

A processor has two essential units. They are1) Program Flow Control Unit (CU) and 2) Execution Unit (EU). The CU includes a fetch unit for fetching instructions from the memory.The EU has circuits that implement the instructions pertaining to data transferoperation and data conversion from one form to another. The EU includes the Arithmetic and Logical Unit (ALU) and also thecircuits that execute instructions for a program control task such as interrupt, or jump to another set ofinstructions. A processor runs the cycles of fetch andexecutes the instructions in the same sequence as they are fetched frommemory.

A microcontroller is a single-chipVLSI unit (also called microcomputer)which, although having limitedcomputational capabilities, possessesenhanced input/output capability and anumber of on-chip functionalmicrocontrollers are particularly used inembedded systems for real-time controlapplications with on-chip program memoryand devices.

II. EXISTING SYSTEMS

In the paper, Live Human Detecting Robot for Earthquake Rescue Operation[3], it is stated that earthquakes produce a devastating effectand they see no difference between human and material lot of times humans areburied among the debris and it became impossible to detect them Detection byrescue workers becomes time consuming and due to the vast area, that getsaffected it becomes more difficult.

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In thepaper,GSM and GPS Based Vehicle Location and Tracking System [2], it is stated that vehicle tracking system combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose-designed computer software to enable the owner or a third party to track the vehicle's location, collecting data in the process. This system proposes that the RF transmitter is attached with the vehicle which has its own identification. This data will be continuously transmitted to the RF receiver connected to the microcontroller. This GPS will be location the position of vehicle and transmit that data to the microcontroller. Suppose the RF receiver not receiving signal from the transmitting unit, receiver unit send the signal to the microcontroller, from that we can identify the theft. If the vehicle is theft it automatically sends location of the vehicle to its owner as a SMS through GSM modem. This will be a much simpler and low cost technique compared to others. If a password like SMS is sent by the owner, it automatically stops the vehicle.

In the paper, War Field Spying Robot with Night Vision Camera[4], the design of the proposed project encourages developing a robotic vehicle based on RF technology for the remote operation connected with the wireless camera mounted on the robot for monitoring purpose. The robot is embedded with 8051 series microcontrollers for desired operation and is generally used for spying purposes. The transmitting module consist of the push buttons that send the commands to the receiving module for controlling the movement of robot either to right, left, forward, downward. In the receiving module of the robot two motors are interfaced with the 8051 series of microcontroller to control its movement via motor driver IC. The remote control (RF transmitter) has a range of 200m that transmits the signals to the RF receiver. The receiver collects and decodes the received signals before feeding it to the microcontroller to drive the DC motors via motor drivers. The wireless camera used for spying purpose also serves in complete darkness using IR lightning.

III. PROPOSED SYSTEM

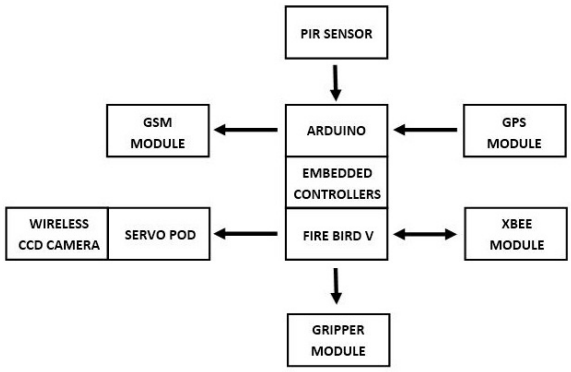

Fig.1 Block Diagram of Robot on Field

Our proposed system is shown in figure 1.Our model is to find the human beings during a natural disastersituation or any other abnormal situation in which the quick rescue of humans isthe need of the hour. For that we would like to use PIR sensor in our system.The PIR sensor will be mounted onto the robot and this output of PIR sensorwill be monitored and further actions will be performed based on that. Anotherimportant module in our system is the XBee pair which enables us to connectour robot to the control system wirelessly. The diagram of on field robot is shown in figure 2.

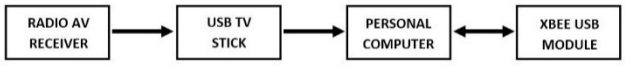

Fig. 2 Block Diagram of Robot on Field

After the detection of human presence in the place we would like to againconfirm it with the help of a wireless CCD camera. Once the presence ofhuman activities is confirmed, the robot uses a GPS module (Global PositioningSystem) to find the human's exact location. Once the location of the victim isconfirmed, the same co-ordinates are sent to the entire rescue team using GSM(Global System for Mobile communication).

IV. METHODOLOGY

Our project can be easily implemented in natural calamities likeearthquake. During such situations, the rescuing operation is too difficultbecause many people will be covered by debris and they are not viewed byrescue team, when the

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area is large it is too difficult and many people will beleft unnoticed and it results in loss of life. To avoid this, we designed our robot.

Our model is to find the human beings during disaster situation for thatwe are using PIR sensor. PIR sensor is based on the principle that all objectswith a temperature above absolute zero limit emit heat energy in the form ofradiation. These sensors don't detect or measure heat, instead they detect theinfrared radiation emitted or reflected from an object. PIR sensor is used todetect motion from humanoids, of about 20 feet away. When an object such ashuman, passes in front of the background, such as a wall, the temperature at thatpoint in the sensor's field of view will rise from room temperature to bodytemperature, and then back again. The sensor converts the resulting change inthe incoming infrared radiation into a change in the output voltage, and triggersthe detection. It runs on 5v -12v power supply and produce output of 3.3vdigital signal. The PIR acts as a digital output so all you need to do is listen forthe pin to flip high(detected) or low (not detected).

When the output of PIR goes high then it indicates the presence ofhuman. After human is detected we once again confirmed using wireless CCDcamera. For the proper working of this camera it needs 9V DC. When thesupply is given, it transmits the online data wirelessly. An antenna is mountedwith camera to transmit wirelessly. This will be received by the receiverconnected with the antenna. The TV-tuner card is used to view the received datain PC. This camera is mounted on a servo pod, so we can easily perform tiltand pan operations. Because of this we can rotate the camera in every direction.Once the presence of human activities is confirmed, finding the exactlocation of the victims will be an important task in rescue operation, for that a GPS module is used to identify the location of the victim. The process is shown in figure 3.

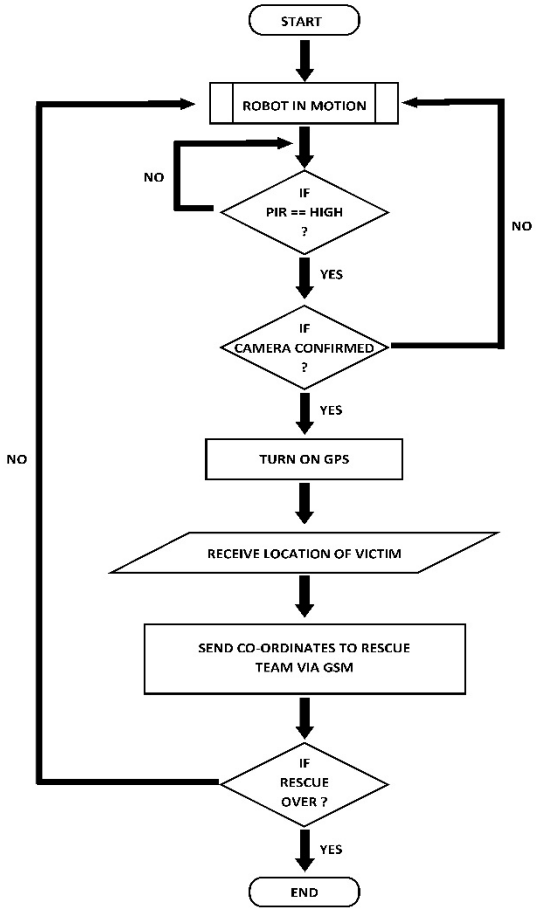

Figure3. Flow chart-Part1

The process used in the detection of obstacle on the field is shown in the figure 4.

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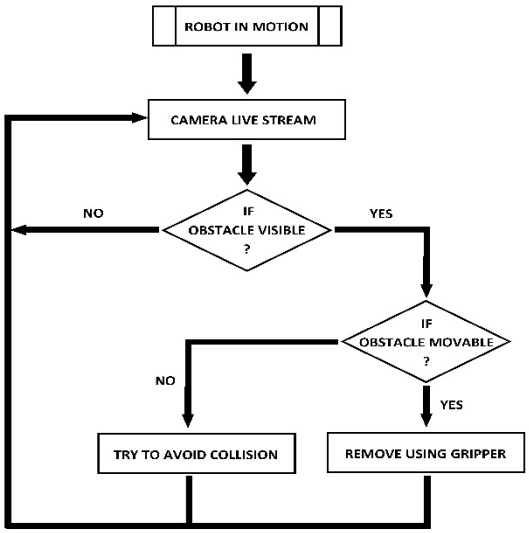

Figure 4.Flow Chart – Part 2

It avoids searching everywhere in therescuing area. It saves lot of time. The GPS module provides geo location andtime information to GPS receiver in all weather conditions anywhere in earth.Because of these characteristics, it is used anywhere in the world. Extraction oflatitude and longitude from NMEA format is done using themicrocontroller.

Once the location of the victim is confirmed, the same co-ordinates aresent to the entire rescue team using GSM (Global System for Mobilecommunication). It is used to establish the communication between computerand GSM system. It reduces the time delay. So, every member of the rescueteam will have the co-ordinate and the member nearer to the victim will helpthem quickly as soon as possible.

The GPS, GSM and the PIR sensor modules are all connected to anArduino Uno Board which will be placed above the Fire Bird V Module. Theother peripherals or modules will be connected directly to the Fire Bird V kitand are controlled by it. A gripper module will be connected to the ATMEGA2560 Microcontroller. It will be used to remove the obstacles in the path of therobot. For that it must be verified that the obstacle which hinders the movementof the robot must be movable. This can be done by using the wireless CCDcamera.

V. HARDWARE COMPONENTS

A. Fire Bird V

Fire Bird V will help us get acquainted with the world of robotics and embedded systems. Fire Bird V is designed by NEX Robotics and Embedded Real-Time Systems lab, CSE IIT Bombay. As a Universal Robotic Research Platform, Fire Bird V provides an excellent environment for experimentation, algorithm development and testing. Fire Bird V is evolved from Fire Bird IV and Fire Bird II which are being used in IIT Bombay to teach embedded systems and robotics. Its modular architecture allows us to control it using multiple processors such as 8051, AVR, PIC and ARM7 etc. Modular sensor pods can be mounted on the platform as dictated by intended applications. Precision position encoders make it possible to have accurate position control.

The platform can be upgraded to tank drive and Hexapod insect or any other desired form very easily. It is powered by high performance rechargeable NiMH batteries. A 2.4 GHz ZigBee module provides state of the art secure and multi-channel wireless communication up to a range of one kilometre. Fire Bird V makes oudr project easy to implement with its whole lot of sensors that are available on board. It has Sharp IR Range sensors, IR proximity Sensors, Ultrasonic Sensors, LCD, Buzzers and LED bars available with it. It is shown in figure 5.

Figure 5. Fire Bird V

A. Arduino

Arduino is community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. Arduino boards are available commercially in preassembled form,or as do-it-yourself kits.

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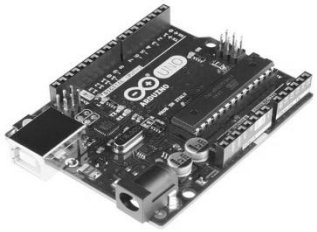

Figure 6.Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

B. XBee Module

Figure 7.XBee Module

Digi International has named their radio module product as XBee which we are using in our project for establishing wireless communication between the robot on field and the control station where we can exercise control over the robot. The XBee radio modules were designed for point-to-point and star communications.The XBee radio modules can all be used with the minimum number of connections — power (3.3 V), ground, data in and data out (UART), with other recommended lines being Reset and Sleep. Additionally, most XBee families have some other flow control, input/output (I/O), analog-to-digital converter (A/D). It is shown in figure 7.

C. Wireless CCD Camera

Figure 8. Wireless CCD camera

We are using a wireless CCD camera as shown in figure 8, which are commonly available in the market. This camera requires a 9 volts DC supply. It has an wire antenna at the top to transmit the signals. Its outputs are in the form of audio and video signals. These signals are directly received in a control station by using a Radio AV Receiver. We are using JMK radio AV receiver in our project. The CCD camera will be placed on the robot. The camera captures the audio and video signals and sends those signals to the remote station. The captured signals will be hooked up to the computer with the help of a specialized module which is the USB TV Tuner stick. It is capable of delivering the audio and video signals on the computer monitor. These are all standalone modules and we are integrating them to meet our requirements.

D. PIR Sensor

PIR stands for Passive Infrared Sensor is a pyroelectric sensor. It is capable of measuring infrared light (IR) radiated by objects in its corresponding field of view. Objects with a temperature above absolute zero will emit heat energy in the form of radiation which is not visible to human eye. PIR sensors can be used to detect these radiations. They are called passive sensors because they do not generate or radiate energy for detection. It only detects the energy emitted by other objects. We are using PIR sensors for the detection of human beings (motion) and to do corresponding actions based on the output generated by the PIR sensor. It is shown in figure 9.

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Figure 9.PIR sensor

E. GPSModule

The output of the GPS receiver will be in standard NMEA format. This GPS module can be connected to the microcontroller very easily because it uses only Transmit, Receive pins of the serial port of the microcontroller.

F. GSM Module

Global System for Mobile Communications or GSM is the popular standard for mobile telephone systems. More than 1.5 billion people across more than 200 countries are using GSM. This means that subscribers are free to use their mobile phones throughout the world which is made possible by international roaming arrangements between various mobile network operators. GSM is different from its predecessors insuch a way that both signalling and speech channels are digital. The GSM standard has given an advantage to the consumers or users by making them benefit from the ability to roam and switch carriers without the difficulty of replacing their handsets. It also helps the network operators, by enabling them to choose equipment provided by many GSM equipment vendors. It is shown in figure 10.

Figure 10. GSM module

G. Gripper Module

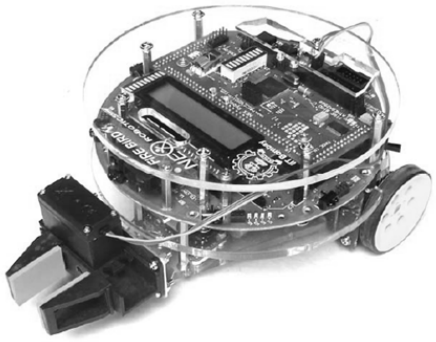

Figure 11. Gripper Module

The light weight gripper module is designed for mobile robotics applications is shown in Figure 11.. It can grip objects with the size up to 33mm with the force up to 250gms. Gripper is made up of plastic parts and comes fully assembled and ready to use. Because of its mechanical link design, gripper jaws move parallel with respect to each other while gripping. Gripper has rubber pads for firm grip. Gripper comes with two high quality dual bearing NRS-585 Servo motors for twisting and gripping action. The gripper module can be used to remove the movable objects in the path of the robot which hinders the navigation of the robot on the affected zone so that the motion will be as efficient as possible.

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VI. RESULTS AND DISCUSSION

S. No.	Description	PIR Value	GPS Location	Camera Capture
1	Human	1	LAT: 10.81696 LONG: 78.68446	
2	Animal	1	LAT: 10.87307 LONG: 78.59719	
3	Human and Animal	1	LAT: 10.84431 LONG: 78.59800	
4	Non – Living Object	0	---	

TABLE Iresult analysis

The above table shows the various values of latitude and longitude values obtained for different objects in the field. The message is sent appropriately to the rescue team.

VII. CONCLUSION AND FUTURE SCOPE

This robot could be used during earthquakes and other accidents which pose a situation in which human beings must be rescued immediately to avoid further unwanted life loss. Since we have established wireless communication, our robot can be used in many situations where humans can't be able to work on field. We have integrated camera module in our project which enables us to use our robot in situations where live streaming of events happening around the field of work is required by the user. We also have connected GPS and GSM modules via Arduino board to our project which helps us to get the co-ordinates of a place and immediately send it to many team members.

The designed robot can be used in War fields for spying purposes. This can be achieved by making little changes to the assembly and minute variations in the coding. By making it fire and water resistant, this robot's feasibility could be extended to help people and assist the rescue team in times of floods and fire accidents. It could also be used for surveillance purposes. PIR sensors can be replaced with thermal sensors which are even more efficient in human detection purposes. Wireless CCD camera can also be put to even greater use. With the technologies being updated rapidly, this project could be much more helpful which is of ultimate worth which is nothing but human life. Human life is worth saving and this project can be of great use in saving such valuable lives in future.

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