

Robot for Surveillance, Combating Terrorism and Rescue Operations

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Abstract - This project proposes a multipurpose robot for surveillance and rescue operations in remote locations and inside of buildings. This is mainly designed to be used for military purpose and can be used by military personnel combating terrorism, as this involves no human activity to have a complete lookout of any area along the borders and thus reduces the loss of human lives. The movement of the robot is controlled with the help of the Radio frequency transceivers. This being mounted with ultrasonic sensor measures the distance it travels and thus gives the exact distance it is from the place of control. This is fitted with various sensors such as the PIR sensor, obstacle sensor, gas sensor which perform various operations. The PIR sensor, which detects the thermal radiation, detects the presence of any human presence in any particular area, even behind walls. The obstacle sensor detects obstacles of any forms, such as walls, objects of any kind and thus bringing the robot to a halt. The presence of any poisonous gases is detected by the gas sensor fitted. The system even has a video camera mounted to it so that the controller can have a clear view of what the area, where the robot is employed, is like. Thus gaining a clear idea about that particular area and this helps in responding with a counter attack in case of any terrorist presence. The detected information is sent through a GSM module fitted to the robot to the control area. Even the exact location of the robot can be sensed with the GPS module mounted and the same can even be shared with the control personnel so that it will be easy to send in the rescue measures in case of any emergency, such that anyone lying injured can be rescued. This can even be used during natural calamities, where people stuck inside fallen building can be found with the help of the sensors attached. For further developments, this robot can be fitted with a mounted weapon which can be triggered from a remote location.

Index Terms – Surveillance robot, Sensors, RF communication, GSM/GPS modules

I. INTRODUCTION

Safety and security have become the biggest concerns in this ever growing modern world. As far as most of the countries are concerned, terrorist activities and the presence of terrorists, their intrusion into their areas have become a major problem. So as to counter these terrorists, the security personnel stay on guard round the clock, and during such search operations, many army people lose their lives. And, to reduce risking of these precious human lives, the robot, equipped with the gadgets necessary to find and report the presence of any threats in the form of humans, objects, and any sort of poisonous gases can be introduced in carrying out such operations.

This has been the concern, not only in our country, but also countries worldwide. This is a field where utmost care needs to be taken, as this involves risking of human lives. Though modern warfare has taken its place these days, involving the support of the technology, humans are still used for most of the rescue missions, or missions involving finding of the hidden terrorists. This needs to be addressed as the involvement of the robot can duly reduce the risking of their lives.

Apart from these military activities, the natural calamities which occur also claim numerous human lives. Taking into consideration the 2004 Tsunami, earthquakes around the world,. Most of the people lost their lives being stuck in the debris without being rescued, as the place where they are stuck is unknown. Thus with the sensors mounted aboard this robot help locate them, and thus the rescue operations in those areas make be fastened.

II. EXISTING METHODOLOGY

From the literature, it is found that, Budiharto .H, [1] has proposed a system design of a special purpose robot used to track any specific location, it was rather used to find and rescue disaster victims. The architecture included Raspberry Pi and AVR based mobile robot controlled with the help of a controller IC. It was also programmed to avoid obstacles using ultrasonic sensors. The video streaming was also made with the Raspberry Pi output and 2.4GHz video transmitter. There were certain limitations which can be overcome in the proposed model.

III. PROPOSED METHODOLOGY

A. Robotic Movement

The most important aspect of this project is the[6] movement of the robot. The robot which is to be used is capable of moving in all the four directions. The rotation of the wheels is controlled by the H-Bridge drive and geared DC motors. The H-Bridge which consists of the switches helps in the forward and the backward movement of the robot. The geared DC motor connected to the H-bridge as well as the power supply powers the Robotic movement. The movement is thus controlled by the [2] RF transmitter and

receiver. The RF (Radio Frequency) module is preferred over IR (Infra Red), as the RF has a larger area cover compared to the IR and thus it can be used for long range communication, and these signals can even travel through obstructions and there is no line of sight communication as compared to IR. The RF is generally used along with an encoder and decoder, as the encoder usually encodes the parallel data for transmission feed, where as the decoder decodes the same in the receiver end.

B. Wireless video transmission and reception

The robotic module which has been developed has a primary attribute of surveillance. For this surveillance purpose a wireless camera with a transmitter and receiver is used. The miniature digital [3] wireless camera with its transmitter is fitted to the robot which sends the video and audio signals in the form of digital packets over high bandwidth radio frequencies to the receiver end. Whereas, the receiver is interfaced with an external display, through which the output video will be reproduced.

The thing that digital is preferred over analog wireless camera is that the digital image is not affected by wireless interferences, and also the quality of the video and the audio is high comparatively. This has increased range and can be connected to multiple outputs.

C. Sensors used in the Robot

Apart from the video surveillance, the robot is capable of various other functionalities including the detection of things including the presence of humans, obstacles and gases of any form. The movement or the presence of the human beings is detected with the help of the PIR (Passive Infrared) sensor. This works in a way that it senses the radiation in the form of heat from live bodies that are entering or leaving any particular area. Humans emit heat radiation at least in the lowest form. The high the temperature of the body is, the higher the heat radiation is. Thus, it becomes easier for the sensor to detect.

The next is the ultrasonic sensor, this sensor is fitted to the front end of the robot. This is capable of detecting obstacles of any form, such as any objects, walls, boulders from a distance without getting into contact with them.

The gas sensors are also used in this robotic setup, which is mounted atop the robot to detect the presence of any gases in the area where the surveillance needs to be undergone.

D. GSM and GPS modules

The GPS module helps in providing with the exact location of the robot. This may be helpful in the sending in of rescue measures wherever necessary. The GSM and the GPS modules are interfaced with the system such that, whenever the sensors mounted aboard the robot senses things, such as, when a PIR sensors senses the movement of humans in any particular area, the intimation regarding the same is given to the control center via the GSM module and the exact location where it has been sensed will be provided with by the GPS module.

This same procedure is followed with the Ultrasonic sensor as well, thus whenever it detects any obstacles, the robotic system comes to a halt, intimates the same to the control center and changes its direction. The location is as well shared with the control area using the GPS through the [8] GSM module mounted, whenever a gas of any form, whose odor lies in the threshold value set previously, is detected.

IV. OVERALL MODULE OF THE ROBOTIC SETUP

The overall block diagram of the entire setup is given below. The block is divided into two, the robotic setup and the Remote control unit. The robotic setup involves the robotic movement control part, the various sensors and the cameras. The processor used here is ARM (LPC2148). The robotic movement control module comprising of the H-Bridge drive and the geared DC motors are interfaced with the micro controller. The various sensors such as the Ultrasonic sensor, PIR sensor and the Gas sensor are also interfaced to the controller. Apart from these, the RF receiver which is used to control the movement is interfaced with the same.

The controller unit consists of the RF transmitter unit, used to control the robotic movement and the PC interface kit for the wireless video receiver, which is used to reproduce the Video and the audio to an external display.

Given Below is the Robotic control module, which is the outdoor unit.

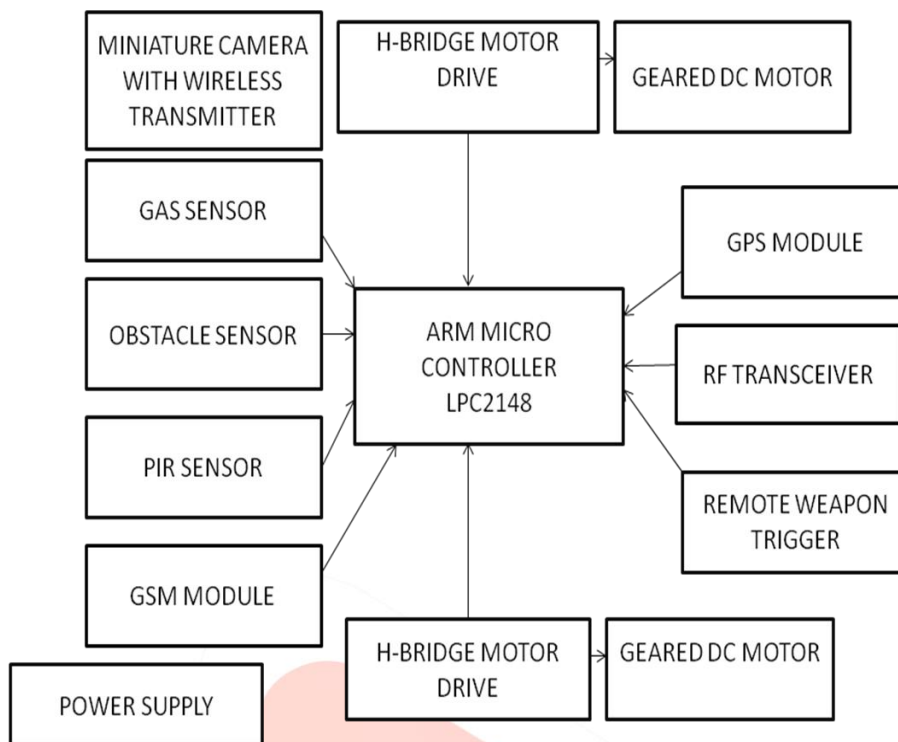


Figure 1 External Robotic module

Now the PC control module consisting of the PC interfacing circuit, interfaced with the RF transceiver and the Wireless digital camera receiver are given. The wireless camera needs an output device such as a display unit to reproduce the video and audio signals sent in by the wireless digital camera transmitter.

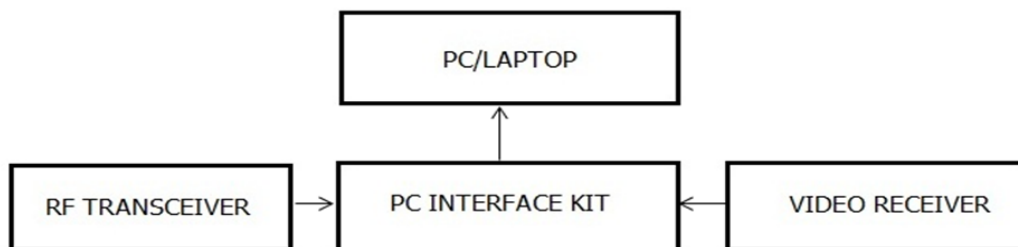


Figure 2 PC/LAPTOP interfacing module

V. HARDWARE IMPLEMENTATION

A. ARM LPC 2148

The microcontroller used is the ARM LPC2148, it has 512 KB program Flash memory and 32+8 KB SRAM. The microcontroller has a crystal frequency of 12 MHZ. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. This frequency has been selected in order to allow maximum execution speed. It has inbuilt A to D and D to A converter. ARM has Von Neumann architecture that is the Program and RAM are in the same space.

B. H-Bridge Drive

An H-Bridge is an arrangement [4] of switches that allows a circuit full control over a standard electric DC motor. That is, an H-bridge allows a microcontroller, logic chip, or remote control to electronically command the motor to go forward, reverse, break and stop. This connected with the DC motor helps in the movement of the robot.

C. Geared DC motor

A DC motor [5] is a machine which converts electrical energy into mechanical energy. It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule and whose magnitude is given by

Force, $F = BI l$ Newton

Where, B is the magnetic field in Weber/ m^2

I is the current in amperes

And l is the length of the coil in meter

The force, current and magnetic fields are all in different directions.

D. Ultrasonic sensor/Obstacle sensor (LM358)

The ultrasonic sensor consists of a transmitter and a receiver, where as the transmitter send out ultrasonic signals forward and when it hits a wall or any other obstacle gets reflected and thus returns back and gets received by the receiver side. This helps in detecting any obstacles in the path of the robot.

E. PIR sensor (HC-SR501)

Passive Infrareds sensors (PIRs) are electronic devices which are used in some security alarm systems to detect motion of an infrared emitting source, usually a human body. The pyroelectric sensor is made of a crystalline material that generates a surface electric charge when exposed to heat in the form of infrared radiation. When the amount of radiation striking the crystal changes, the amount of charge also changes and can then be measured with a sensitive FET device built into the sensor. This radiation (energy) is invisible to the human eye but can be detected by electronic devices designed for such a purpose.

F. Gas sensor (MQ-5)

The MQ-5 gas sensor is used in the detection of the presence of any gases in the areas where the surveillance is to be made. The MQ-5 has high sensitivity towards natural gas, LPG and has low sensitivity to alcohol and smoke. This even has a fast response time compared to its older versions. The detection range is from 100 - 10,000 ppm.

G. RF Module

The RF module used for wireless communication works at a frequency range of 10 KHZ to 300 GHZ. It is used to refer to the radio signal generated by the system transmitter, or to energy present from other sources that may be picked by the wireless receiver. This module consists of the RF transmitter and the RF receiver.

RF Transmitter (TWS434)

The transmitter output is Up to 8mW and works at a frequency of 433.92 MHZ with a communication range of about 400 Feet. The TWS434 transmitter accepts both linear and digital inputs that can operate from 1.5 to 12 volts-DC. Its size is approximately 1/3 the size of a standard postage stamp. This transmitter is used to control the movement of the robot, through which the instruction for the robot to move in any particular direction is given.

RF Receiver (RWS434)

The RF receiver (RWS434) also works at 433.92 MHZ frequency range and has a sensitivity of about 3uV. The RWS434 receiver operates from 4.5 to 5.5 volts-DC, and even this like the RF transmitter has both linear and digital outputs. This receiver is mounted atop the robot module, interfaced with the H-Bridge and the DC motor helping in the movement of the same.

H. Global System for Mobile Communication (SIM900A)

This GSM modem is designed with RS232 level converter circuitry, which allows to directly interfacing PC serial port. It works at a frequency of about 850 MHZ, 900 MHZ, 1800 MHZ, 1900 MHZ. It requires only 3 wires (Tx, Rx, GND) except power supply to interface with microcontroller. It has built in SIM card holder. This is used in the robot to communicate with the control center regarding the things from the detection of humans, obstacles and any gases in the area of surveillance.

I. Global Positioning System (QUECTEL L10)

The [7] GPS module has 210 PRN channels, with 66 search channels and 22 simultaneous tracking channels with low tracking power consumption (38mA). The position accuracy of the GPS module is about 3.0m 2D-RMS 2.5m. This module is used in sharing the location information of the robot, whenever it detects any humans, or any obstacles in its path. Thus this helps in alerting the security personnel, if the humans detected turn out to be terrorists.

VI. SIMULATION OUTPUT

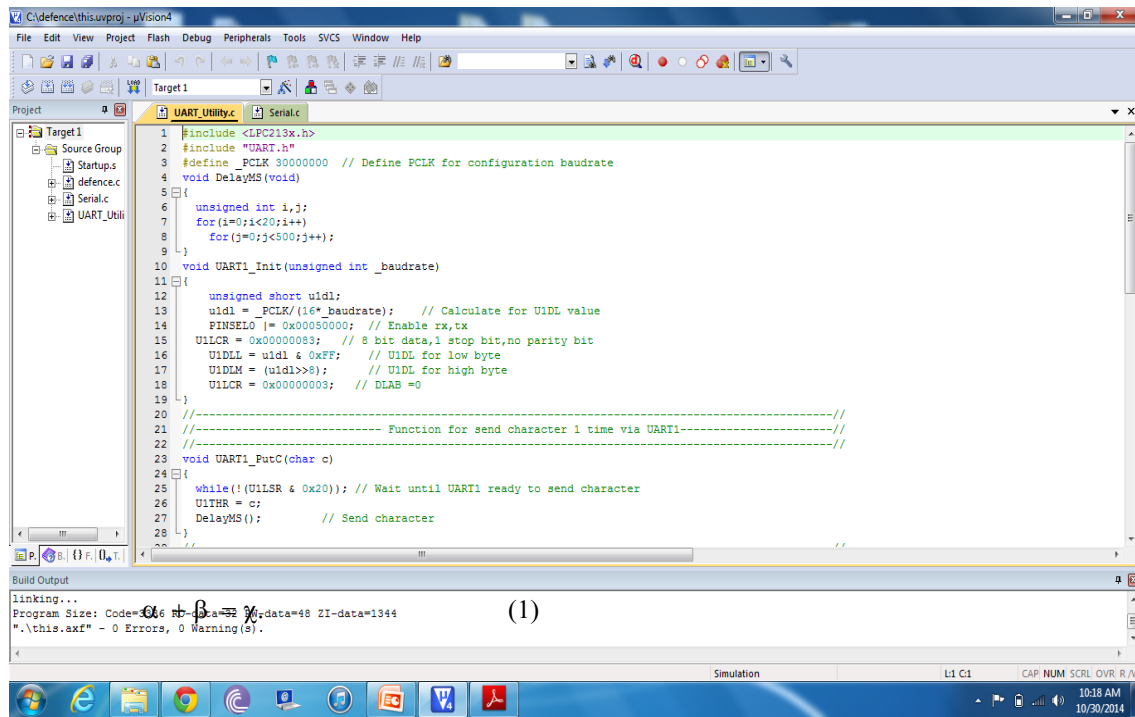


Figure 3 Simulation output image of the robotic module

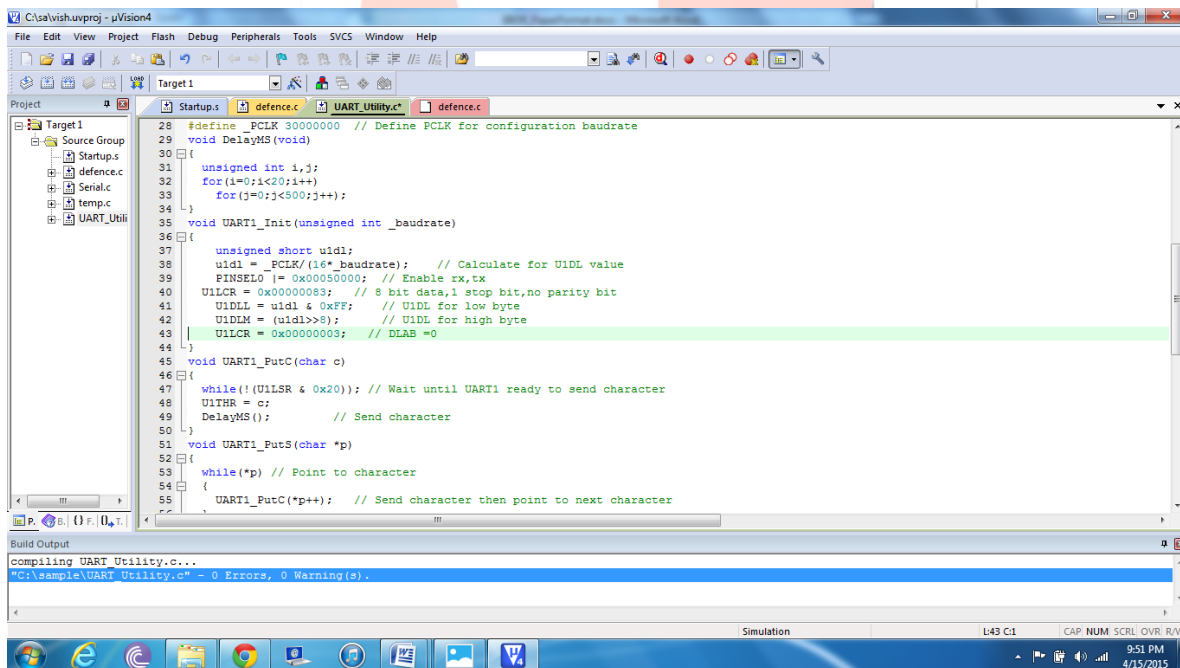


Figure 4 Simulation output image of the UART serial communication

The above two simulated output images are screenshots taken from the KEIL IDE software, where the embedded 'C' code for interfacing the above components have been simulated and the output is obtained without any errors and warnings.

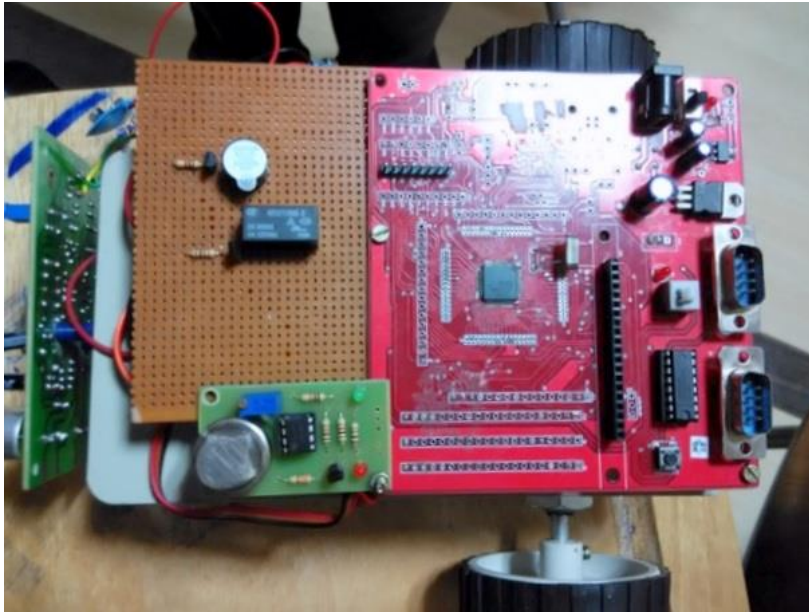


Figure 5 Photograph showing the ARM LPC2148 board interfaced with the Gas sensor and the Ultrasonic sensor

VII. CONCLUSION

This project aims at providing with the location information of remote areas and even helps the military personnel in combating terrorism, as it can be used in the borders where terrorist presence may be high and human being cannot be risked in such areas. This is even helpful during the times of natural calamities and other accidents as this robot helps in detecting human presence between rumbles of buildings and ensures timely rescue. This is very useful in unknown areas where the nature of the terrain, presence of obstacles and poisonous gases can be detected with the help of the sensors mounted. Thus, the risking of humans involved in such searching operation will be reduced with this.

VIII. ACKNOWLEDGEMENT

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