International Journal of Research Studies in Science, Engineering and Technology
Volume 2, Issue 11, November 2015, PP 35-39
ISSN 2349-4751 (Print) & ISSN 2349-476X (Online)

Implementation of a Self-Driven Robot for Remote Surveillance

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Abstract: *A self-driven mobile robot that can be controlled by itself automatically with the help sensors as well controllable with a smart remote control. The proposed robotic system is intended for remote surveillance in case of natural disasters and explosions, etc. The implemented robotic system is based on ARM 7 architecture along with IEEE 802.15 Bluetooth standard. The image acquisition device attached with the robotic vehicle is capable of streaming the video through IP address based communication channel. The smart remote control feature can be accomplished by a mobile or a laptop with inbuilt Bluetooth. The performance evaluation of the robot has done in terms of range of video streaming and remote accessing.*

Keywords: *Bluetooth, Surveillance, Remote access, Self-driven*

1. INTRODUCTION

The evolution of mobile robotics from the past few years has been creating many modern robotic applications in the aspects of surveillance, disaster rescue and security, etc. The robotic technology is always intended for mimicking the various human characteristics which we can't say replacing the human being in a specific application. In several applications, robotics will perform the activities where a human being can't even enter into the places. For example, when the natural disasters like earth quakes occurred, there might be a huge loss of property and human lives, and some victims may fight for the life under the pieces of distracted constructions and need someone's help. In such cases, human being can't enter into the narrow places at least to recognize the victim existence, and a robot can enter into such small areas easily because of it is minimized and robust architecture.

The artificial intelligence in robotics makes it accurate and faster compared to human brains. Robotics are the artificial machines to perform specialized tasks where a human being is ill-suited to perform it. An important concern in the design of robotic machines is about locomotion. The locomotion will depends on the mechanical design of a robot. The locomotion unit of a robot involves a rotational devices drives with a power source and it needs an electrical to mechanical conversion of energy source and that can be achieved by using the motors. Motors will helps the robot to move forward, backward and take turns. The issue is to choose the motor with a sufficient torque and speed.

Surveillance is a security aspect for monitoring the behaviour of objects. The surveillance applications require an image acquisition device to record the video stream or to capture the images of the particular place where an accident or disaster occurred. The places where disasters occurred are usually consists a lot of obstacles for robot movement. In some case, the robots have to move ascending and descending paths and they might be plane surfaces or shapeless surfaces. In such cases, design of the robot should capable of climbing up and down by escaping from obstacles. The design concerns also includes torque and gravity while choosing the motors for ascending movement and for descending movement, payload and mass have to consider. In military applications, the robots have to carry weights, and for that, torque of the motor should be high. Generally the motors with high torque will give a less speed.

2. DESIGN STRATEGY

The Design strategy of the proposed system firstly describes about the locomotion unit. For this robotic system, among various types of driving methods, we preferred differentia drive. In differential

drive method, robot consists of two wheels in the back side and one free wheel in its front. The two back wheels contain one motor on each wheel. The motors connected with the wheels are 60rpm DC motors which will give high torque. The free wheel moves accordingly in any direction based on the programmatically instructions given by the microcontroller. The mechanical body of the robotic system should be good enough for placing the items to be carried on it based on the application. The wheel placement of the differential driving method is shown in the below figure.

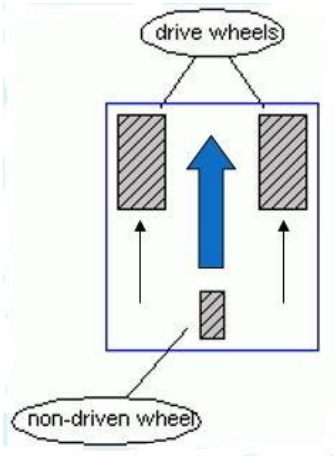

Fig1. *Differential Drive*

The power supply is also an important concern for a mobile robot. The robot requires a continuous power source to run the robot for a longer times in remote areas where a human can't give the power supply manually and the power source must be uninterrupted. The motors connected with the robot wheels requires more current compared to other peripherals connected to it. For amplifying the current given from the logic values of microcontroller IO pins, we use a driver circuit between the microcontroller and motors.

The self-driving feature for the proposed robotic system can be accomplished by monitoring the obstacles while moving the robot in any direction, the change in moving direction should be taken based on the direction of and distance from the detected obstacles. The obstacles can be detected by any of the proximity sensing methods. By studying about all the proximity methods, we considered the ultrasonic sensors. The ultrasonic sensors will works based RADAR working principle. The sensor emits microwave signals to the free space and if any obstacles detected by the sensors, then the distance and direction can be analysed by the microcontroller and the instruction can be given to the locomotion unit to take turn by skipping the obstacle. The distance measurement from the obstacle is shown in the below figure.

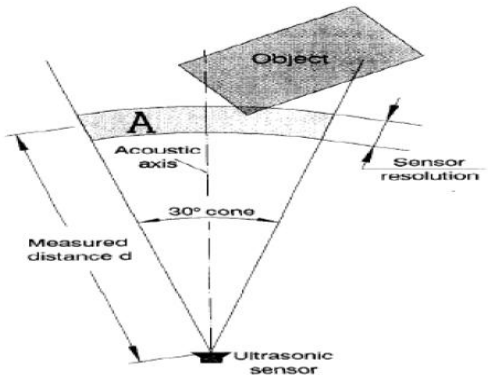

Fig2. *Ultrasonic Sensor working*

In the proposed system, we used 2 ultrasonic sensors to get precise obstacle avoidance and self-driving. The surveillance application can be achieved by using a digital web cam, which is placed on the robot in forward direction and that can be communicated through its IP address. The user can watch and record the video stream from the camera through its IP address in the web browser of

laptop or any mobile device. The range of video streaming depends on the communication range of the established local area network.

3. SYSTEM ARCHITECTURE

The system architecture involves a detailed description of hardware modules used in the proposed system.

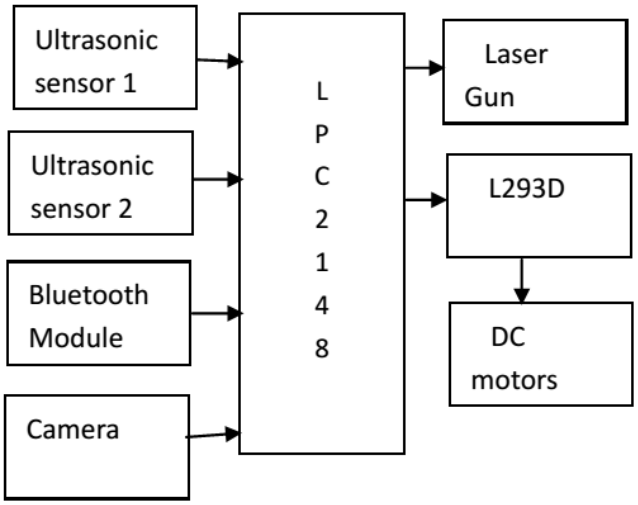

Fig3. *Block Diagram of system design process*

It is an ARM7 based 32 bit microcontroller with a simplified RISC architecture. It is having many on-board features like SPI, I2C and UART etc.

The communication between the robot and the smart remote gadget can be established with IEEE 802.15 Bluetooth standard. The Bluetooth module connected with the microcontroller will be paired up with the internal Bluetooth in the mobile phone or laptop. The ultrasonic sensors used is HCSR04, which is a 4 pin sensor device. It is having two sections in the sensor, one is trigger and another is echo receiver. The triggering section emits the microwave signals into space, and the echo receiver will waits for receiving the echo signal. The received echo signal will be continuously checked by the microcontroller to obtain the distance and depending upon a specific distance we process the communication with robot in different directions.

The motors used here are gearless DC motors and they require a power source with more power source. To amplify the current drawn from the microcontroller IO lines, we used a driver IC L293D, which can be worked with a source voltage range of 5 to 24v. The speed of the motor will vary depends on the supply voltage given to it.

Additionally, the robotic system consists of a laser gun as a self-rescue feature. In the war field applications, if a human soldier is not able to enter into some narrow places where he/she fond an enemy hidden there, he can be able to fire with a laser gun fixed on robot by controlling with his/her mobile phone.

4. SOFTWARE IMPLEMENTATION

We used 2 software tools for programming the LPC2148. They are

- Keil u Vision
- Flash Magic

Keil uVision is an IDE used for programming the many microcontrollers. It is having a text editor, C/C++ code compiler, assembler and simulator. All the required header files and libraries of various microcontrollers will be included in this IDE. A powerful programming environment will be provided by Keil uVision along with the hex file generation of the compiled C/C++ code which is required to flash into the microcontroller.

Flash magic is a code writing tool used for writing the code in the form of hex file into microcontroller's flash memory. It is also having a terminal application which is used to send/receive serial data to the devices communicated with serial port.

The algorithm followed in this robot is shown in the below flow diagram.

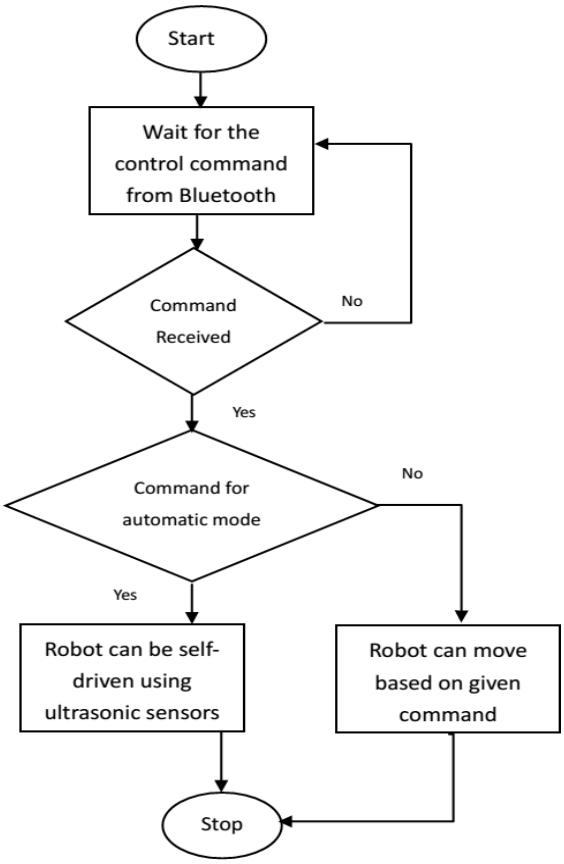

Fig4. *Flow Chart*

5. RESULTS

The robotic system was experimentally tested in the aspects of communication range and video streaming distance.

The experimental results of the implemented robotic system is as shown in the below picture.

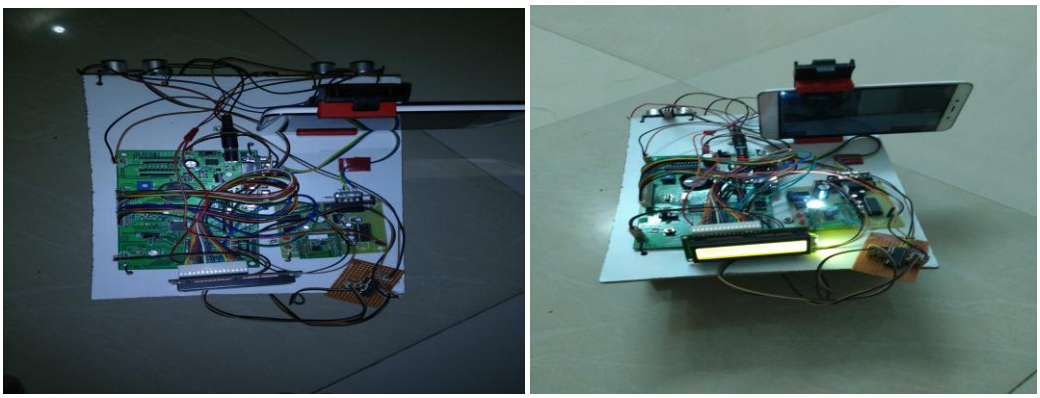

Fig5. *Designed Robotic System*

6. CONCLUSION

The proposed system of self-driven robot is an economic solution for surveillance applications. The robot will accomplish the tasks which can't be done by a human being in some special cases. Due to

usage of robotics in surveillance applications in war fields, we can reduce the man power losses for an unnecessary cause. The system is experimentally tested for video streaming and it is getting a communication range of nearly 50m, which is good enough for many surveillance applications. We can use this system in few more areas like industrial & disaster management by adding fire sensors, temperature sensors.

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