J-Component

CSE2006 - Microprocessor and Interfacing

SurB: Wireless Surveillance Bot

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VIT®

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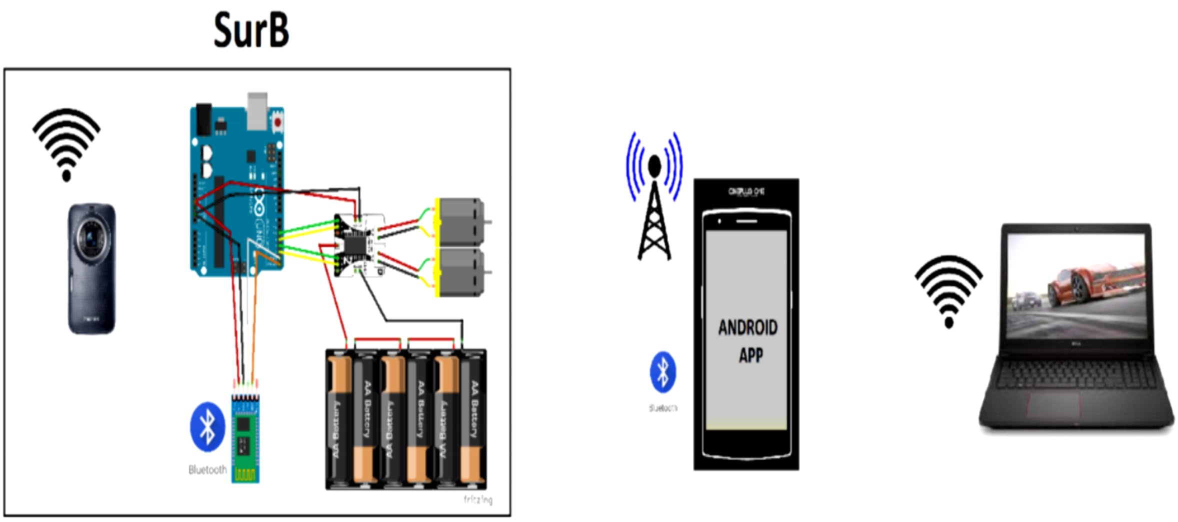
1. ABSTRACT

Aim of our project is to design and build an IoT enabled manually controlled surveillance ground robot. Its main purpose is to explore a given unfavourable conditioned remote environment (where humans cannot reach) while transmitting back real-time video footage to the remote monitoring station. This real-time data can then be used by the controller (human) to navigate the robot and to study the environment. We are specifically targeting Coal Mines as our remote environment. This is because, the harmful sulphur fumes which cause suffocation, poor visibility, fire causing massive explosions and the risk of tunnel collapsing makes it difficult for humans to go for inspecting the coal mines.

The received footage can be processed and enhanced by Image Processing Algorithms and analysed by Computer Vision, Neural Networks and Deep Learning Algorithms for detailed study and other scientific purposes. The robot is named, "SurB" (acronym for Surveillance Bot). The SurB prototype which we will make is a small IoT enabled bot which has a simple body (acrylic chassis, 2 motor wheels, 1 castor wheel), Arduino UNO, L293D (Motor Driver), Bluetooth Module (HC-05), a battery holder (6 AA), Wi-Fi module and a camera. This camera can be of any type based on the requirement. Some may use Infrared and UV cameras for special purposes. We are making use of simple camera of mobile phone which works in visible light spectrum. By using a mobile phone as camera, we also get built in Wi-Fi module which is interfaced with camera using an android application.

2. DESIGN & IMPLEMENTATION



From the system architecture diagram, we can clearly interpret working of SurB. The WiFi of both, sender mobile camera of SurB and the receiver laptop (to stream video) areconnected to WiFi hotspot of host mobile, creating a LAN over which video is parsed.

Bluetooth module of SurB is connected to Bluetooth of host mobile, which controls SurB's movements by an exclusively developed android application (mySurB).

3. LITERATURE SURVEY

A surveillance robot with hopping capabilities for home security: Most traditional home robots have always had problems with stairs, doorsills and other obstacles that humans cross with ease in cluttered indoor environments. This paper presents the development and characterization of a surveillance robot with hopping capabilities for home security. The proposed robot, which is 9 cm in height and 250 g in weight, can leap over obstacles more than 4 times its own size. It depends on the elastic elements in a six-bar linkage leg system to enable hopping locomotion. It can also roll freely on flat floors and change its directions by the two-wheeled differential drive system. It adopts the ZigBee protocol for wireless communication and therefore can be added to a ZigBee-based home control network as a mobile video sensor node. Experimental results verify that the prototype robot is a powerful home security device that can patrol in cluttered home environments with ease.

Wireless indoor surveillance robot: Self-propelled patrolling vehicle can patrol periodically in the designed area as a surveillance robot to ensure the safety like men do. The proposed robot based on the self-propelled vehicle not only can save manpower but also ensure the operation of surveillance being well performed. Due to the limitation of manpower and the fixed camera positions, using surveillance is different from the traditional patrolling system. The paper proposes a self-propelled patrolling vehicle which can move automatically to a wider range and record the monitored image within a predefined patrolling route to improve the performance of the traditional patrolling system. Besides, the surveillance robot can be connected to the mobile device or website on Internet at anytime and anywhere. Furthermore, the vehicle can be remote controlled by the instruction sent form the server or Smartphone to move to the position to get the indoor image we want. On the other hand, the position of self-propelled vehicles can be detected by the RFID readers mounted on the wall of the patrolling path as a feedback. The IP-CAM is also mounted on the proposed robot to record the images and transmit them back to the server via Wi-Fi system for face tracking and discriminating analysis. As an alarm report, the proposed surveillance would use the build-in MSN module to notice users of the predefined events when happened. Experimental results are given in the paper to validate its performance.

Vision Based Robotic System for Military Applications -- Design and Real Time Validation: This paper presents the design, development and validation of vision based autonomous robotic system for military applications. Sum of Absolute Difference (SAD) algorithm is used for the implementation of the proposed image processing algorithm. It works on the principle of image subtraction. The developed algorithm is validated in real time by change-based moving object detection method. The novelty of this work is the application of the developed autonomous robot for the detection of mines in the war field. Developed algorithm is validated both in offline using MATLAB simulation and in real time by conducting an experiment. Once the confidence of using the algorithm is increased, developed algorithm is coded into the Microcontroller based hardware and is validated in real time. Real time experimental results match well with those of the offline simulation results. However, there is only a small mismatch in distance and accuracy of the target detection, which is due to the limitations of the hardware used for the implementation.

Accurate fusion of robot, camera and wireless sensors for surveillance applications:

Often within the field of tracking people within only fixed cameras are used. This can mean that when the illumination of the image changes or object occlusion occurs, the tracking can fail. The paper proposes an approach that uses three simultaneous separate sensors. The fixed surveillance cameras track objects of interest cross camera through incrementally learning relationships between regions on the image. Cameras and laser rangefinder sensors onboard robots also provide an estimate of the person. Moreover, the signal strength of mobile devices carried by the person can be used to estimate his position. The estimate from all these sources is then combined using data fusion to provide an increase in performance. We present results of the fixed camera based tracking operating in real time on a large outdoor environment of over 20 non-overlapping cameras. Moreover, the tracking algorithms for robots and wireless nodes are described. A decentralized data fusion algorithm for combining all these information is presented.

Wadoro: An autonomous mobile robot for surveillance: This paper presents Wadoro (WAtch DOg RObot); an autonomous mobile robot for household surveillance in open-spaces like roof at night; but only shaded areas such as verandah during daytime. The robot has the capability to detect humans in near real-time round-the-clock using passive infrared motion sensors and camera. The work cycle of the robot is divided into phases of human detection; tracking; recognition and alert-generation with simultaneous phase of self-protection. On detecting a human; it starts tracking to detect the face using Haar-like features based cascade classifier. Subsequent recognition is done using local binary pattern histograms approach to ascertain if the face matches with the face in database. In case of mismatch; an alert in the form of phone call to the mobile phone is generated. Self-protection ensures collision-free movements and prevents it from being stolen by generating an alert call on detecting its pick up from the ground. The experimental results demonstrate its successful operation.

Design, simulation and manufacturing of a Tracked Surveillance unmanned ground Vehicle: This paper describes design, Simulation and manufacturing procedures of HIRAD - a tele-operated Tracked Surveillance UGV for military, Rescue and other civilian missions in various hazardous environments. A Double Stabilizer Flipper mechanism mounted on front pulleys enables the Robot to have good performance in travelling over uneven terrains and climbing stairs. Using this Stabilizer flipper mechanism reduces energy consumption while climbing the stairs or crossing over obstacles. The locomotion system mechanical design is also described in detail. The CAD geometry 3D-model has been produced by CATIA software. To analyse the system mobility, a virtual model was developed with ADAMS Software. This simulation included different mobility maneuvers such as stair climbing, gap crossing and travelling over steep slopes. The simulations enabled us to define motor torque requirements. We performed many experiments with manufactured prototype under various terrain conditions Such as stair climbing, gap crossing and slope elevation. In experiments, HIRAD shows good overcoming ability for the tested terrain conditions.

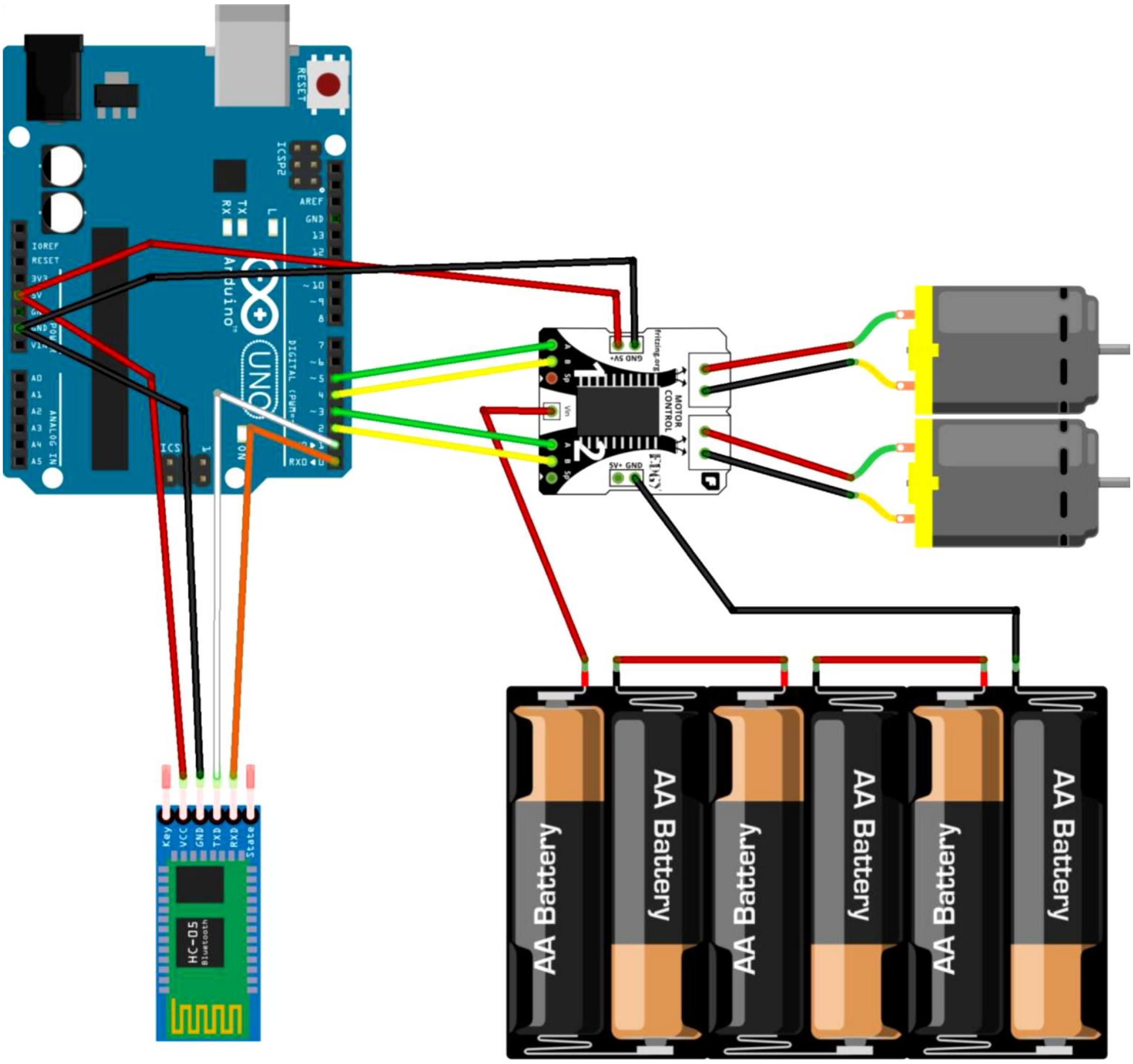
Obstacle avoidance and wireless network surveillance of a weapon robot: As one of the major steps toward fully intelligent autonomous robotic weapon, this paper works have accomplished in three major areas: (1) design of the surveillance system by 89C51 microcomputers, (2) implementation of the obstacle avoidance system, and (3) performance of the human machine interface surveillance system via LabVIEW graphical programming environment and wireless network surveillance equipment, such that the supervisor can control the vehicle by keyboard or genius mouse. In order to accomplish all these three achievements, there have been major additions and overhaul in both system software code and system circuit board developments. All these development including the developed algorithm, and hardware implementation are covered in this paper. The experimental results have shown the practicality of the 89C51 microcomputer, obstacle avoidance systems, LabVIEW graphical programming environment, wireless network surveillance equipment, and the ZigBee wireless technology applied to weapon robots.

Remote surveillance via wireless-controlled mobile robots: This work addresses visual remote surveillance through the World Wide Web. A mobile robot built at the RISC lab is controlled via the Internet with the help of images obtained from a network camera. The user specifies the desired position by utilizing the real time Web based visual interface. The autonomous robot moves to that location avoiding obstacles. The RISC team at University of Bridgeport has developed a web based wireless robot for remote applications. The mobile robot “UBROBO” allows remote control over the Internet using a lava-enabled web browser. A network camera installed in the lab provides real time feedback to the user regarding the robot's position.

Novel design of a wireless communication based automatic surveillance system for detection of suspicious objects: The paper presents the design, implementation of the unique type of computer controlled wireless mobile surveillance robot equipped with intelligence. Building an experimental autonomous mobile wireless vehicle, which has the ability to perform in real time environments is both a technical and scientific challenge and demands the development of systems for perception, modeling, planning and navigation. Within this scope, this paper describes the construction of a low cost mobile autonomous robot, intended for educational and surveillance purposes. This is a technology demonstration work. The objective of the work is to design, fabricate each part and construct a mobile robot and control it with a computer through wireless link which would accomplish two dimensional motion on a horizontal plane, moving from one place to another, avoiding obstacles in its path of motion by using infra-red sensors and performing the pick and place motion.

Video surveillance robot control using smartphone and Raspberry Pi: This paper proposes a method for controlling a wireless robot for surveillance using an application built on Android platform. The Android application will open a web-page which has video screen for surveillance and buttons to control robot and camera. Android Smartphone and Raspberry pi board is connected to Wi-Fi. An Android Smartphone sends a wireless command which is received by Raspberry pi board and accordingly robot moves. The Video Streaming is done using MJPG streamer program that gets jpeg data and sends it through a HTTP session. The Raspberry pi programming is done in python language. The experimental result shows that the video streamed up to 15 frames per second.

4. CIRCUIT DIAGRAM



5. HARDWARE & SOFTWARE SPECIFICATION

5.1.Hardware Specification

Component	Model #	Specifications	Price	Link
Robotic Chassiswith motorsand wheels	NA	- Acrylicplatform of size 15.5cm X 10cm - Acrylic platform of size 10cm X 10cm - 2 BO motor of 300 RPM each - 2 wheels - 1 castor wheel Required - screw, nuts, studs, spacers etc. - Double side foam tape pieces.	**₹ 449**	[1]

Thinkware 6AA BatteryHolder	TW183	6 AA BatteryHolder withconnector	**₹ 120**	[2]
Motor Driver	NA	- It uses thepopular L293motor driver IC. It can drive 4 DC motors on and off, or drive 2 DC motors withdirectional andspeed control. - It can drive motors up to36V with atotalDC current ofup to 600mA. -Onboard Heat-sink forbetterperformance.	**₹ 208**	[3]
Arduino Uno	R3	-The ArduinoUno is amicrocontroller board based on the ATmega328. - It has 14 digital GPIO pins (of which 6 can be used as PWM outputs) - 6 Analog inputs - a 16 MHzcrystal oscillator - a USB connection, a power jack, an ICSP header, and a resetbutton.	**₹ 540**	[4]
Bluetooth Module (HC-05)	DX49685	- Voltage 4.5V - The Default Baud Rate:9600 - Supports Android mobilephone Bluetooth	**₹ 329**	[5]
Miscellaneous	NA	- Jumper Wires - AA batteries - Android Smartphone - Laptop	**Not Definite**	-

5.2.Software Specifications

SOFTWARE	VERSION
IP Webcam	>= 1.8.23
Arduino IDE (only to burn the sketch)	>= 1.8.5
VLC Media Player	>=2.2.6
mySurB Android App	1.0

6. ARDUINO SKETCH

```
#include<SoftwareSerial.h>
SoftwareSerialmySerial(6, 7);
#define m11 5 // left-motor-forward
#define m12 4 // left-motor-backward
#define m21 3 // right-motor-forward
#define m22 2 // right-motor-backward
void forward()
```

```
{
digitalWrite(m11, HIGH);
digitalWrite(m12, L
digitalWrite(m11, LOW);
digitalWrite(m12, LOW);
digitalWrite(m21, HIGH);
digitalWrite(m22, LOW);
}
void right(){
digitalWrite(m11, HIGH);
digitalWrite(m12, LOW);
digitalWrite(m21, LOW);
digitalWrite(m22, LOW);
}
void Stop()
{
digitalWrite(m11, LOW);
digitalWrite(m12, LOW);
digitalWrite(m21, LOW);
digitalWrite(m22, LOW);
}
void setup()
{
mySerial.begin(9600);
pinMode(m11, OUTPUT);
pinMode(m12, OUTPUT);
pinMode(m21, OUTPUT);
pinMode(m22, OUTPUT);
}
void loop()
{
 if (mySerial.available())
 {
 char ch=(char)(mySerial.read());
 if(ch=='W')
 {
forward();
 }
 else if(ch=='D')
 {
right();
 }
 else if(ch=='A')
 {
left();
 }
 else if(ch=='S')
 {
backward();
 }
 else if(ch=='X')
 {
Stop();
 }
 }
}
```

7. SNAPSHOTS

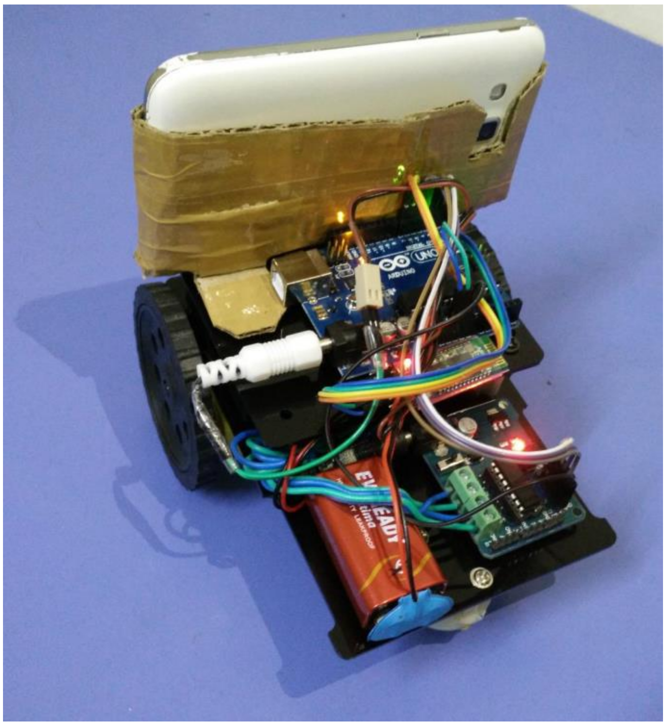


Figure 1 Picture of the SurB bot

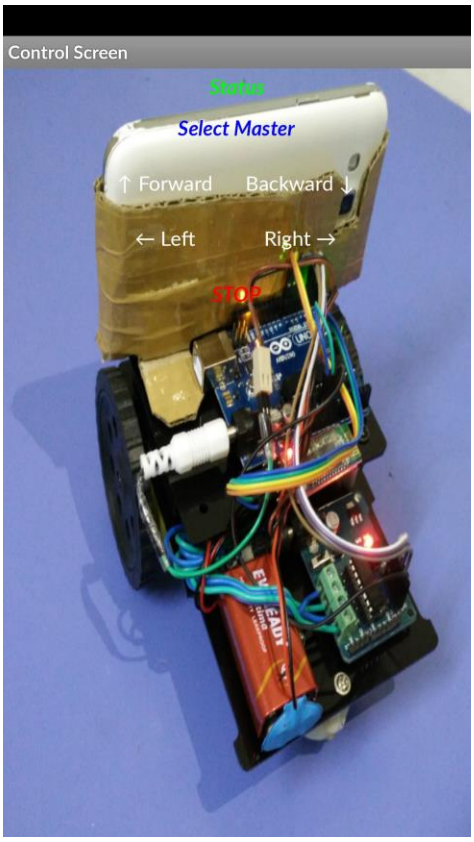


Figure 2 Screenshot of the mySurB Android App

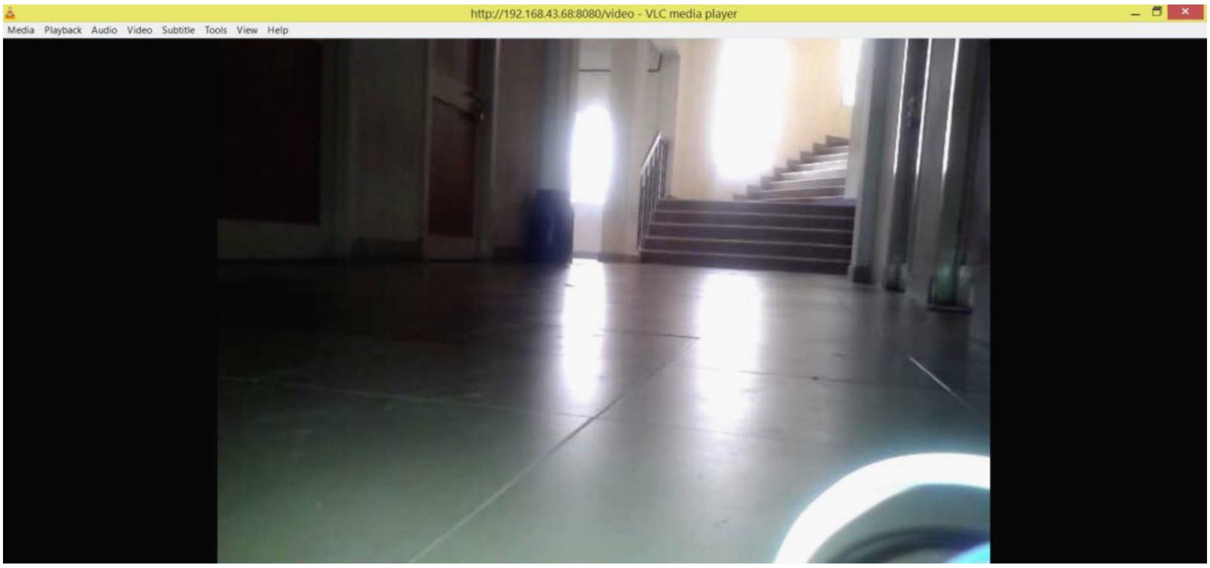


Figure 3 Viewing the live video stream on a remote computer in VLC

8. CONCLUSION& FUTURE WORK

This project offers a lot of scope for adding newer features. Since there are no resource constraints apart from the bandwidth of the network. We can program the robot such that it can detect objects and reach them on its own. Thus, we can make it completely autonomous. Also, with the presence of GPS navigation and mapping software, the robot can have the capability of finding the best route possible to reach a certain location. Also, by making it sturdier and giving it extra protection, we can make it an all-terrain robot, which would make it ideal for a surveillance robot. There is also the option of adding sound processing to the remote computer, thus giving it greater surveillance capabilities. The possibilities are endless. This robot in its current state provides a platform for further research into improving its capabilities.

In future, the project SurB can be further enhanced in many ways:

- Hopping capabilities can be added to the bot by altering the design and structure to let it petrol in cluttered environment with ease.
- Robot gains online cloud connectivity which will increase its domain of use.
- It can be used for security purposes in homes for detecting any unknown presence or saving mankind work.
- Application can be extended to military use. We can add high image processing capabilities to the surveillance section of bot help in surveying in battlefield detecting mines and other deadly bodies.
- Laser module attachment over the bot will let the robot to sense distance can be used as an add-on feature.
- Bot can be given a centipede like body which will enable it moving through after earthquake debris looking for survivors.
- With a waterproof body and wheels replaced with flippers, this bot can even inspect marine life.

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