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MECABOT: A Home Security Smart Phone Robot

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Abstract- **Now a day's home security is a critical issue in society. An android controlled locomotive robot platform, developed in order to enhance home security. The drive mechanism consists of 3 differential locomotive modes, with 2 steerable and 4 derivable wheels. MECABOT is controlled by 2.4 GHz short range radio frequency band. The data is transmitted using a frequency hopping spread spectrum of Bluetooth technology. Motor driver with PWM (Pulse Width Modulator) is used to control motor power and direction. The data transmitted to control robot is send by an android app inbuild facility of Bluetooth. In this system the mobile robot platform was developed using Android and Arduino environment.**

Keywords: **Android App, Bluetooth, PWM (Pulse Width Modulator), IR (Infrared Rays)**

I. INTRODUCTION

With the everyday advancing technology true revolution has been taken in the field of cellular systems, resilience computing and mobile robotics. Mobile robots are machines with a large mobility within its environment. They introduce a certain level of autonomy and perception ability widely accepted in industries, military, medical and surgical operations. One of the most successful large-scale endeavors of mobile robot is the driver less car. Google driverless car consists of lasers, sensors & cameras to detect object in all directions, Maps to follow the correct path and software to determine the safe speed for the vehicle that reduces human involvement and thus degrades accidental losses. There are many small-scale projects like human tracking system, danger scanner and wireless obstacle detection for home security. Mobile robots can also be used for indoor purpose as room cleaner, object finder, emergency support and home security. For home security CCTV cameras are mostly used but this system is static system and requires many CCTV cameras to cover the entire home, which makes the security method complex, less efficient and costly. The android based mobile robot "Mecabot" is introduced to overcome this problem.

The system is designed with a night vision camera and an infrared detector to detect the anonymous entity in enters the house. This robot is controlled through an android device. The command to control the robot and to operate the camera is send from the android platform to the Mecabot. For this an Android app is developed which consist of the 3 differential speed modes, IR mode to detect the obstacles. App provides user an interactive interface to select the desire speed and IR modes, the data is transmitted to the device through an inbuilt Bluetooth. For communication, Bluetooth uses the piconets to communicate through the devices. The data is passed through PWM and the robot is made to run over the desired mode. These implementations make mecabot evolve as an efficient and less costly home security device as compared to CCTV camera.

II. RELATED WORK

Many of the mobile robots have been developed and researched with distinct features. The word robot was introduced in 1921 in English and the first three wheeled mobile robotic vehicle was built by Grey Walter [12].The Pyxis, a battery operated robotic courier designed to perform material transport within the hospital without the use of external guidance like fixed tracks or guiding wires and provide tighter security for medication and supplies [15]. Robots in medical field includes Wheelesley an user interactive robotic wheelchair developed in MIT Artificial Intelligence Laboratory to help user with driving assessments by adapting both indoor and outdoor environments and provide navigation for efficient travel [14].

The new college vision and data sets is a robotics research to collect data from the robots that drive for kilometers all the data is time stamped and is human readable which can be used for further analysis [11]. Algorithm for mobile robot mapping with application to multi robot and 3D mapping build 3D maps of large cyclic environment using the multi resolution approach in real time environment [13].

Social Robot was one of the robots developed for elderly home care [6] and also designed for offering independent functionalities for monitoring and maintaining the security and health and psychological wellbeing of elderly people to help in their daily routine. This robot provides personalized services based on the user preferences, information and routine, making it easier and more comfortable for elderly people to work independently. With a different approach a human tracking system mobile Robot was designed by Suat Kakaya [10]. It also consists of differential drives to do mobile robot researches. The robot is remote controlled with Infrared LED and camera for localization and uses LIDAR (Laser Imaging Detection and Ranging) to detect obstacles.

Pick and place android robot was designed by Butkar Vinayak. D to do pick and drop of objects with a catching

gripper it can safely pick up the bomb without getting exploded, it can be used to reduce the labor work in industries and to make the functioning more efficient [9]. This robot uses Bluetooth communication for transmission of data and consists of a television set to view the functioning of robot. An autonomous android control robot using wireless energy [7] is designed to initiate the task using voice input, this robot eliminates the sensors used to detect the object and is detected by android application.

Another totally different approach is behind the autonomous question and answering through the mobile robot [1] and this robot answers natural language question about large scale dynamic environment asked by the user. It predicts the viewpoint and then work towards the viewpoint and meanwhile it adapts the new information from the environment. As images can be analyzed easily this robot uses end to end framework capable of answering the question by analyzing the image captured by the robot. These robots can be used in offices, hospitals and even warehouses.

Recent researches and innovations include probabilistic approach of visual homing of a mobile robot in the presence of dynamic obstacles [5]. In this work, the robot comes back to its reference position by comparing the image captured at current and reference position with the help of probability framework that assures the optimist performance and successful movement of the robot. Scene recognition for mobile Robot [2] Experience based path planning [3] visual programming for mobile robots [4] has set an emergence to develop more advance and reliable home security mobile robot. Most closely related to our work was Bluetooth communication controlled mobile robot [8] which uses gesture recognition to control the movement of the robot and the gripper arm pair. This robot uses an android app for user interface, accelerometer and Bluetooth module. In this robot two approaches have been displayed. First the phone acts as the processing unit and in another approach external accelerometer for gesture recognition is used with Arduino and Bluetooth module. This robot consists of gripper for holding object and can also control the speed and direction of the robot according to users' interest using gestures and control wheel in user interface.

III. PROPOSED SYSTEM

The android device controlled mecabot is developed using the Bluetooth communication and android platform. The modes and locomotion of the robot is controlled by the android mobile application. The app sends the data through the Bluetooth, Bluetooth uses radio waves instead of wires. The communication between Bluetooth devices works on short range ad-hoc network known as piconets and the Bluetooth receiver on the other hand configured with the Arduino board receives the data. The Arduino processes the instruction and thus the operation commands are transferred to the mecabot.

A. Bluetooth Communication

The Bluetooth communication module (Master/Slave HC-05) is connected through the Smart phone (Bluetooth enabled). The port in Bluetooth module HC-05 acts as slave and get automatically paired when the user device request for Bluetooth communication.

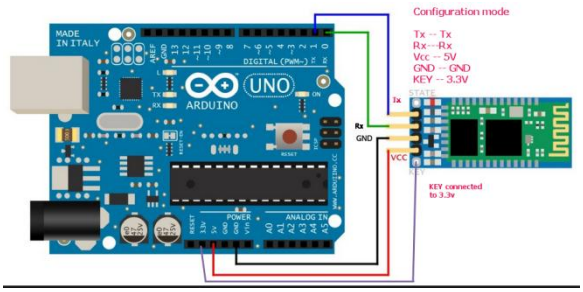

Fig. 1 Bluetooth with Arduino Connection

The Bluetooth module HC-05 gets connected with the Arduino as shown in Fig. 1. The Rx of Bluetooth is connected with the Rx of Arduino, TX of Bluetooth gets connected with the TX of the Arduino, Vcc is connected to 5v power port and the GND gets connected with the GND port of Arduino. HC-05 module with Arduino processing performs the mecabot operations. The Smart phone acts as the transmitter in the app named Robo_car.

1. Transmitter

The smart phone acts as transmitter. In the android app (Robot car) uses the smart phone sensors which compute the data using Smart phone processors, encode the data into Bluetooth module acceptable format and sends the data to the Bluetooth module.

2. Receiver

In this system Arduino is the receiver. Arduino receives the signals from the Bluetooth and executes the robot operations. Arduino gives command to PWM for motor operation for vehicle direction and for speed.

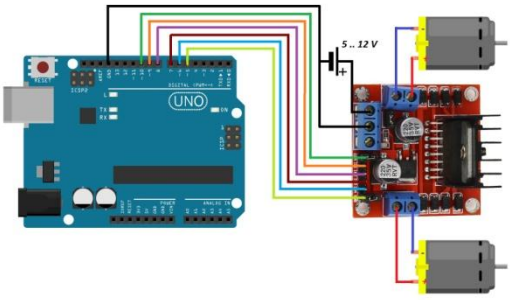

Fig. 2 Motor Driver L298N-H Bridge with Arduino Connection

In Fig. 2, the two driving motors are connected on the right and left side of bridge. The PWM of right side motor is

connected to digital pin 12 of arduino and high and low inputs are connected to pin 7 and 8. Similarly for left side motor the PWM is connected with pin 9 and the high and low inputs are connected with pins 10 and 11 thus modulating the speed and direction of the motor.

B. System Connection

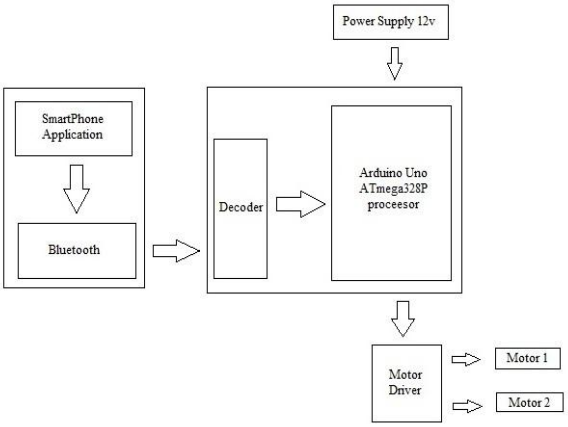

Fig. 3 Block Diagram Representing Instruction Flow

Fig. 3 represents the block diagram of the instruction flow from the user's Smart phone to the Arduino. As the user sends the command form the smart phone application (Robo Car), the data goes to the smartphone Bluetooth, from there the data get transmitted to the Bluetooth module HC-05 then the data get decoded and is transmitted to the Arduino. Arduino reads the data and send the instruction to Motor drive that runs the motors of the Mecabot accordingly.

C. Android Application

The android app is developed to process and compute the user inputs to control the robot car (Mecabot). The app consists of GUI interface for the user. Directions keys are provided in the interface to control the movement of the car. The locomotive speed of Mecabot is controlled with the radio buttons placed at the top right corner. It also consists of Bluetooth pairing button to pair the Smart phone with the Bluetooth module.

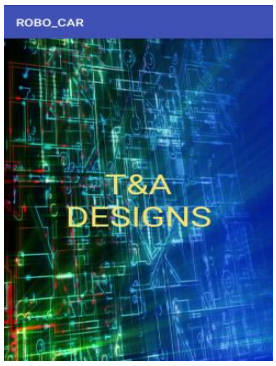

Fig. 4 Main Window of ROBO_CAR App

First, the users have to connect the app with the Bluetooth module HC-05 by clicking on the Bluetooth button the default password is 0000 or 1234.Then the user can operate the Mecabot through the android app. The user can control the robot direction by pressing the upper arrow key to move forward, lower arrow key for moving backward, right arrow key for turning right and left arrow key for turning left. It has a stop button in the middle to stop the Robo_car, by switching off both the motors. This app also consists of 3 differential moving mode high speed, medium speed and low speed, user can select these modes by clicking over the radio buttons in the app as shown in Fig. 5.

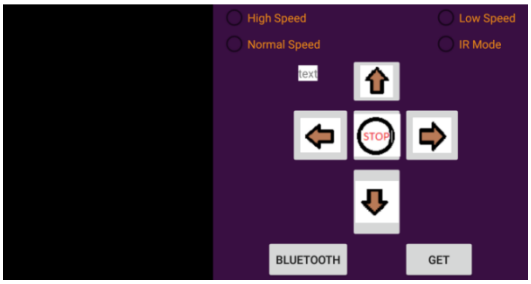

Fig. 5 Main Control Panel of Mecabot in ROBO_CAR App

The Android app also consists of a video panel at the left of the screen and IR mode radio button for future prospectus. This panel will display the real-time image obtained by the camera attached with the Mecabot.

D. Power Supply

For power supply, Arduino uses 9V carbon zinc battery and two 9v batteries power supply is required for the motor driver.

E. Locomotion

For locomotion of the Mecabot, L298N-H bridge DC driver controller is used. The speed of the motor is controlled by the PWM thus providing three different speed modes for the Mecabot motors.

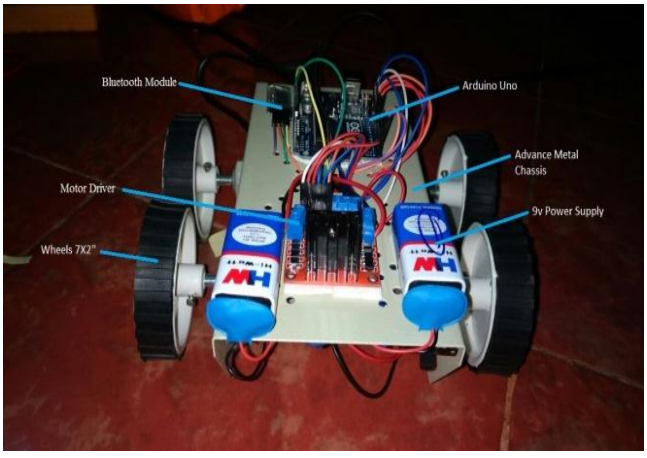

Fig. 6 Mecabot Chassis Implementation

F. Chassis

Advance metal chassis is used with holes to fix Arduino, Bluetooth module, motor driver and 4 pieces of 7 x 2 wheels with the nuts bolt.

IV. IMPLEMENTATION RESULTS

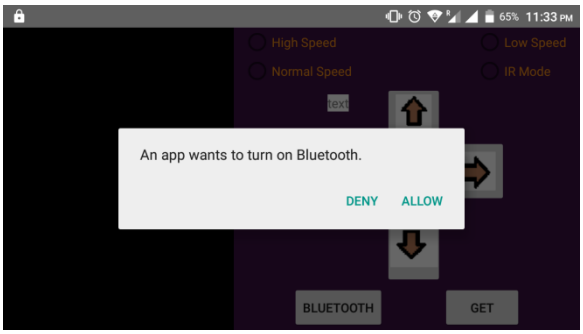

Fig. 7 Output when Bluetooth button is pressed

As shown in Fig. 7, when Bluetooth button is pressed the app will ask permission from the user to switch on the Bluetooth of the device. Once the device is paired, the user can check the paired device by clicking GET button. GET button displays the information of the device paired in the text field.

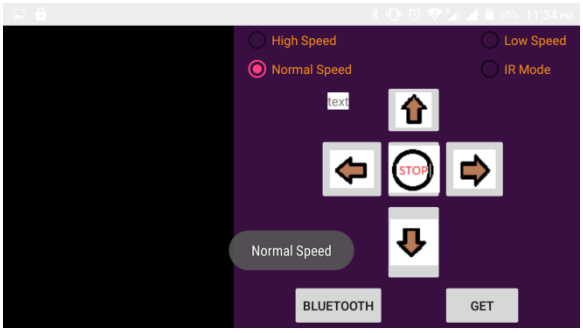

Fig. 8 Output when Normal speed button is selected

There are 4 mode options available in the app, as in fig.8 when the normal speed button is selected the Mecabot start running at 170 rpm.

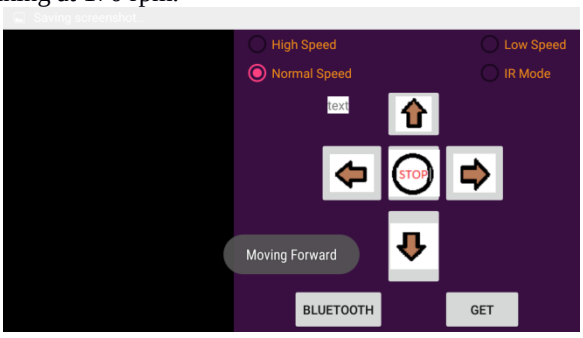

Fig. 9 Output when Upward Arrow button is pressed

As shown in Fig .8 when the upward arrow is pressed by the user the signal is transmitted to the Arduino and the Mecabot start moving in forward direction, similarly when downward arrow is pressed the mecabot moves in backward direction. For moving right and left, right and left arrow keys are to be pressed by the user respectively and a stop button is been attached at the center which signals the Arduino to stop the motor.

V. FUTURE PROSPECTUS

Nowadays capturing theft is not enough to reduce the crime rate because with increase in technology vulnerability is also increasing such as

1. Camera can lose its integrity
2. Mecabot can be damaged
3. Mecabot get stuck with the household objects.

To overcome these problems, further improvisations to be made in the mobile robot which consist of following components

1. Night Vision camera
2. Wi-Fi connectivity with the android device
3. IR sensors to detect obstacles
4. Parabolic cover with adjustable robot height.

A. Night Vision Camera

The night vision camera is a device used to see the real-world objects in dark. This device sends infrared signals and is capable of detecting it in camera. Humans cannot see infrared rays with our naked eyes but is visible with the help of infrared detection camera making the object visible in dark. This camera will help to enhance the security by detecting the movement of person during night hours and can send alert message to the user.

B. Wi-Fi Connectivity

The Wi-Fi stands for wireless fidelity. It works on the principle of sending the data to the receiver through radio waves. The data is transmitted through radio signals to the decoder (router) where the data is decoded and send to the Internet through wired connection. Wi-Fi covers 802.11 IEEE standards for transmission of data and the data gets transmitted at a frequency of 2.4GHz or 5GHz. Wi-Fi module can connect more than one user and can be detected at greater distance with faster data transmission as compared to Bluetooth.

C. Infrared Sensors

Infrared sensor works to detect the objects around the robot. IR consists of a transmitter LED and a detector photodiode. Light from the transmitter travels and bounces off the object and travels back to the receiver. Receiver differentiates between the transmitted and received light waves thus detect's the object. IR sensors in the robot will detect the

obstacle in its path to avoid damage to the Mecabot caused due to collision.

D. Adjustable Robot Height

The Mecabot will be equipped with parabolic cover to protect the connections of the robot and flexible wheels with spring suspension. The wheel spring will be provided with manual compression and expansion mechanism. If the Mecabot gets stuck in the home furniture like sofa, table, the spring will get compressed and the height of the vehicle will be lowered and the Mecabot can come out of that area, once the Mecabot comes out, the spring get expanded to its original state. This system can be further enhanced by configuring mecabot to function without any external guidance and human interface. Thus, making Mecabot is completely compatible for home security.

VI. CONCLUSION

This paper deals with the locomotive home security system in which the mobile robot is controlled and navigated by user preferences by a Smart Phone App ROBO_CAR. When the user selects a preference either to move forward, backward, right, left or any of the differential modes, the data is transmitted from the smartphone with the help of Bluetooth to the paired Bluetooth module HC-05 attached with the Mecabot.

The data is then decoded and executed by the Arduino processing unit and is performed by the Mecabot. On further up gradation with the hardware of the Mecabot, the motor driving speed can be increased, long lasting and rechargeable power supply and faster data transmission between Smart phone, to create a more flexible and efficient interface for the user and making the mecabot move without any external guidance like guiding wire. The robot can serve as reliable, user friendly, easy to use as well as economical home security device.

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