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Prototype Development of a Smartphone-Controlled Robotic Vehicle with Pick- Place Capability

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Abstract— The work in this paper is directed towards the development of a robotic vehicle with arm and gripper, whose movements can be controlled by giving commands through android based Smartphone over Bluetooth wireless protocol. The Smartphone has been equipped with a suitable android application which can send up to Thirteen different codes wirelessly that can be decoded at the Bluetooth receiver end with the help of microcontroller based circuitry. The controller circuitry can then activate the various motors as per the code through suitable circuitry as long as the particular code is being received. The vehicle can move clockwise, anti-clockwise, forward and in reverse fashion. The arm has an elbow movement and the gripper has holding and releasing action.
Keywords— Bluetooth wireless protocol, Robotic vehicle, arm and gripper, Android application

I. INTRODUCTION

Now a day's Smartphone's based on android OS are becoming quite popular because of a wide variety of applications available for this particular OS. In this paper one of these applications known as "BLUECONTROL" has been utilized. With help of this application the user can send unique and discrete codes via Bluetooth communication protocol. Each code is decoded at the Bluetooth receiver end with the help of microcontroller 89C51 based circuit. The controller then generates outputs resulting in a particular movement such as movement of vehicle in forward and reverse direction, movement of elbow and gripper etc by activating suitable motors depending on what code is being received. The movement happens only for that amount of time for which a particular code is received successfully. Pick and place can be designed in various ways as in [1], [2] and [5]. Also android based Bluetooth technology implementation can be done using standard applications (e.g. [3], [4], [8] and [10]).

II. PURPOSE

The purpose in this paper is to design prototype of a wirelessly controllable robotic vehicle which can also pick and place small objects. Such a robot can in future be used in Industries for picking and placing objects in hazardous conditions. The main objectives are:
To use android phone for giving commands to the robot for a particular movement to happen.
Usage of Bluetooth technology
Pick and place operation of small light-weight objects.

III. MATERIAL AND COMPONENTS USED

A. Microcontroller 89C51

AT89C51 is an 8-bit microcontroller and belongs to Atmel's 8051 family. **ATMEL 89C51** has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times. In 40 pin AT89C51, there are four ports designated as P_1, P_2, P_3 and P_0. All these ports are 8-bit bi-directional ports, i.e., they can be used as both input and output ports. Port P_0 and P_2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port 3 has multiplexed pins for special functions like serial communication, hardware interrupts, timer inputs and read/write operation from external memory. AT89C51 has an inbuilt UART for serial communication. It can be programmed to operate at different baud rates. Including two timers & hardware interrupts, it has a total of six interrupts

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B. HC05 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup as in [7]. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

Fig. 1. HC-05 Bluetooth Module

C. L293D Motor Driver IC

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

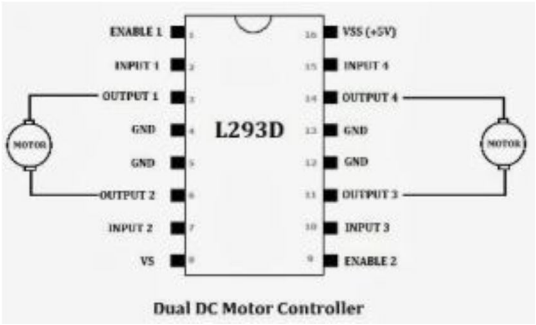

Fig. 2. L293D Motor Driver IC

D. DC Motors

This helps in moving various parts of the robot. The 5 V dc motor has two terminals. By changing the polarity of the supplied voltage at these terminals, one can change the direction of rotation of the motor. Two such motors have been used in the vehicle which helps in its forward, reverse, clockwise and anti clockwise movements. One more motor has been used for providing the elbow movement.

E. 5V Servo Motor

A Servo is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. As the coded signal changes, the angular position of the shaft changes. In practice, servos are used in radio controlled airplanes to position control surfaces like the elevators and rudders. They are also used in radio controlled cars, puppets, and of course, robots.

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Fig. 3. 5V DC Servo motor

One such motor has been used to provide the gripper holding and releasing movements.

F. 7805 Voltage Regulator

This provides regulated 5V dc for the control as well as the power circuit.

G. Blue Control V2.0 Application

This is an android application which has been installed in a Smartphone as in [6], [9]. It helps in operating the phone as a universal remote control for sending commands to the microcontroller over Bluetooth protocol.

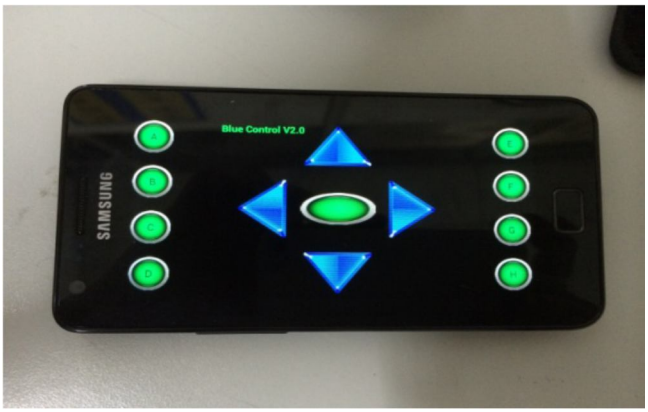

Fig. 4. Bluetooth Remote Control Interface (Blue Control V2.0)

IV. BLOCK DIAGRAM OF SYSTEM

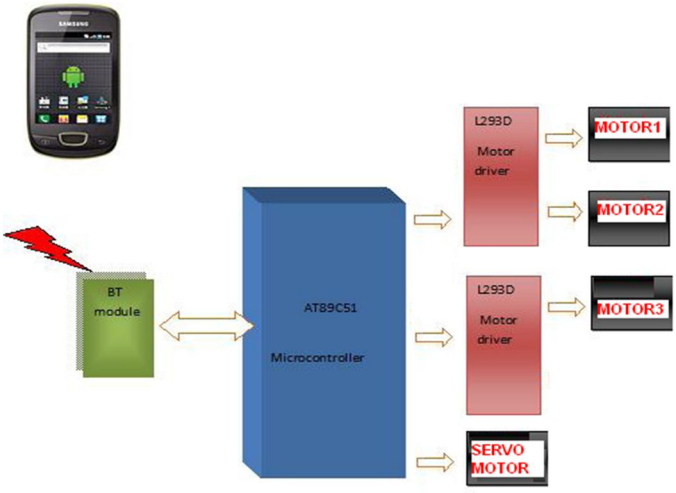

Fig. 5. Block diagram

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With the help of "Blue-control" application different messages in the form of ASCII characters are sent from phone to the receiver, interfaced to the microcontroller. These characters are detected by the microcontroller and for each particular character it enables particular outputs at the output ports. The outputs are then amplified with the help of motor driver ICs and finally lead to the movement of the motors.

For the servo motor, the microcontroller sends timed pulses so as to achieve a definite positional displacement of the motor which finally leads to a proportionate movement of the gripper.

V. CONTROL LOGIC

Microcontroller waits until it receives a character at the serial port.

After that it compares the received value with some preset reference values.

If value matches then a particular value reserved against the preset reference value is sent to the output port which activates dc motors accordingly.

In case of servo motor the timed delays of the pulses is changed depending upon whether the gripper has to holding or releasing.

The loop is repeated by going back to step1 of the control logic.

VI. RESULTS AND DISCUSSION

After the mechanical and electronic fabrication, the robot has been tested for operation. Following results have been obtained:

The vehicle moves in forward direction when UP arrow button is pressed in the Smartphone application.

When DOWN arrow is pressed the vehicle moves in the reverse direction.

Pressing of LEFT arrow button leads to the vehicle rotating clockwise.

Pressing of RIGHT arrow button leads to the vehicle moving in anticlockwise direction.

On pressing "A" button the elbow moves upwards.

On pressing "B" button the elbow moves downwards.

"C" button activation leads the gripper to open.

"D" button activation leads the gripper to close.

Various views of the robot have been shown in figure no. 6 to figure no.11. which give an idea of the mechanical structure as well as the electronic pcb used.

Two limit switches have also been used which may not be visible in the images. These switches help in limiting the span of the elbow movement in order to protect the dc motor against sudden surge of high current when elbow reaches the maximum traversable distance and is unable to move further because of the mechanical limits. These switches cut off the dc supply to the motors when end limits of movement are reached.

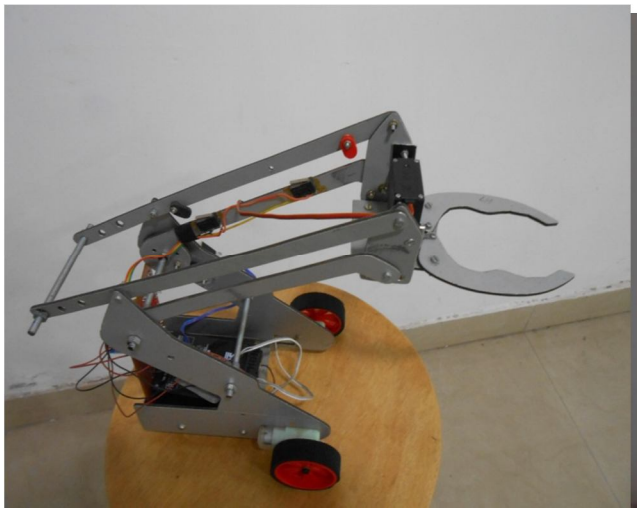
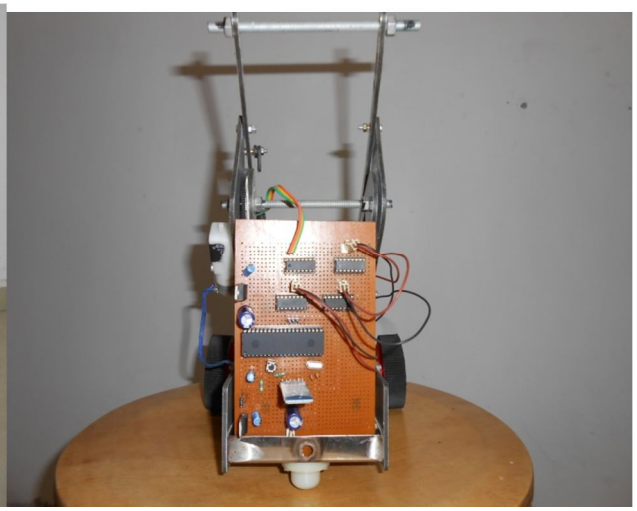


Fig. 6. Robot Image1.



.Fig. 7. Robot Image2

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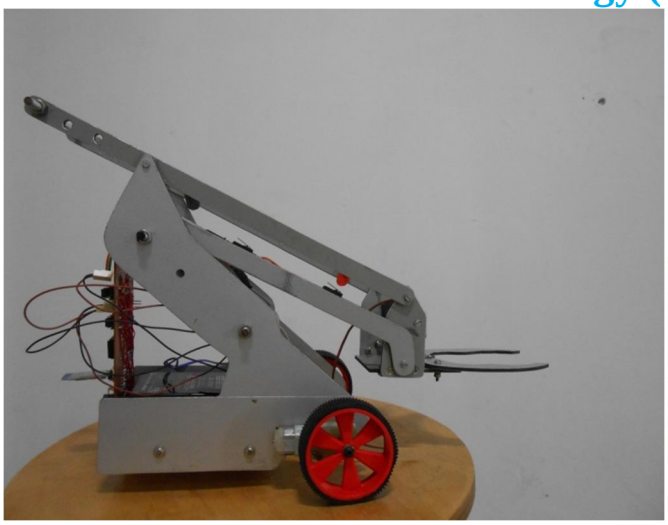

Fig. 8. Robot Image3

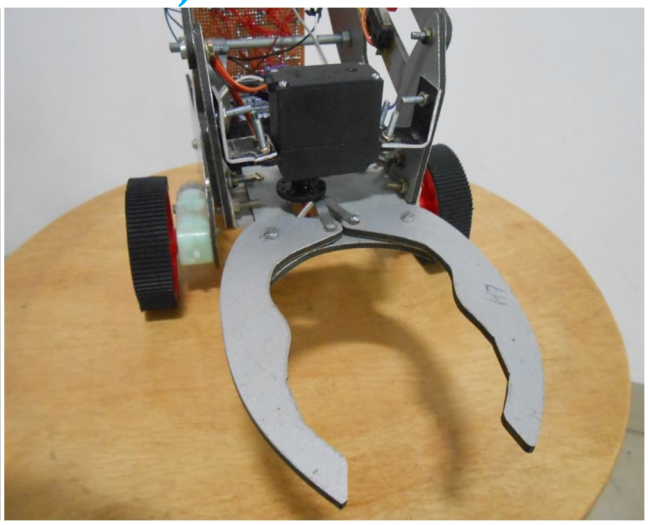

Fig. 9. Robot Image4

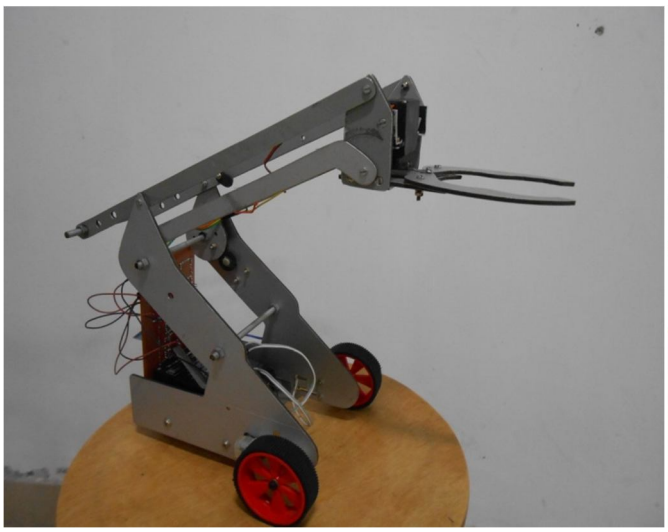

Fig. 10. Robot Image5

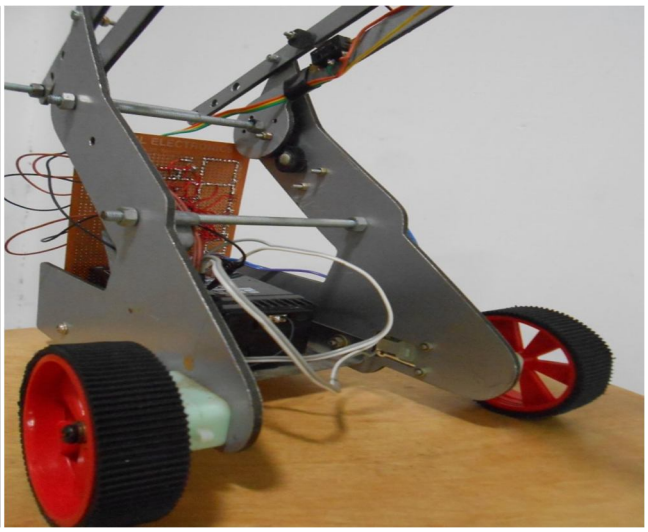

Fig. 11. Robot Image6

VII. CONCLUSION

A wirelessly controllable robotic vehicle with pick and place capability has been designed. Such a robot can be used in hazardous industrial environments where there is danger to the human workers and labour etc. Also, the bluetooth technology is free to use and thus provides a cheap way to control devices wirelessly. The robot can be equipped with a wireless camera in future for better remote accessebility.

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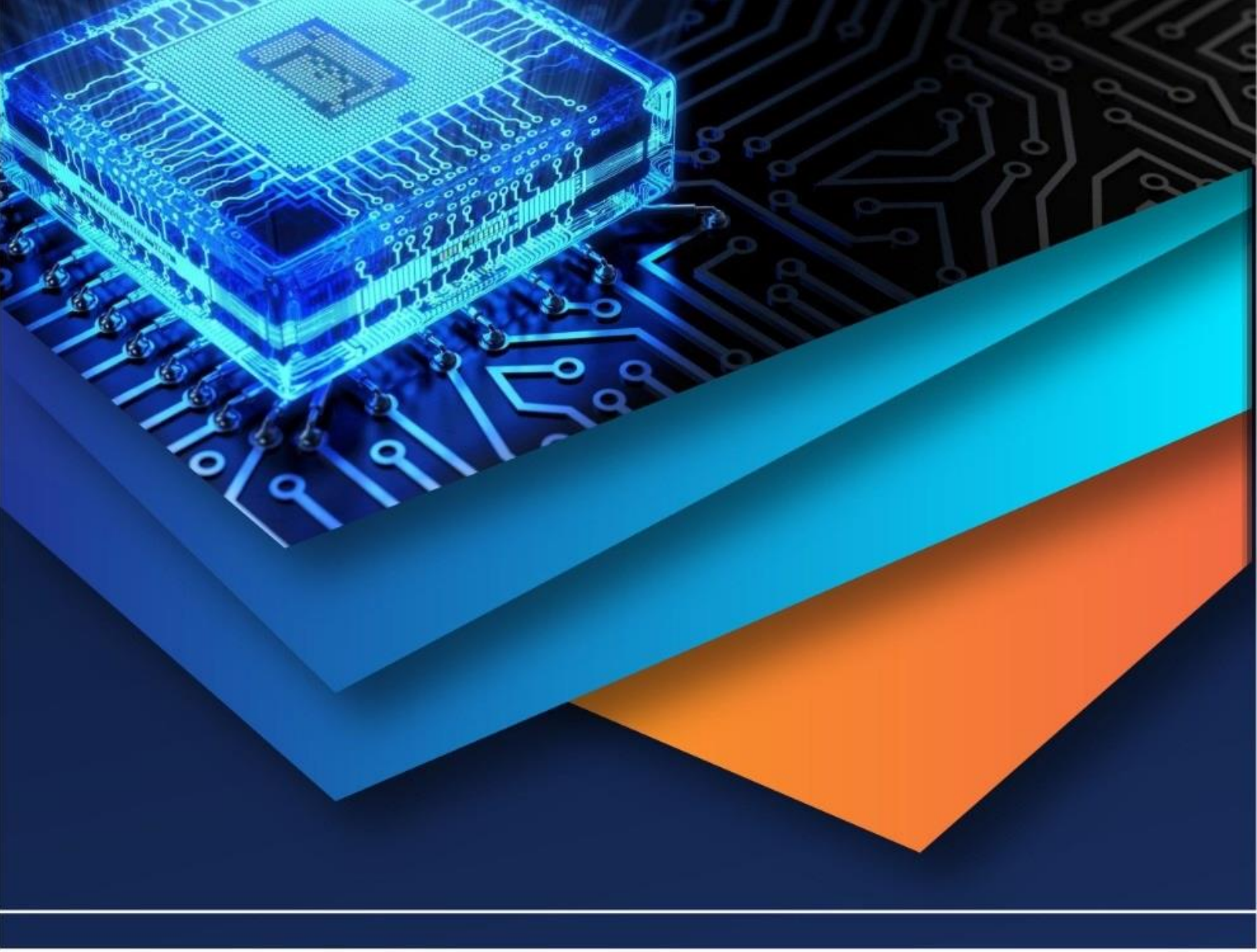

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