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LNBC Physical Status Monitoring System on PDA

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Abstract - *In this paper we present a study of a robotic system that consists of an unmanned aerial vehicle (UAVs) and unmanned ground vehicles (UGVs). The idea is to design android application based a robotic vehicle for remote operation or (UGVs). This is a kind of robot can be helpful for mobility aid or elderly people. We get the live video streaming data on the operator side during site observation by robot. The quadcopter or FPV (First Person View) or video piloting, is a method used to control a radio-controlled vehicle from the driver or pilot's view point. Most commonly it is used to pilot a radio controlled aircraft or other type of unmanned aerial vehicle (UAV).In future this robotic is applicable in various fields. The proposed algorithm shows efficient energy utilization and increased flight time. The main aspect to monitor the physical status of parabolic dish antenna without approaching to real field.*

Keywords: *Robotic vehicle; first person view; radio controlled vehicle; video streaming; parabolic dish antenna*

I. INTRODUCTION

Our project is based on domain embedded system and Robotics. An embedded system is a computer system with a dedicated function for specific task in which microcontroller programming is used, often real time constrains. Microcontroller chip is as a system on a chip which contains a little amount of inbuilt RAM, ROM, Flash memory itself. A robot is a mechanical or virtual artificial agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry. A Robot is a mechatronics device which also in includes resourcefulness or autonomy. A device with autonomy does its thing “on its own” without a human directly guiding it moment-by-moment Robotics is a confluence science using the continuing advancements of mechanical engineering, material science, sensor fabrication, manufacturing techniques, and advanced algorithms. The study and practice of robotics will expose a dabbler or professional to hundreds of different avenues of study. For some, the romanticism of robotics brings forth an almost magical curiosity of the world leading to creation of amazing machines. A journey of a lifetime waits in robotics. Robotics can be defined as the science or study of the technology primarily associated with design, fabrication, theory, and application of robots. The video streaming is advance feature in our robot we had tried to make it very cost effective with high resolution of viewing.

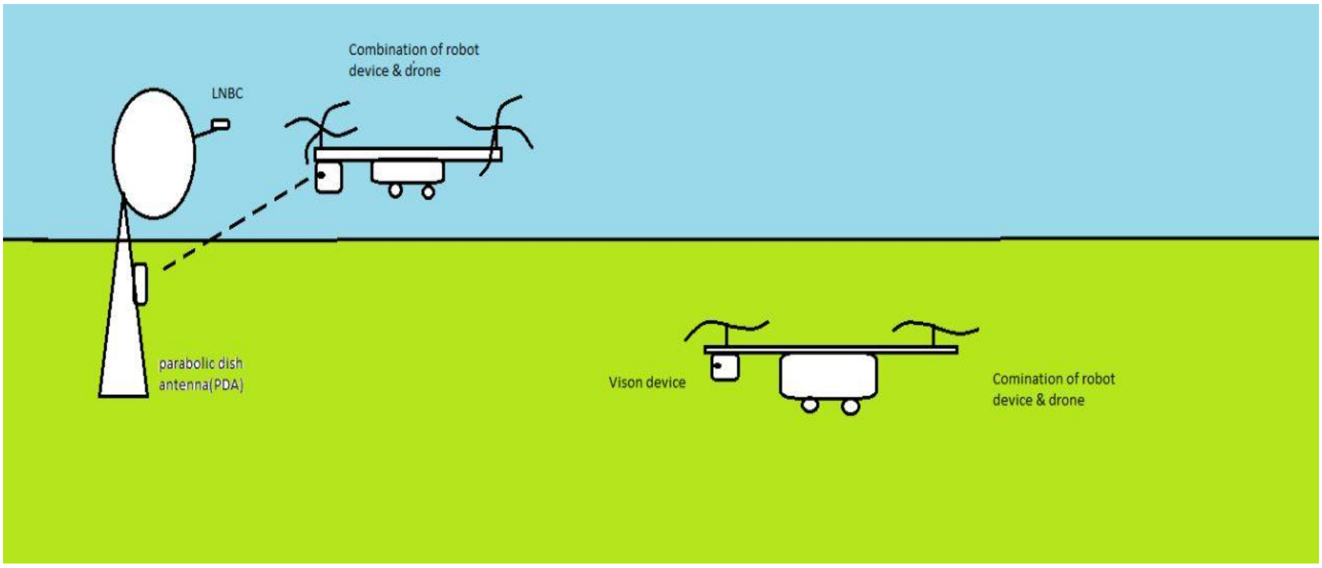

Figure: 1.1 Overview of Concept

II. PRINCIPLE DISCRIPTION

The designed robot is combination of robotic car and quadcopter. A quadrotor helicopter (quadcopter) is a helicopter which has four equally spaced rotors, usually arranged at the corners of a square body. With four independent rotors, the need for a swash plate mechanism is alleviated. The development of quadcopter has stalled until very recently, because controlling four independent rotors has proven to be incredibly difficult and impossible without electronic assistance. The decreasing cost of modern microprocessors has made electronic and even completely autonomous control of quadcopter feasible for commercial, military, and even hobbyist purposes. Quadcopter control is a fundamentally difficult and interesting problem. With six degrees of freedom (three translational and three rotational) and only four independent inputs (rotor speeds), quadcopter is severely under actuated. In order to achieve six degrees of freedom, rotational and translational motion is coupled. The resulting dynamics are highly nonlinear, especially after accounting for the complicated aerodynamic effects. Finally, unlike ground vehicles, helicopters have very little friction to prevent their motion, so they must provide their own damping in order to stop moving and remain stable. Together, these factors create a very interesting control problem. We will present a very simplified model of quadcopter dynamics and design controllers for our dynamics to follow a designated trajectory. For live video streaming we are using a mobile for high resolution image capturing and video monitoring in prototype model.

2.1 Quadcopter dynamics and mathematical modeling.

We will start deriving quadcopter dynamics by introducing the two frames in which will operate. The inertial frame is defined by the ground, with gravity pointing in the negative z direction. The body frame is defined by the orientation of the quadcopter, with the rotor axes pointing in the positive z direction and the arms pointing in the x and y directions.

2.2 Kinematics

The physics of quadcopter motion let us formalize the kinematics in the body and inertial frames. We define the position and velocity of the quadcopter in the inertial frame as X=(x, y, z) and $\dot{x}$ = ($\dot{x}$, $\dot{y}$, $\dot{z}$) T, respectively. Similarly, we define the roll, pitch, and yaw angles in the body frame as $\theta = (\emptyset, \theta, \varphi)$T, with corresponding angular velocities equal to $\dot{\theta} = (\dot{\emptyset}, \dot{\theta}, \dot{\varphi})$T. However, note that the angular velocity vector $\omega \neq \dot{\theta}$. The angular velocity is a vector pointing along the axis of rotation, while $\dot{\theta}$ is just the time derivative of yaw, pitch, and roll. In order to convert these angular velocities into the angular velocity vector, we can use the following relation.

$$\omega = \begin{bmatrix} 1 & 0 & -s\theta \\ 0 & c\emptyset & c\theta s\emptyset \\ 0 & -s\emptyset & c\theta c\emptyset \end{bmatrix} \dot{\theta}$$

Where *ωthe angular velocity vector in the body frame .We is* can relate the body and inertial frame by a rotation matrix R which goes from the body frame to the inertial frame. This matrix is derived by using the ZYZ Euler angle conventions and successively "undoing" the yaw, pitch, and roll.

$$R = \begin{bmatrix} c\emptyset c\varphi - c\theta s\emptyset s\varphi & -c\varphi s\emptyset - c\emptyset c\theta s\varphi & s\theta s\varphi \\ c\theta c\varphi s\emptyset + c\emptyset s\varphi & c\emptyset c\theta c\varphi - s\emptyset s\varphi & -c\varphi s\theta \\ s\emptyset s\theta & c\emptyset s\theta & c\theta \end{bmatrix}$$

For a given vector ~v in the body frame, the corresponding vector is given by R~v in the inertial frame.

2.3 Mathematical modeling

The schematic movement of Quadcopter is represented in Figure and based on this schematic, the Quadcopter mathematical modeling is derived as below.

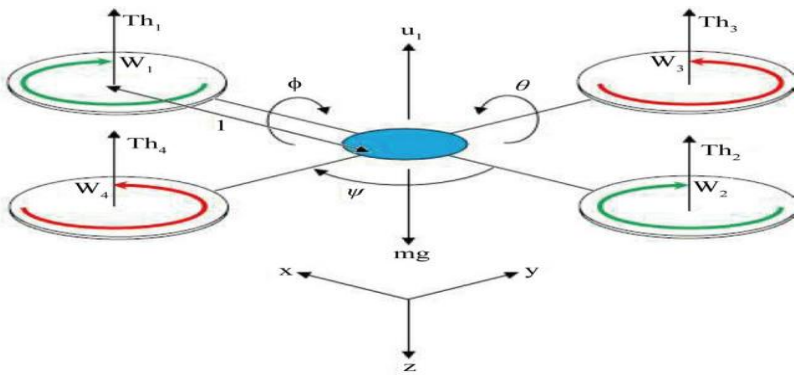

Figure2.1: Schematic of quadcopter

Where,

U1 = sum of the thrust of each motor.
Th1= thrust generated by front motor.
Th2= thrust generated by rear motor.
Th3= thrust generated by right motor.
Th4= thrust generated by left motor.
m = mass of Quadcopter.
g = the acceleration of gravity.
l = the half length of the Quadcopter.
x, y, z = three position.
θ, ϕ, φ = three Euler angles representing pitch, roll, and yaw.

The dynamics formulation of Quadcopter moving from landing position to a fixed point in the space is given as:

$$R = \begin{bmatrix} c\emptyset c\varphi - c\theta s\emptyset s\varphi & -c\varphi s\emptyset - c\emptyset c\theta s\varphi & s\theta s\varphi \\ c\theta c\varphi s\emptyset + c\emptyset s\varphi & c\emptyset c\theta c\varphi - s\emptyset s\varphi & -c\varphi s\theta \\ s\emptyset s\theta & c\emptyset s\theta & c\theta \end{bmatrix}$$

Where,

R = matrix transformation
Sθ = Sin (θ), S$\emptyset$= Sin ($\emptyset$), Sφ= Sin (φ)
Cθ = Cos (θ), C$\emptyset$= Cos ($\emptyset$), Cφ= Cos (φ)

By applying the force and moment balance laws, the Quadcopter motion equation are given in following Equation and Pythagoras theorem is computed as Figure 2.2.

$$\ddot{x} = u1(Cos\emptyset Sin\theta Cos\varphi + Sin\emptyset Sin) - K1\dot{x}/m$$

$$\ddot{y} = u1(Sin\emptyset Sin\theta Cos\varphi + Cos\emptyset Sin) - K2\dot{y}/m$$

$$\ddot{z} = u1(Cos\emptyset Cos\varphi)g - K3\dot{z}/m$$

Where,

Ki = Drag coefficient (Assume zero since drag is negligible at low speed)

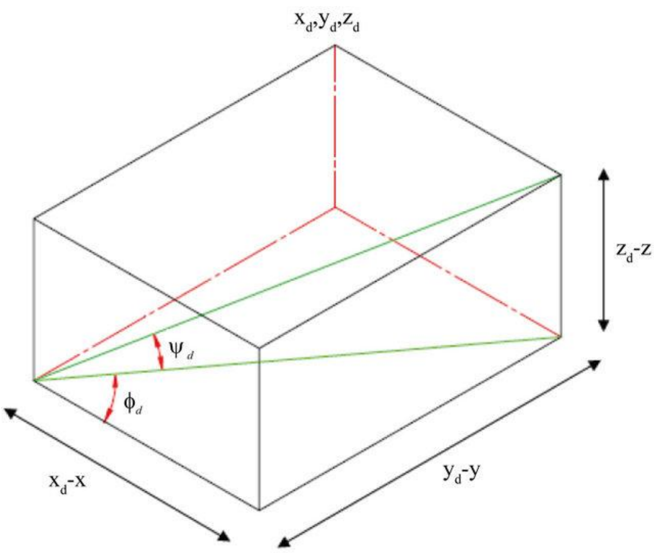

Figure 2.2: Angle movement of quadcopter

The angle $\emptyset$d and φd in Figure 2.2 are determined using following Equation respectively.

$$\emptyset d = \frac{1}{tan}\left(\frac{yd-y}{xd-x}\right)$$

$$\varphi d = \frac{1}{tan}\left(\frac{zd-z}{\sqrt{(xd-x)^2+(yd-y)^2}}\right)$$

Quadcopter have four controller input forces U1, U2, U3, and U4 that will affects certain side of Quadcopter. U1 affect the attitude of the Quadcopter, U2 affects the rotation in roll angle, U3 affects the pitch angle and U4 control the yaw angle. To control the Quadcopter movement is done by controlling each input variable. The equations of them are as below.

$$U \begin{Bmatrix} U1 = {(Th1 + Th2 + Th3 + Th4)}/{m1} \\ U2 = 1\,(-Th1 - Th2 + Th3 + Th4)/I1 \\ U3 = 1\,(-Th1 + Th2 + Th3 - Th4)/I2 \\ U4 = 1\,(Th1 + Th2 + Th3 + Th4)/I3 \end{Bmatrix}$$

Where,

Thi = thrust generated by four motor.
C = the force to moment scaling factor.
Ii = the moment of inertia with respect to the axes.

Then the second derivatives of each angle are:

$$\ddot{\theta} = U2 - 1K4\dot{\theta}/I1$$
$$\ddot{\varphi} = U3 - 1K5\dot{\varphi}/I2$$
$$\ddot{\emptyset} = U1 - 1K6\dot{\emptyset}/I3$$

A. Power calculation of BLDC.

Brushless motors are used for all quadcopter applications. For our electric motors, the torque produced is given by

$$\tau = K_t(I - I_0)$$

Where *t* is the motor torque, I is the input current, I0 is the current when there is no load on the motor, and Kt is the torque proportionality constant. The voltage across the motor is the sum of the back-EMF and some resistive loss.

$$V = IR_m + K_v\omega$$

$$P \approx \frac{Kv}{Kt}\tau\omega.$$

Where V is the voltage drop across the motor, R_m is the motor resistance, ω is the angular velocity of the motor, and Kv is a proportionality constant. Further simplifying our model, we assume that $K_tI_0 \ll \tau$. This is not altogether unreasonable, since I_0 is the current when there is no load, and is thus rather small. In practice, this approximation holds well enough. Thus, we obtain our final, simplified equation for power.

B. Forces on quadcopter

The power is used to keep the quadcopter aloft. By conservation of energy, we know that the energy the motor expends in a given time period is equal to the force generated on the propeller times the distance that the air it displaces moves (Pd t = F d x). Equivalently, the power is equal to the thrust times the air velocity ($P = F\frac{dx}{dt}$).

$$P = Tv_h$$

We assume vehicle speeds are low, so vh is the air velocity when hovering. We also assume that the free stream velocity, V∞, is zero.

$$Vh = \sqrt{\frac{T}{2\rho A}}$$

$$P = \frac{Kv}{Kt}\tau\omega = \frac{KvK\tau}{Kt}T\omega = \frac{T^{\frac{3}{2}}}{\sqrt{2\rho A}}.$$

Where, *r* is the density of the surrounding air and A is the area swept out by the rotor. Using our simplified equation for power, we can then write as shown above. Note that in the general case, $\tau = \vec{r} \times \overleftarrow{F}$; in this case, the torque is proportional to the thrust T by some constant ratio Kt determined by the blade configuration and parameters. Solving for the thrust magnitude T, we obtain that thrust is proportional to the square of angular velocity of the motor.

$$T = K\omega^2$$

So the mathematical calculation of forces is shown.

III. QUADCOPTER MOVEMENT MECHANISM

Quadcopter can described as a small vehicle with four propellers attached to rotor located at the cross frame. This aim for fixed pitch rotors are use to control the vehicle motion. The speeds of these four rotors are independent. By independent, pitch, roll and yaw attitude of the vehicle can be control easily. The below figure shows the Yaw, Pitch and Roll axis of quad.

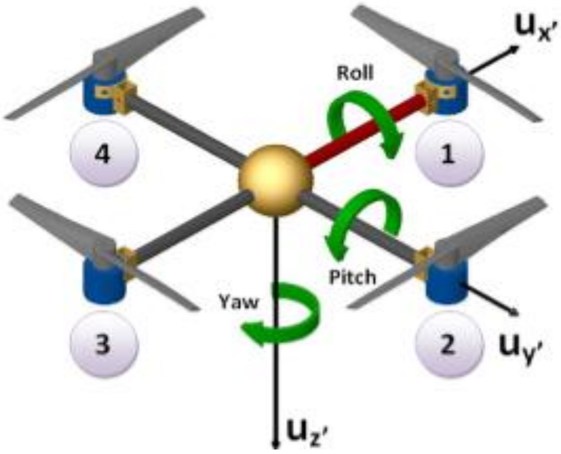

***Figure 3.1 Yaw, pitch and roll direction of quadcopter*.**

Quadcopter have four inputs force and basically the thrust that produced by the propeller that connect to the rotor. The motion of Quadcopter can control through fix the thrust that produced. These thrust can control by the speed of each rotor.

Take-off is movement of Quadcopter that lift up from ground to hover position and landing position is versa of take-off position. Take-off (landing) motion is control by increasing (decreasing) speed of four rotors simultaneously which means changing the vertical motion. Figure 3.2 illustrated the take-off and landing motion of Quadcopter respectively.

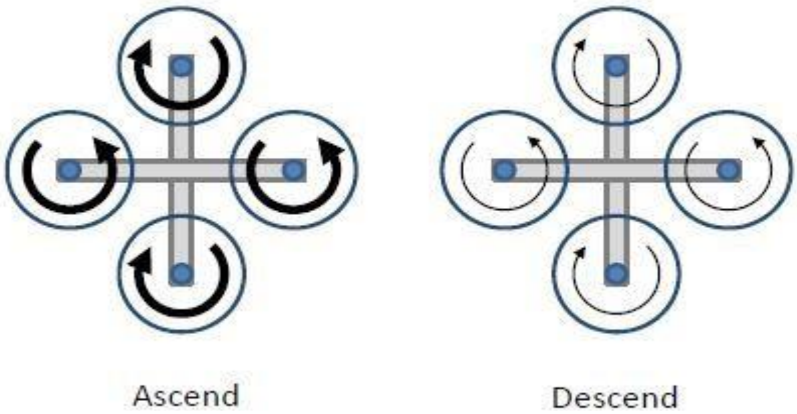

***Figure 3.2 Take-off and landing direction of quadcopter*.**

Forward (backward) motion is control by increasing (decreasing) speed of rear (front) rotor. Decreasing (increasing) rear (front) rotor speed simultaneously will affect the pitch angle of the Quadcopter. The forward and backward motions of Quadcopter are represented in Figure respectively.

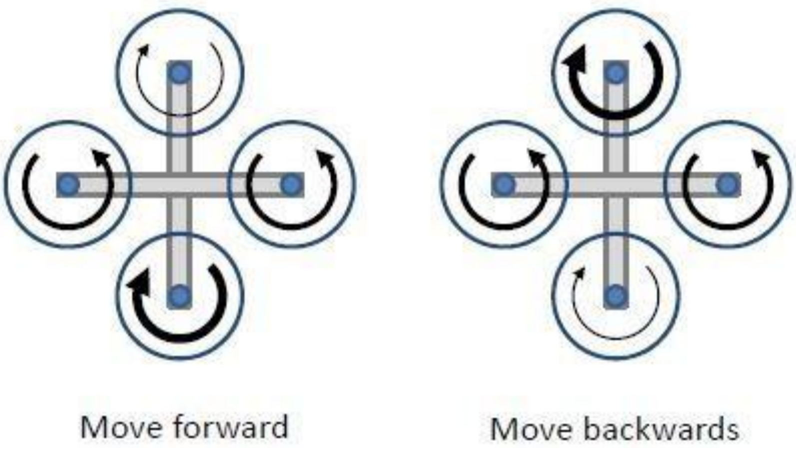

Figure 3.3 Move forward and backward direction of quadcopter.

IV. PID ARCHITECTURE

For PID controller design, parallel architecture has been used (Astrom & aagglund, 2009; see Fig. 3).

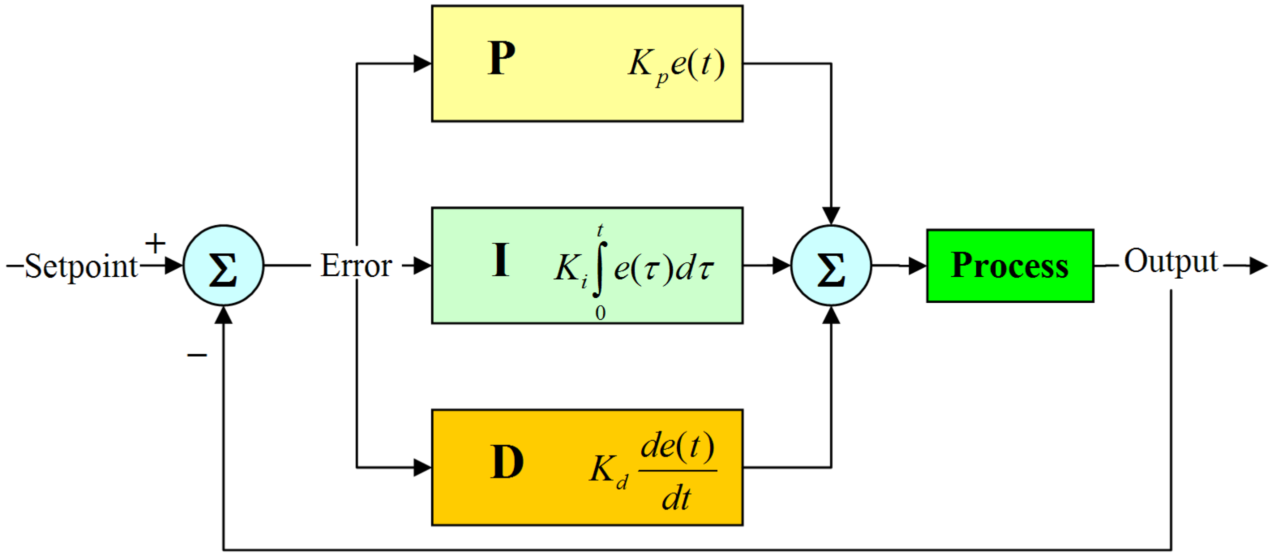

Figure 4.1 PID architecture of quadcopter.

In the diagram, there is an additional block corresponding to a scale factor, which compensates the aerodynamic parameters of the quadcopter so that the PID design becomes simpler. This block also scales the control signal to values compatible with the existing hardware. Finally, at the output there is a signal saturation block. Roll, pitch, yaw, and altitude controllers have a similar architecture with minimal changes, especially for yaw and altitude.

The yaw controller reads the commands received from the RC transmitter as angular velocities to improve the movement of the system and avoid oversensitivity with yaw movement. Thus, on the controller input there is an integrator which translates the angular velocity into an angular set-point. Additionally, in yaw control, the discontinuities of the system in 360° and -360° must be taken into account and corrected to avoid misbehaviour of the system. For altitude control, the architecture is almost the same, with the difference that on the output of the PID there is a summation device used to compensate for the value of gravity.

V. BLUETOOTH CONTROLLING LAND ROVER ROBOT

5.1 Proposed system

The purpose of our research is to provide simpler robot's hardware architecture but with powerful computational platforms so that robot's designer can focus on their research and tests instead of Bluetooth connection infrastructure. This simple architecture is also useful for educational robotics, because students can build their own robots with low cost and use them as platform for experiments in several courses. Common control architectures: The following list Shows typical robot control architecture.

5.2 Arduino

Arduino is open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world. Arduino had used the Atmel Atmega AVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560.

5.3 HC-05(Bluetooth module)

A HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

5.4 DC motor

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motor is used to power hundreds of devices we use in everyday life. An example of small motor applications includes motors used in automobiles, robot, hand power tools and food blenders. Micro-machines are electric machines with parts the size of red blood cells and find many applications in medicine.

5.5 Circuit diagram

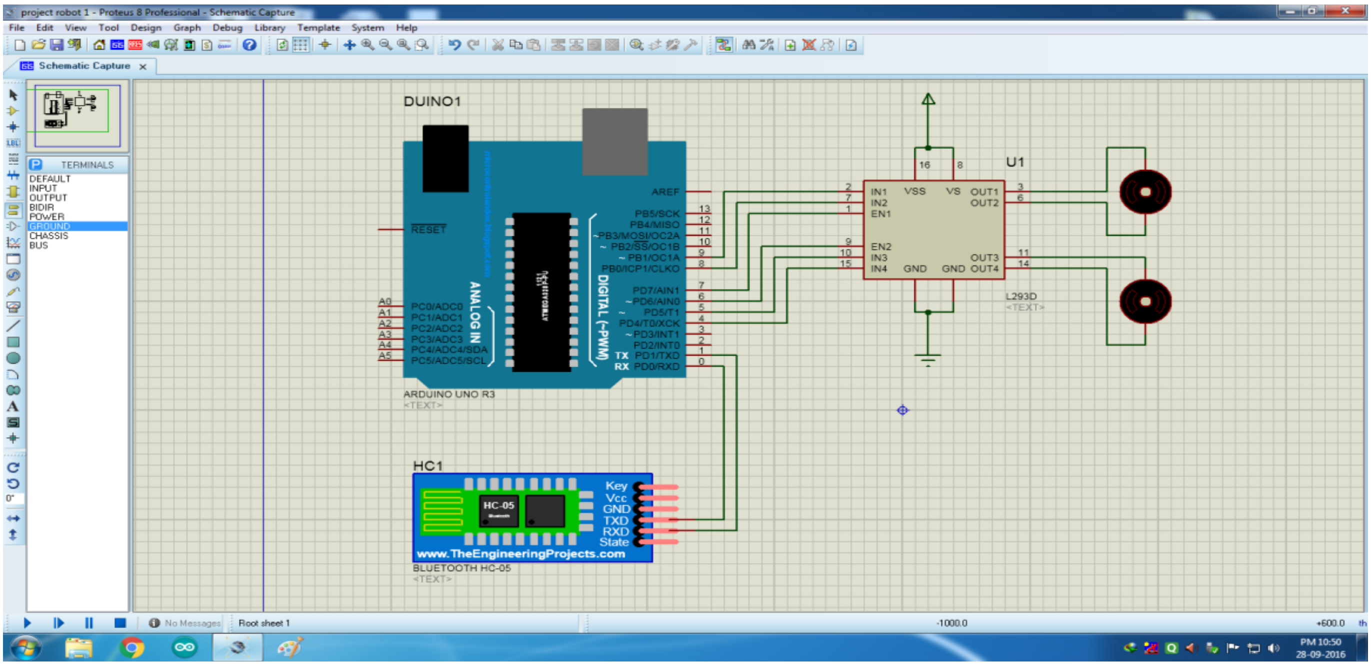

Fig.5.1 Circuit diagram of the robotic car.

5.6 Circuit description

Here in this robot we have used a Bluetooth module which controls the robot via 2 DC High Torque motors at 10,000 RPM approx. The robot is control by an android phone application. Microcontroller used here is Arduino UNO R3 from microcontroller family which contributes in a serial communication UART mode and the communication is governed on 9800bps to communicate it with the Bluetooth module. The Wireless control is one of the most important basic needs for all the people all over the world. But unfortunately the technology is not fully utilized due to a huge amount of data and communication overheads. Generally many of the wireless controlled robots use RF modules. But our project for robotic control makes use of Android mobile phone which is very cheap and easily available. The available control commands are more than RF modules. The wireless communication techniques used to control the robot is nothing than Bluetooth technology. User can use several commands like move reverse, forward, move left, move right using these commands which are given from the Android mobile. Robot has a Bluetooth receiver unit that receives the commands and move left, move right using these commands which are given from the Android mobile and send it to the Arduino circuit to control the motors. The Arduino UNO then transfers the signal to the motor driver IC's to operate the motors.

VI. HARDWARE RESULT

Figure 6.1 Hardware view output

VII. CONCLUSION

This is also user friendly, economical, fully automatic and efficient device. This project will be helpful to technician who analysis the alignment of LNBC mounted on PDA (parabolic dish antenna) physically. We can analyze it by wireless monitoring and controlling. Site observing robot like (curiosity on mars).The project is designed to develop android application based a robotic vehicle for remote operation. This is a kind of robot can be helpful for mobility aid for elderly people (technicians). To improve the system behavior, in future works, the implementation of non-linear controls can be made, which would be based on a non-simplified model, allowing wider ranges on roll and pitch angles. We had made this project as **"MAKE IN INDIA"**

VIII. ACKNOWLEDGEMENT

Fundamentals during the project. We acknowledge the support and help provided by our **internal guide Mr. Viral Patel (Asst. Prof.)**.Without their support, guidance and encouragement this project couldn't have been put together. We are highly indebted to our **Head of Department Mr. Jignesh Jethva** for providing us this opportunity to prepare this project. We would also like to thank entire staff of Electronics and Communication Department. Being final year students, making of the project adds a final touch to our. We are also thankful to all doordarshan staff for their support.

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