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LAND SURVEY BY ROBOT

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ABSTRACT

This paper is an effort that has been put to cater the needs of land survey. Here, a robot is developed to conduct land survey, specifically to calculate the area of a given land and to divide it into subplots. The process involves two parts- Survey Robot and area measurement module. The Survey Robot is controlled through the ZigBee module to move about the entire plot. The distance travelled by the Survey Robot is calculated by timer concept and this value is then transmitted to the PC. The second part involves the area measurement module designed using Embedded C allowing the user to efficiently determine the area of the plot.

Keywords: Area Measurement, Land Survey, Survey Robot.

I. INTRODUCTION

Land measurement is a general terminology which is used to describe, in best possible manner, the theory and application of measurement of land. This also includes land conversion that can be known as the procedure by which land or property is measured. It is the process which explains how the land or property is converted from one unit to another. To put it in more specific terms how much of land is one acre and so on. Land surveying forms an integral part of this conversion. Survey Robot, also referred as SURVOBOT is being designed keeping in mind the complexities that are involved in present techniques of area measurement and land survey.

In conventional survey operations, a primary requirement of the survey party is to determine distance between two points. The surveyor has many devices that are used to determine distance. These range from the 30-meter steel tape to electronic instruments. Distance measurement is a basic operation that every surveyor must be able to perform with the tools available. Some of the surveying methods and equipments used to measure area of land are described below:

1. Horizontal Taping - Horizontal taping is used in conventional surveys. In this method, all measurements are made with the tape held horizontally. Measure the horizontal distance between the rear station and the forward station. Usually the distance between stations is more than a full tape length. The taping team determines the distance by measuring successive full tape lengths. When the distance remaining is less than a full tape length, the team measures the partial tape length. The total distance between the stations is determined by multiplying the number of full tape lengths by the length of the tape and adding the partial tape length.
2. EDM - Survey sections equipped with the EDM (Electronic Distance Measurement) can measure distances in minimum time. The EDM is a compact, lightweight, economical, and simple-to-operate instrument that is especially suitable for short- and medium-range survey operations.

The EDM consists of the distance meter and the retro reflector prisms. These units mount on any universal tripod. The distance meter and the retro reflectors are packaged and transported in separate carrying cases--the distance meter case and the retro reflector cases.

The Land Survey using a Robot is an effort being put to cater the needs of land survey, in particular, area measurement. Here a robot is being used for area measurement. Surveying or land surveying is the science and technique of accurately determining the terrestrial or three-dimensional position of points, distances and angles between them. To accomplish their objective, surveyors use elements of mathematics (which includes geometry and trigonometry), physics, engineering and law. Also, wide range of surveying equipments are used for this purpose.

II. NEED FOR SURVEY ROBOT

The present surveying technique used is EDM. The disadvantage of EDM is that it has heavy equipments that are to be carried and combined together every time for the set up. This set up takes a considerable amount of time. Also, if the plot is in terms of hectares, then carrying the entire equipment will become an issue. After the measurement of the sides, the obtained sides have to be transmitted to total station wherein the further calculations are done. So, for the measurement of sides, at least two people have to move on the plot continuously that increases the labor time.

Here comes the need for Survey robot. To avoid the tiring procedure of area calculation that involves separate side measurement, carrying of the equipment and sending the obtained side to total station, we incorporate Survey robot which combines all these features. In other words, it performs three most important tasks. Firstly, it can be freely moved about the plot when given a desired direction. Secondly, it obtains the length of any desired plot as it moves and transmits the length. This transmitted length is stored in the PC and then an area measurement module is used to find the area. Thirdly, if the user wishes to subdivide his entire plot then we just need to program the Survey robot appropriately and the subdivision of plot is done in a very less duration.

Survey robot replaces the conventional techniques of area measurement and the complexities involved with it, by automating the entire process.

III. SURVEY ROBOT

The Survey robot consists of the following components:

- Microcontroller – P89V51RD2
- ZigBee

- Geared Dc motors
- Stepper motor
- L293D drivers
- ULN2003 driver
- Battery – 12V/ MAXCON Adapter 12V
- Buzzer

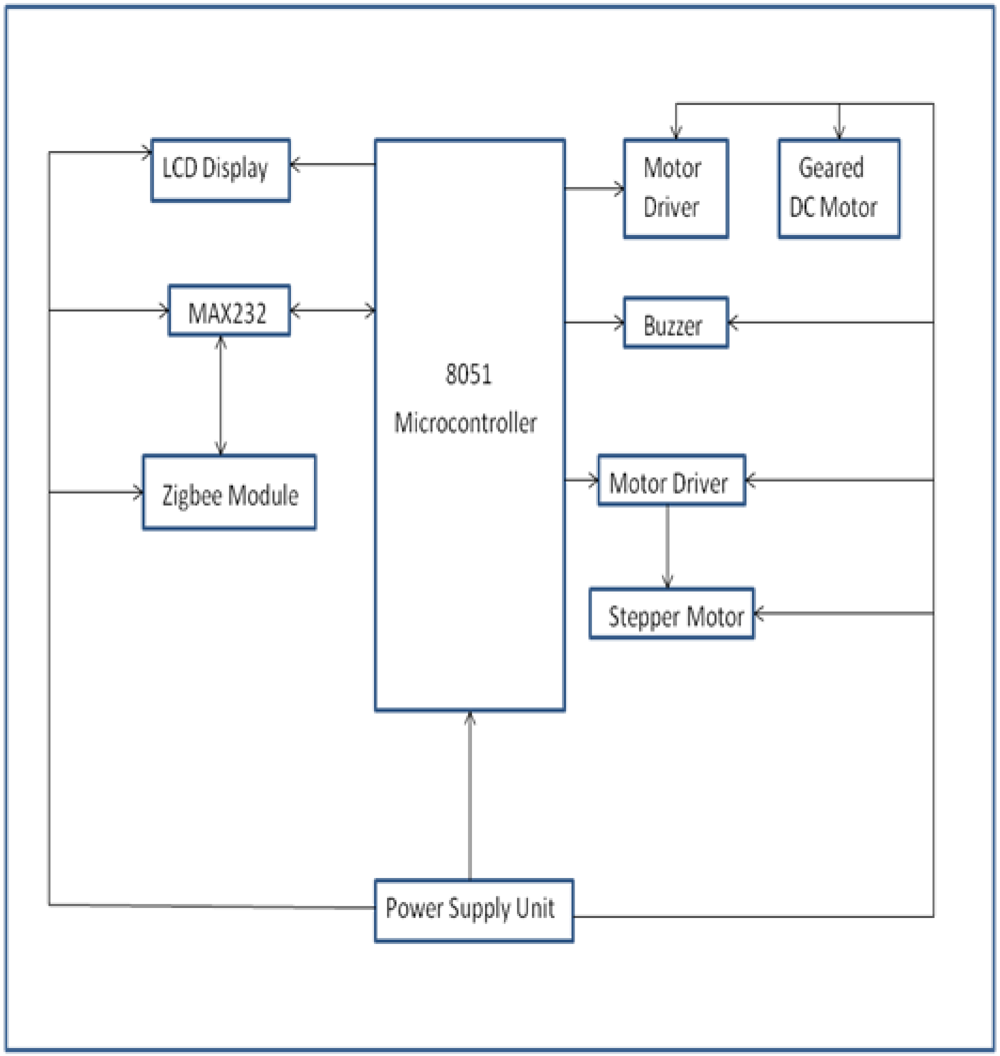

Fig.1: Survey Robot unit

In brief, the control unit transmits the command through ZigBee at the transmitter side which is received by the ZigBee on the Survey robot. The Survey robot then performs appropriate tasks. The LCD displays the length covered. The buzzer and stepper motor are used when subdivision of plots is performed. The geared DC motor is used to run the Survey robot. To control the motor and its speed, a L293D motor driver is used. Power supply unit can be a rechargeable battery of 12V or a 12V adapter.[1][2]

3.1 Survey Robot Construction

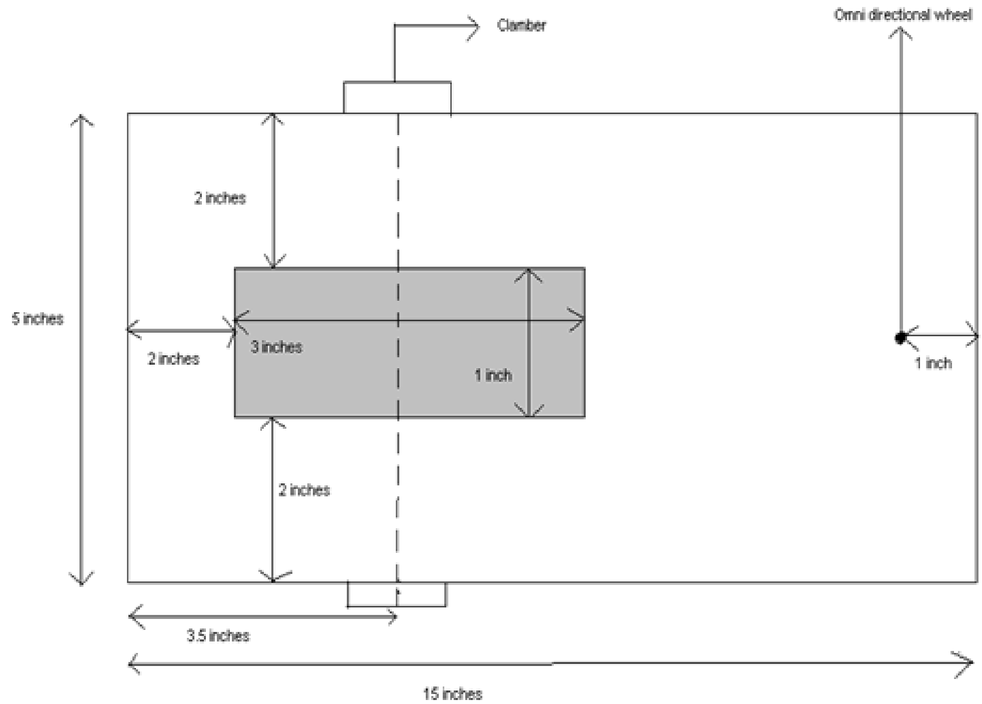

Fig. 2: Survey Robot Dimensions

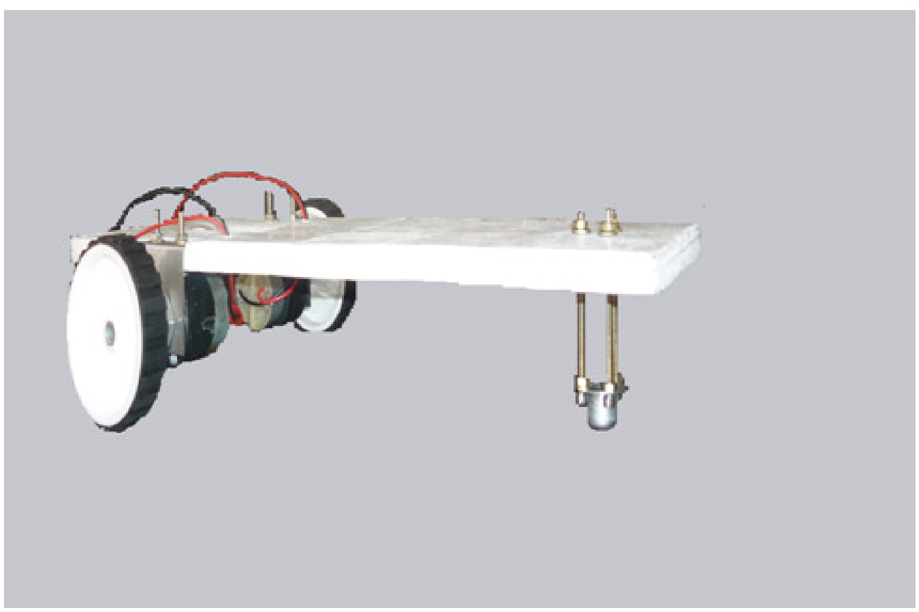

Fig. 3: Side view of the Chassis

As seen in the figure, a Survey robot is a 2 wheeled robot which has an Omni-directional wheel attached to the front portion. The body material of the robot is made of ply wood which is of 12mm thickness, having dimensions of 15 x 5 inches. Here, the ply wood of such a dimension is used to neatly place the microcontroller which provides the control mechanism viaZigBee module for transmission and the various drivers used to drive their respective motors. Also it provides a suitable space to insert the marker used in subdivision of plot.[3]

We have a rectangular slot of dimension 3 x 1 inches which has been cut as shown in figure. This slot serves as an opening wherein we place a marker that will be later used when we have to divide the plot into subplot.

In the front portion on the Survey robot, three holes are drilled, 1 inch from the side of the ply wood, which are used to hold the Omni directional wheel using three screws. Here this Omni directional wheel is used to provide direction to the Survey robot, that is, it enables the robot to take turns at an easier pace. At the rear end, pair of clampers is connected at opposite sides. It is used to hold the chassis wheels and the DC motors onto the plywood. The geared DC motors is used to provide controlled motion for the Survey robot[4].

3.2 Survey Robot Movement and Control mechanism

Initially when the user opens the user interface, he is provided with three options to choose from, namely:

Module 1. To move the Survey robot. The user has to press key from the computer keyboard if he wishes to move the robot simply and not for any calculation. The diagram of this module and appropriate screenshot is provided below.

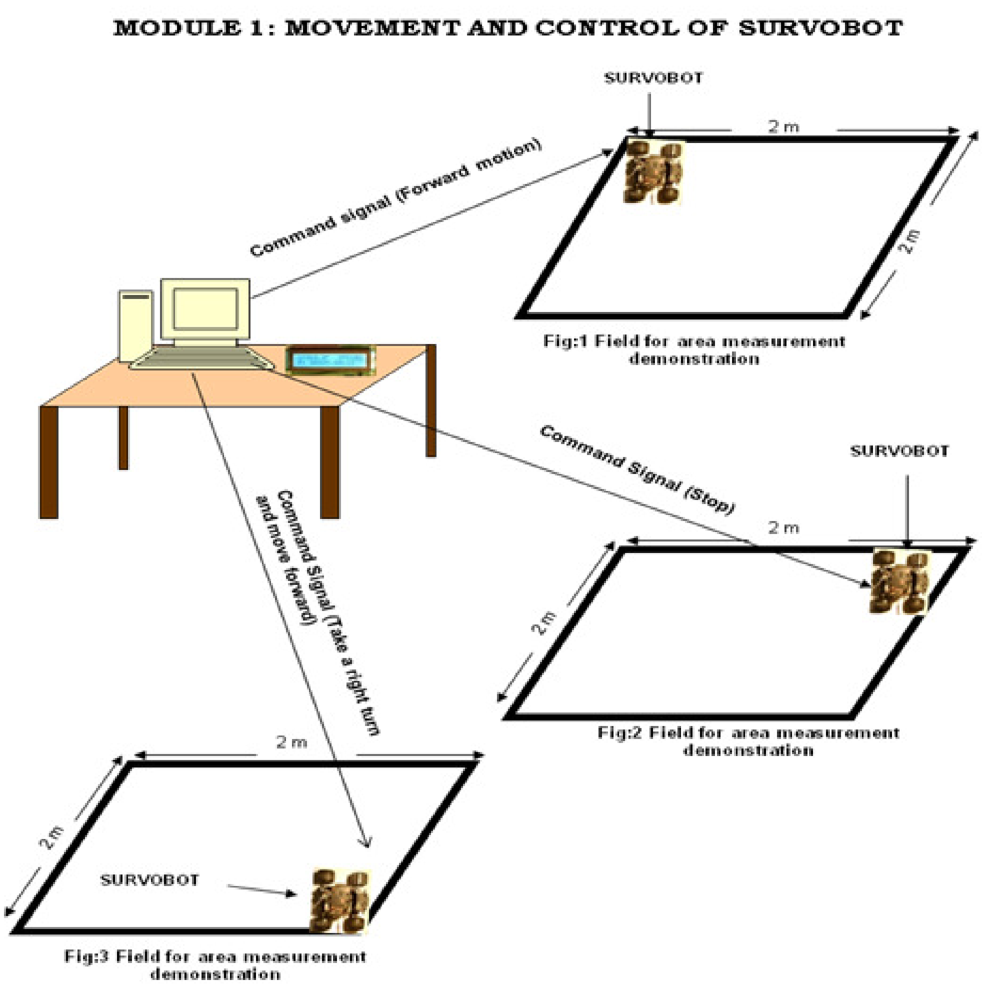

Fig. 4: Control and movement of Survey Robot

The above figure shows how the robot is initially given the command to move forward then made to stop and then commanded to take a sharp right turn and then move forward.

Given below is the screen shot of the first module. As can be seen, three choices are given to the user. When the user presses key 1 from the computer, four options are further introduced which are:-

- To rotate left, we press 'l'
- To rotate right, we press 'r'
- To end the moving operation, we press 's'
- To cancel a move operation, we press 'q'

An illustration is given below. Once the move operation is performed, the user will enter into the previous interface where he can again make choices amongst Module 1, Module 2 or Module 3.

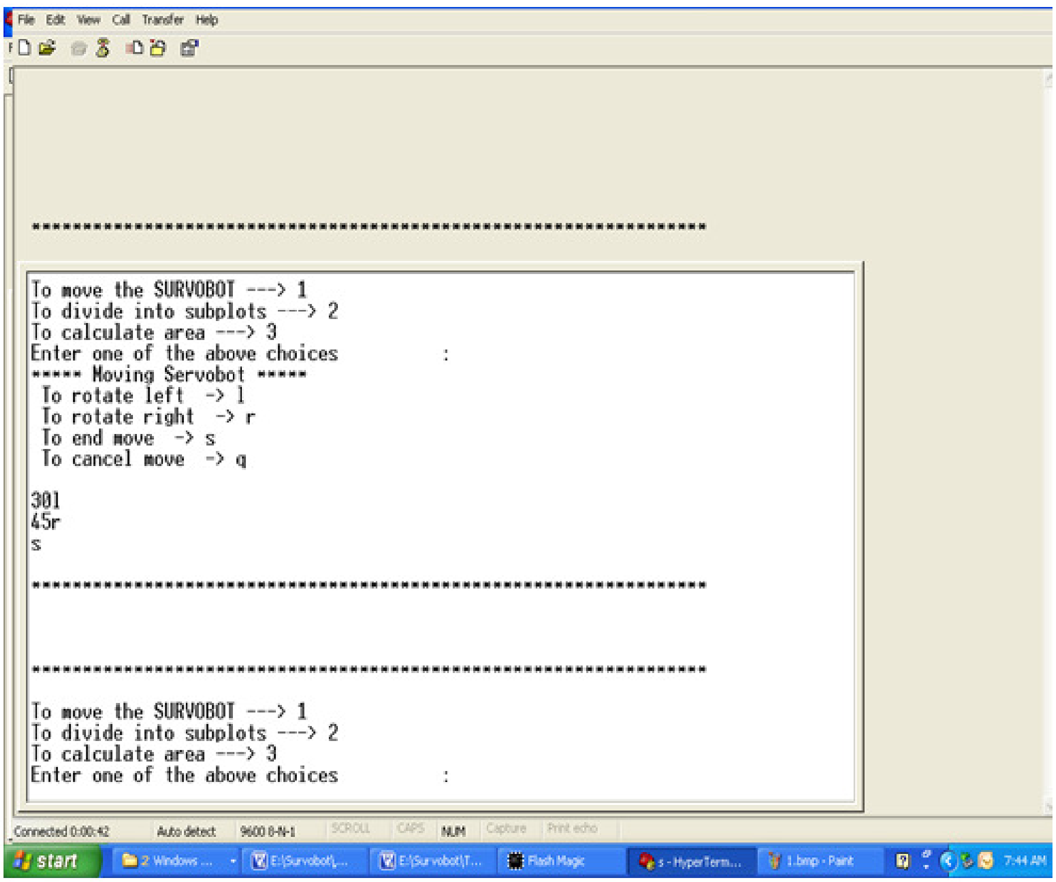

Fig. 5: Module 1 Screenshot

Module 2. To subdivide a given plot. The user has to press key 2 from the computer keyboardif he wishes to subdivide a plot.

When a buyer buys a land, it can be of any size or dimension. If a commercialized plot is obtained which is in terms of acres or hectares, the builder or civil engineer may propose the construction of apartments or villas. So here the entire plot needs to be subdivided into subsections.

The subdivision of plot is completely time based. That is, it depends upon the number of interrupts generated in a given amount of time and the machine cycle. 8051 has a machine cycle of

1.085 microseconds. Here a timer 0/timer 1 is used in Mode 1 which has maximum count value of 65536. Therefore, one interrupt takes

1.085 microseconds X 65536 = 71.1 ms……………(1)

Therefore for 1 second, 14 interrupts are generated. The speed of the Survey robot is 10 RPM. Here, for subdivision of plot, the user decides the distance to be travelled. Hence in the user interface, the only requirement is to give input values and the plot is subdivided repeatedly. We have to determine the time taken which is converted to count value. This is performed by using the generalized formula,

Time = Distance/ Speed ………….…………..(2)

Assuming that distance to be covered is 3 inches. According to the movement of Survey robot, it takes 6 seconds to move 1 inch. Therefore for 3inches, it takes 18 seconds. So,

18 X 14 = 252 ………………….…………….(3)

During the movement of 3 inches, 252 interrupts are generated which corresponds to 18 seconds. Once these 252 interrupts are generated, buzzer beeps indicating that the Survey robot has completed that part of the plot. This process is repeated multiple number of times until the entire plot is divided.

The user is at the liberty to enter any distance value that he wishes the Survey robot to move. To know that subdivision is performed accurately, we make use of stepper motor with a marker which is fitted suitably in a slot within the Survey robot.

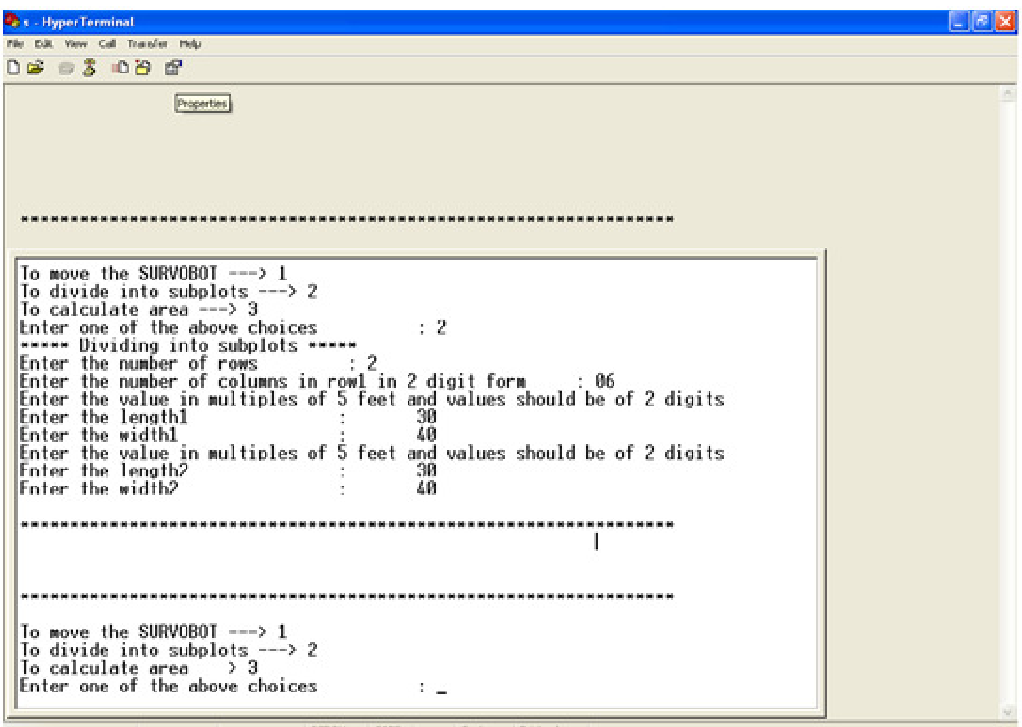

Fig. 6: Module 2 Screen Shot

Module 3. To calculate the area --The user has to press key 3 from the computer keyboard if he wishes to calculate area of any plot.

Let us consider a square plot of 5 ft X 5 ft.

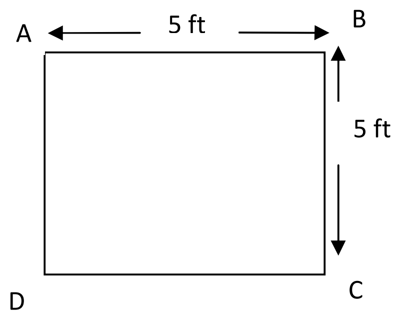

Fig. 7: A square plot

Once the user presses the key 3 from the computer, the module for area calculation appears. Then the Survey robot has to be placed on the desired side, say on point A from the figure.

When key A is pressed from the keypad, the Survey robot is ready for area calculation. Then the user has to press the key B from keypad. In case, for plots like trapezium, where there are sharp deviations required, press key C or D. If the angle of deviation is known prior, then the user has to press 0 and then enter the angle in 2 digit form. The Survey robot deviates according to that angle specified.

Assuming that Survey robot has moved from point A to B, user has to press E to stop the robot. Then take deviation and align it to a position to measure the length B to C. Once all the lengths have been calculated, the user has to press F once and if user has to come out of area calculation module, then he has to press F twice.

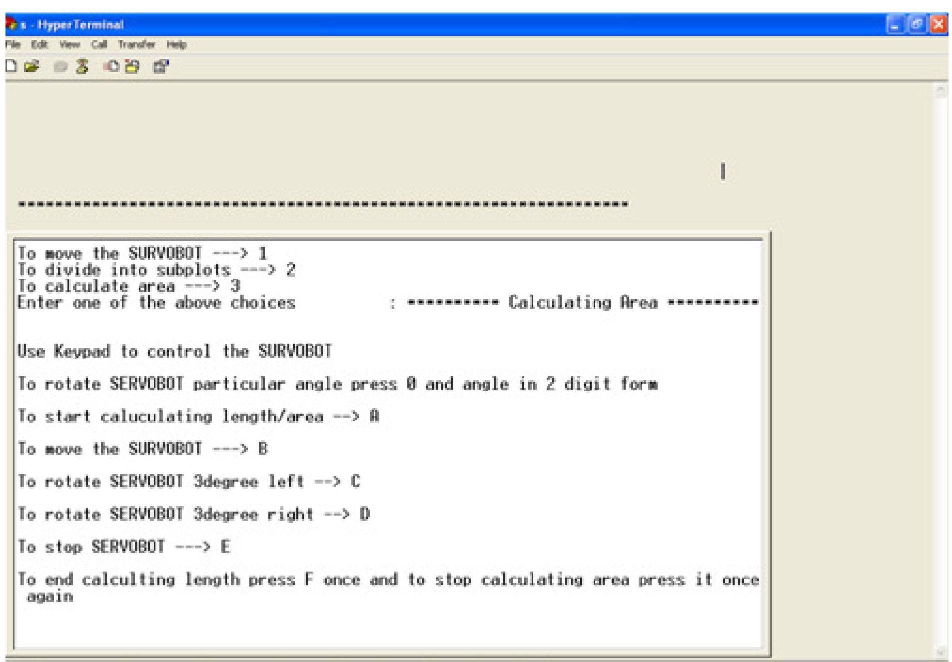

Fig. 8: Module 3 Screen Shot

After the session terminates, the lengths are transmitted to PC via ZigBee. The lengths are represented in terms of units and not meters where each unit is 3 inch. So, for the above square plot of 5ft x 5ft, the output shown will be as follows. According to the analysis, we designed a new parameter 'unit', which is,

$$1 \text{ unit} = 3 \text{ inches}$$

We know that,

$$1 \text{ feet} = 12 \text{ inches}$$

Therefore,

$$5 \text{ feet} = 60 \text{ inches}$$

$$5 \text{ feet} = \frac{60}{3} = 20 \text{ units}$$

So,

$$5 \text{ feet x } 5 \text{ feet} = 20 \text{ x } 20 \text{ units} = 400 \text{ sq. Units.}$$

Depending upon the shape of the plot the respective formula is chosen and the area is calculated and the final area is displayed on the LCD. [5]

IV. SNAPSHOTS OF SURVEY ROBOT

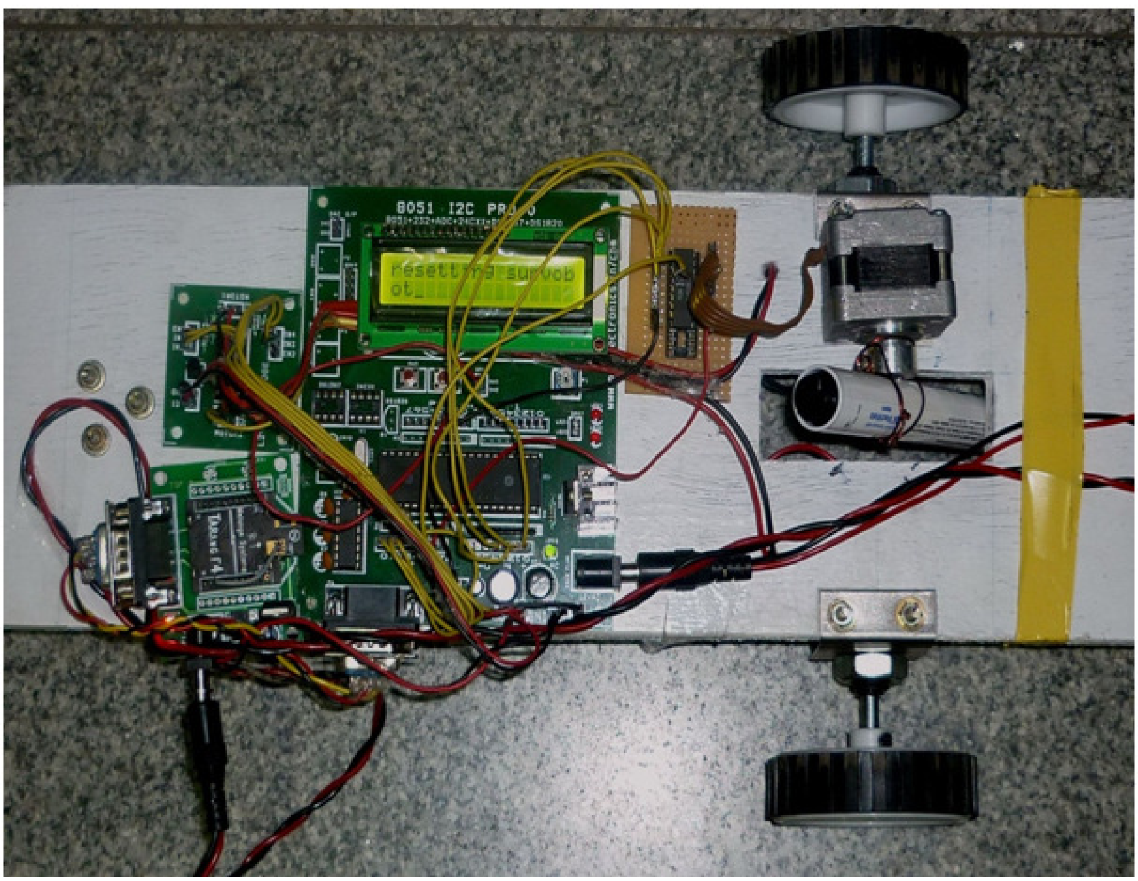

Fig. 9: TOP VIEW of Survey Robot

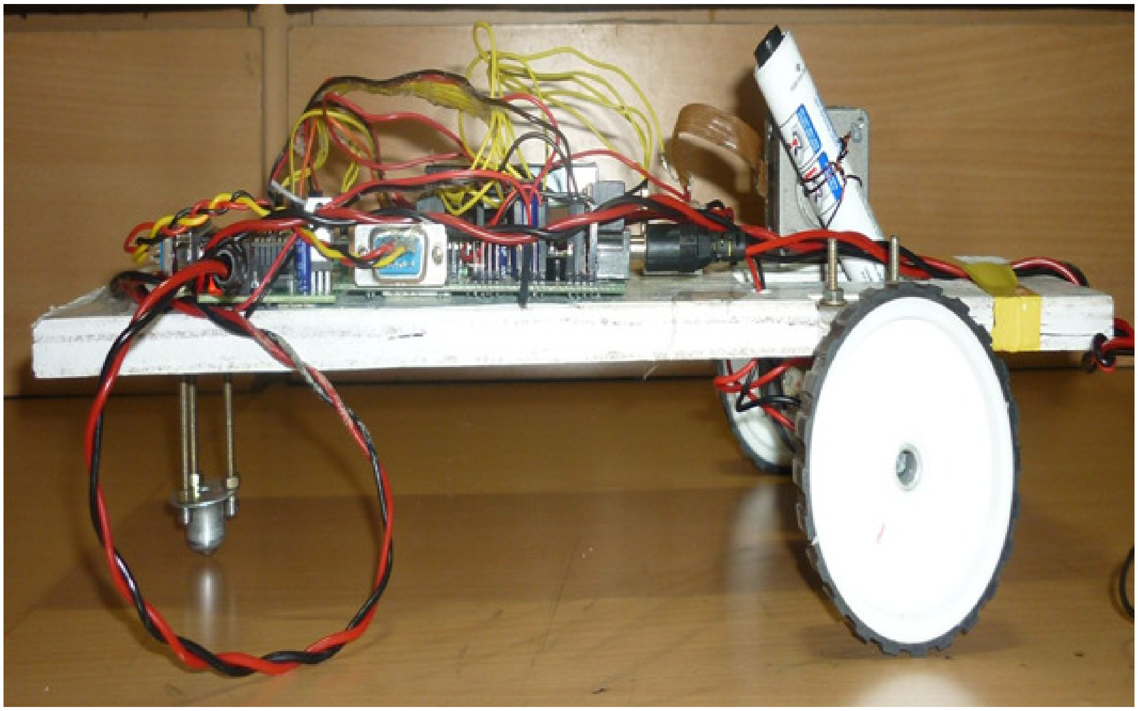

Fig. 10: SIDE VIEW of Survey Robot

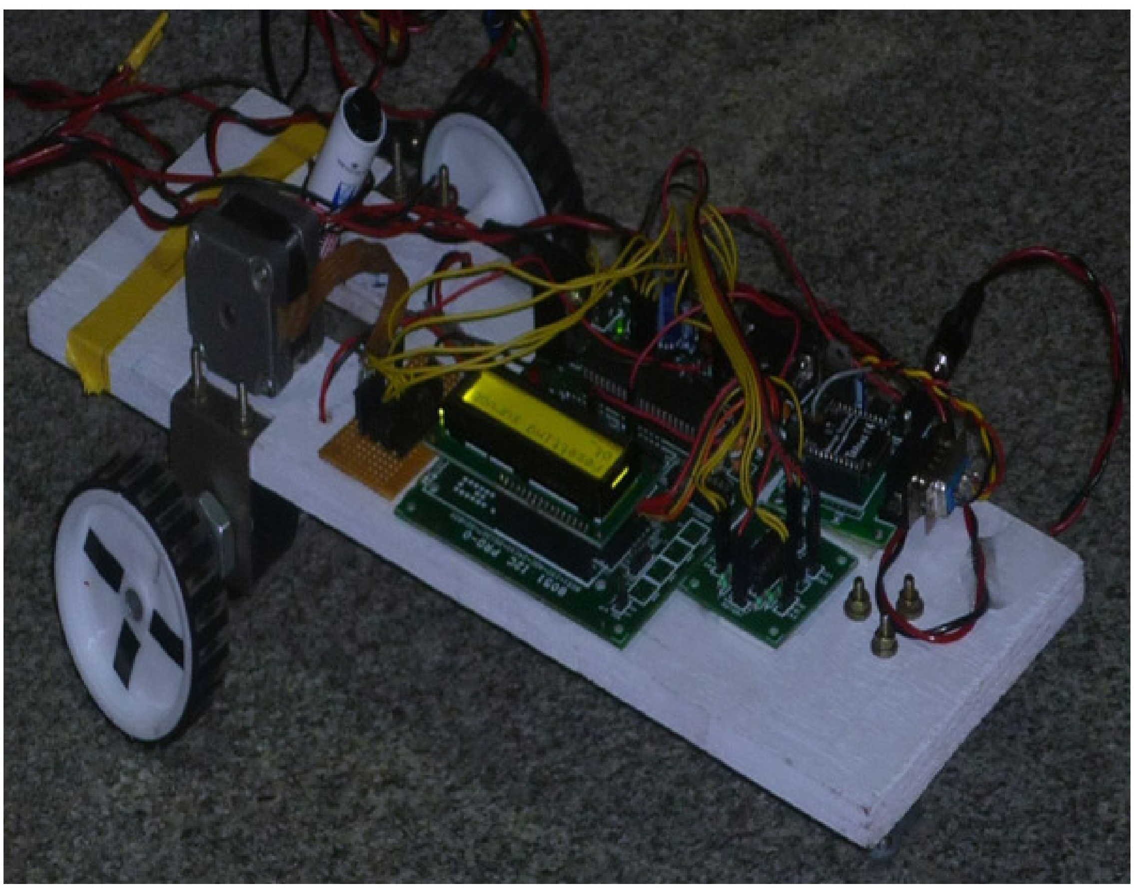

Fig. 11: FRONT VIEW of Survey Robot

V. CONCLUSION

The Survey Robot so designed specializes in area measurement for commercialized plots. This implies that Survey robot would perhaps become a boon for those who are involved in large property dealings across metropolitan cities. Since time immemorial, for measuring the area of regular size plot or any other plot, more manpower is required. This is because, there are various tools that are involved in this process such as measuring tape, rulers etc. So at least a minimum of two people have to stand end–to-end to measure each side of the plot. This measured value is then recorded by a third person who does the required conversion. And then the area of that particular plot is obtained. Hence the present surveying or area measurement techniques are tedious and tiring.

On the other hand, the major advantages of Survey robot is that manpower required and equipments used are less. The time consumed for area measurement is considerably less compared to the conventional technique and it has better accuracy making reprogramming easier. It is cost effective as well. Also, robots have now become a major part of today's technological advancements. Hence we have designed and implemented a robot that can solve this disadvantage of present surveying technique and reduce manual labor. Being a new concept, it has a great scope for improvement.

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