IC201P: Design Practicum (Feb 2017)

Sports Field Marking Robot

Team Number 17

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Team Photograph :

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Abstract

We all enjoy playing games with friends and family, but without the field lines on the ground, there would be no game at all! Line marking process of sports ground is time-consuming, manual and resource-intensive task. Field manager, grounds-men and volunteers collectively do the task . At present this is done either manually by hands or by using a lawn mowing technique and even by using strings and sticks in order to mark the lines. This require a lot of expertise and accurate equipment and also it led to inconsistency in the final result. This is an extremely time-consuming event and took approximately 3-4 hour of hard work per field.

This project aims at making an autonomous robot which can automatically mark the sports ground field lines precisely and without consuming much time. This robot can mark the layouts of different line badminton, football, athletic track etc. accurately. In order to operate the robot we will make a user interface panel on the robot through which user can feed the information about which ground it has to mark and its dimensions. After this the robot will find its path using GPS technology and starts marking the sports ground. Thus this bot will reduce the human efforts to a great extent and with precision too.

Introduction

Sports field marking robot is an autonomous robot that can mark the field lines on the ground. In order to operate this robot the user only have to feed the instruction about the type of sports ground (basketball, football, running tracks etc) and dimensions of the respective ground. After this micro-controller (Raspberry Pi) will define the path of the robot using Raspberry Pi GPS module on which the bot will move and at the same time it will spray the paint on ground to mark the lines.

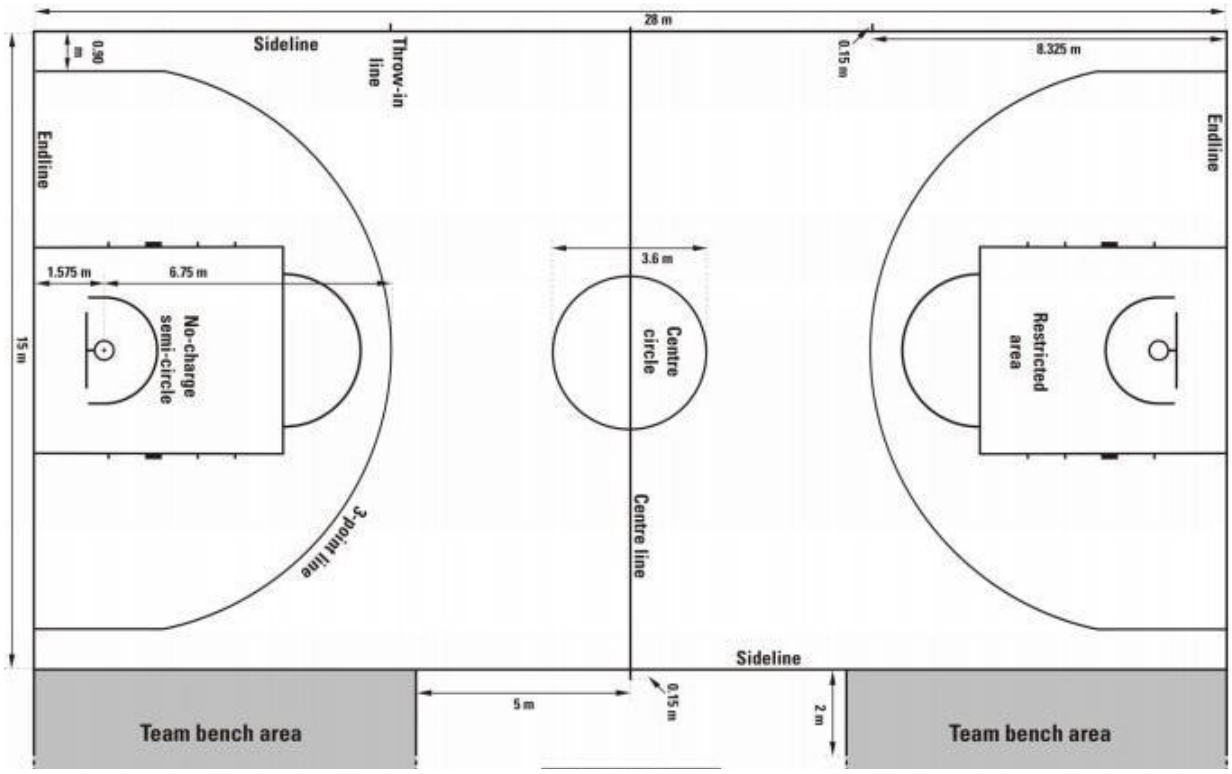
Currently, sports ground field lines are marked by hands rather than automatically or electronically. In this process at least three-four volunteers are also needed out of which one has to carry the huge weight of line marking material (calcium carbonate), one has to use string/sticks to define the path on which the calcium carbonate is dropped manually by hands. This hectic process would take roughly take 3-4 hours to mark just the single ground. But with this self-governing bot it will reduce time as well as human efforts to a great extent in the sports field marking process.

This bot will be beneficial for many sports organizations as well other schools and colleges who frequently organize sports events. This bot will be a one time investment and thus in long term it would be worthwhile to buy. Since only one person can operate this robot, there is no need to hire 3-4 volunteers specifically for this purpose.

At present we haven't any such kind of robot in any sports organization, colleges or schools which can mark the lines on playing area precisely and without consuming much time. The GPS system will help the bot to work accurately. Thus with bot we can achieve accuracy and reduce both time and capital.

Working

Let's say user have to mark the outlines of a basketball ground, in doing so user has has to enter the dimensions of the field like length and width only and it will make dimension of other lines proportionately. User also has to set reference form which our robot will start marking.



Now, our robot knows the dimensions of the ground, the micro-controller will now define the path for the bot which it has to move. In the above case if starting point is bottom left corner then it first move 28m straight then take a left turn and move 15m then again take right turn and move 28m straight and take left turn and move 15m. In this way outline of the ground will be ready. Now it will mark the mid line, then the center circle, then it will mark 3-pointer region and so on. In this way our bot will move and mark lines simultaneously.

Problem Definition

Using micro-controller, GPS module and a spraying mechanism this sports ground marking robot will draw the field line on the ground based on the input about the dimensions and shape of the ground given by the operator.

Team's other ideas (8 best)

S.No.	**Idea**	**Intended beneficiary**
1	Dam Flow Control	Nearby villages and towns
2	Waste sorting machine	Environment
3	Hexa spy bot	Defense & security purposes
4	Smart stick for Blind	Blind people
5	Mini Printer	Physically challenged people
6	Unbalanced wheel	Wall clock manufacturers
7	Anti-collision system in blind tunnels	Common people
8	Energy production using body heat	Travelers

Ideas Description

1. **Dam flow control:** It aims at controlling the release of water by the help of sensors and gates based on the current pressure and flow of water in the river. It had an additional advantage of power generation.

2. **Waste Sorting device:** This device would separate the degradable and the non-biodegradable items/material from a garbage heap using physical and chemical processes to sort the garbage.

3. **Hexa spy bot:** This is a spider shaped robot which would be able to move on uneven terrains and could have several applications in defense section and security purposes.

4. **Smart Stick:** This stick would use would use image processing along with other sensors (ultrasonic, sonar etc) and can tell the blind man about the surroundings. This stick would give the information about the surroundings to the visually impaired person through a head-phone.

5. **Mini Printer:** This is a voice controlled portable printer which has the capability to print on A4 sheet paper. You can send the pdf document to the mini printer over Wi-Fi network and it can print it on spot on the A4 sheet paper. This would also help physically challenged people to write on a paper via voice command.

6. **Unbalanced wheel:** Generates power using Davinci unbalanced wheel. The power produce on small scale would help many wall clock/wrist watch to use this power instead of buying battery each time.

7. **Anti-collision system:** This device would help the driver to see vehicles on the other side of the blind turns. It will reduce the vehicle collision in curvy turns, foggy weather etc.

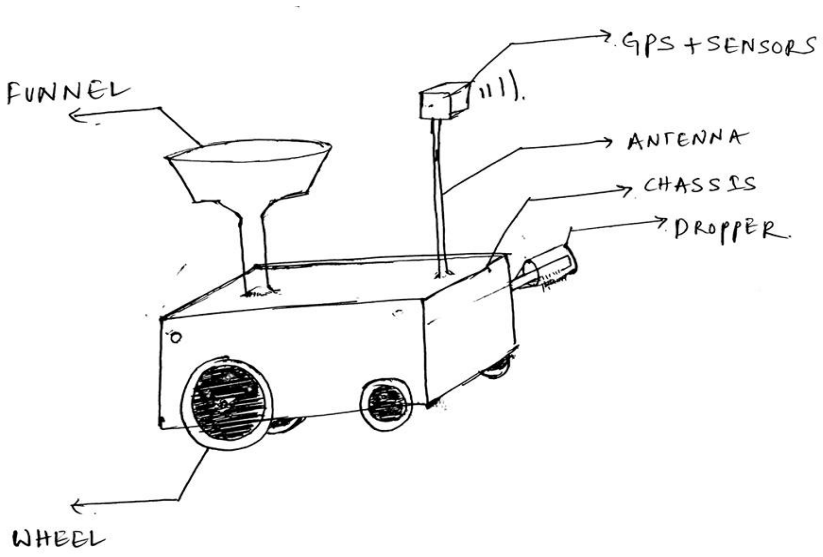
8. **Energy producing using body heat:** This device uses piezoelectric transducer to convert the body heat to electrical energy which later can be used to charge devices like mobile phone, watches etc.

Proposed Solutions/Concept

Hardware Design

Design 1:

In order to operate this bot the operator only has to give the input of the dimensions of the field to be marked. In this design we have decided to pour the line marking material (Calcium Carbonate) in a conical funnel structure which is poured from an outlet onto the ground to mark the lines.



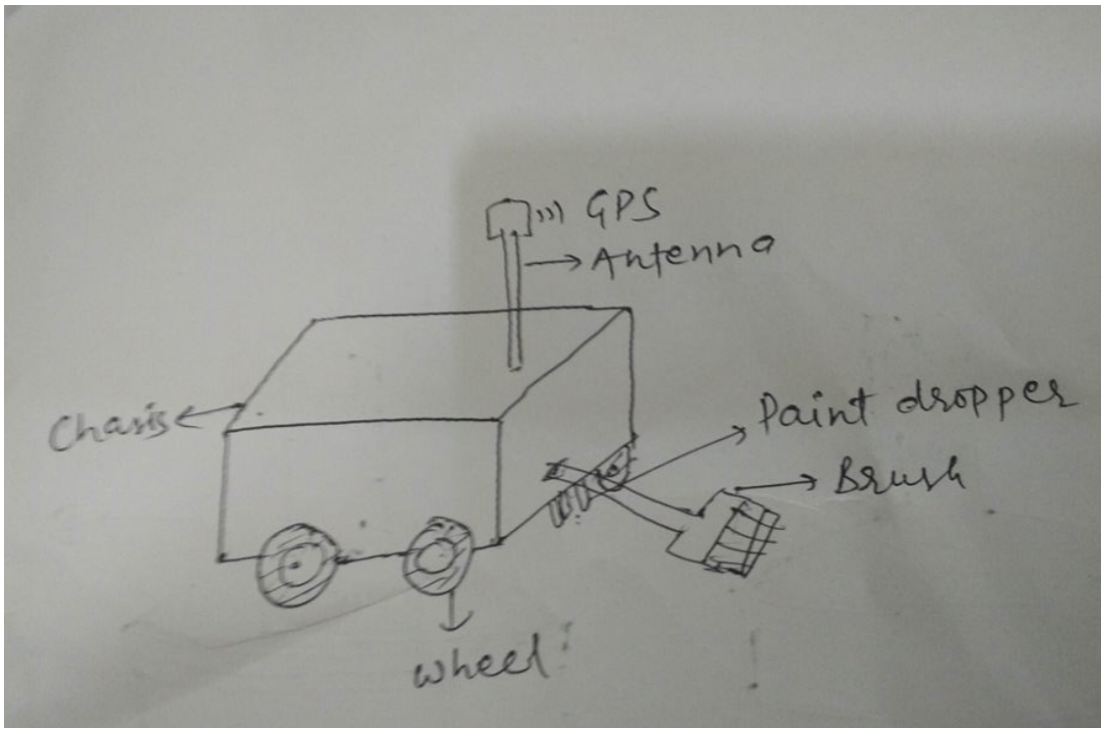
Cons:

- We have to carry huge weight of calcium carbonate on the robot hence power consumption will be high and hence more power battery would be used which again add more weight to the robot.

- It may happen during pouring of the calcium carbonate it may get choked in the outlet. In order to avoid this we can vibrate the outlet at regular interval to avoid blocking. But because of the vibration the path of the robot may get disturbed and it produces inaccuracies and inconsistency in the markings.

Design 2:

In this design instead of using calcium carbonate as our line marking material we will be using paint colors to mark the lines. A fixed size of tank of capacity 2-3 litres would pe present where paint color will be stored. Now we make three outlets on the lower portion of the robot from where paint we can release paints when needed, over this we ran a paint brush which would evenly spread the paint over the ground to mark the lines.



Pros:

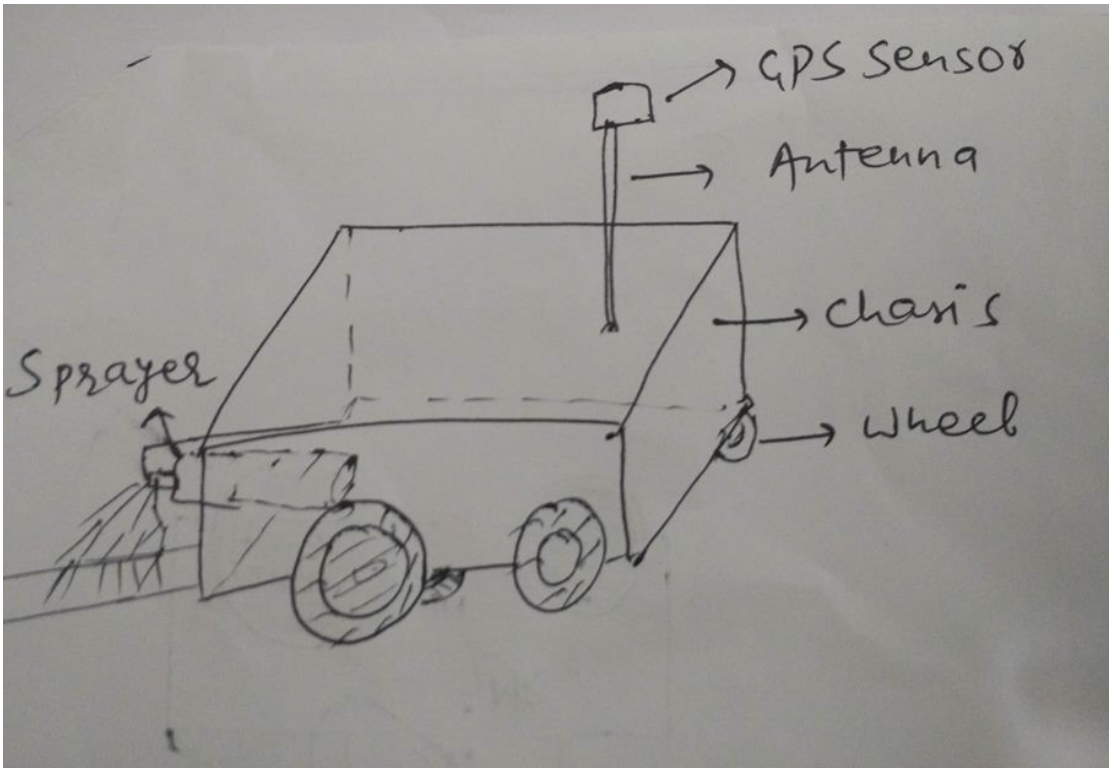
- We do not have to carry the huge weight of calcium carbonate. Thus power consumption would be low.
- Choking of outlets would nerver happen.

Cons:

- Soil content may get mixed with the brush.
- Since we are using a brush which is moving over the groud it may get tattered and get torn quickly.
- Line drawn would not be of equal width due to mixing of soil with bursh.

Design 3 (Finalized Design)

In this design instead of running a brush over the paint on the ground we have decided to spray the paint from the reservior with a spraying mechanism which sprays the color onto the ground through a nozzle only when it gets instruction from the micro-controller..



Pros:

- Weight of the robot would be less. Hence less power will be consumed.
- Wastage of paint would be less since we are using a spraying system. Which only sprays for a specific interval of time upon the instruction given by the micro-controller.
- Blocking of nozzle will not arise.

Software

1) Using motor encoder:

In this software design we decided to manually feed the path of the robot on which it has to move. The distance moved by the bot will be measured by the motor encoders. And after moving a fixed distance it will take left/right turn according to the outline of the field.

Cons:

- If we tried to mark field on uneven surface its path may get disturbed and hence it will produce some precision error.
- Manual input of the path is time-consuming and cumbersome.
- Marking arcs will be difficult.

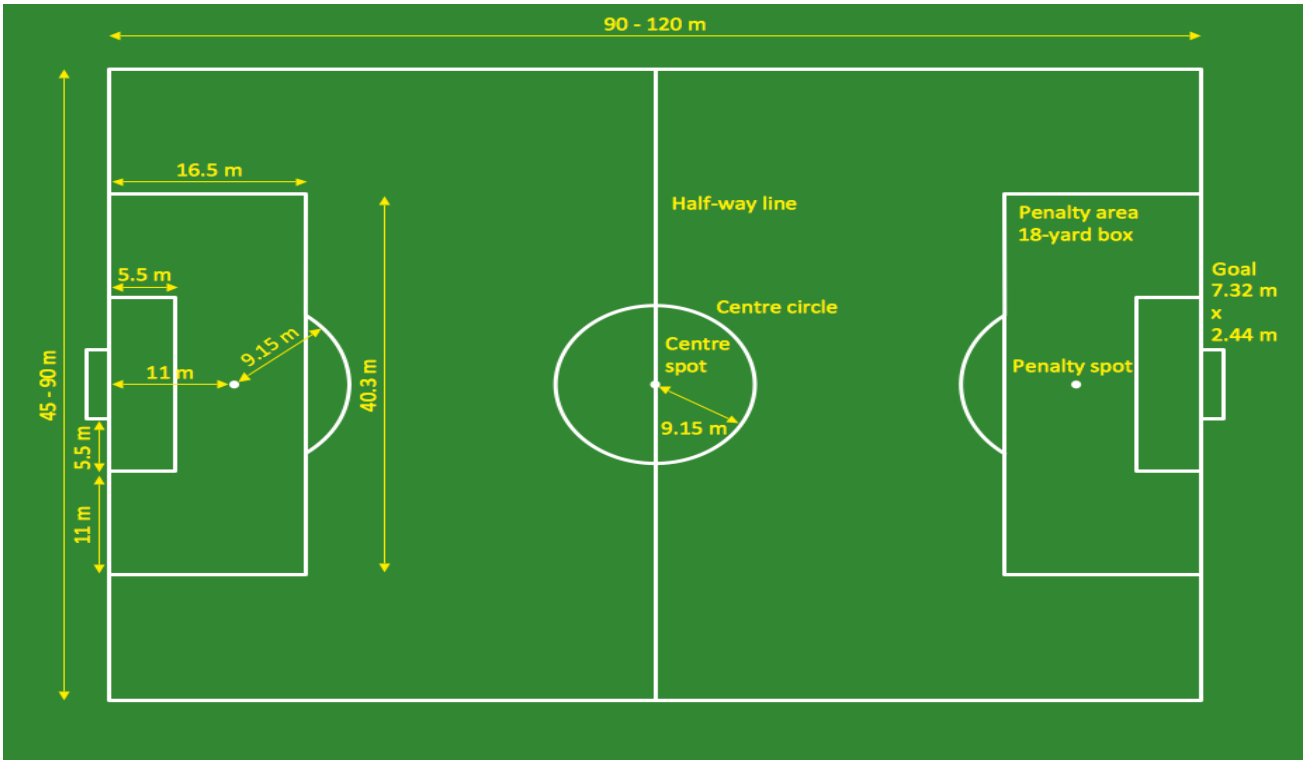
2) Using Raspberry pi GPS module (Finalized software)

In this design the user only have to feed the dimension of the field to the device through user panel and then microcontroller will generate the path for the bot on which it has to move. In this design input about the path of the bot will be based on the coordinates of the ground which will be captured by the GPS module. Since we are moving over the specified coordinates the precision error will be less.

Working

Let's say user wants to mark the lines of a football ground. Now we will provide an user interface panel on the robot through which user can give input to bot that he wants to mark a football ground and then user has to enter the dimension of length and width only. Microcontroller then automatically calculate the dimensions of penalty area, center cirle etc. automatically using relative proportions between different dimensions of lines.

Now with the help of GPS module we will get the coordinates of different points on the lines where it has to move. Now using these coordinates the micro-controller will form a path for the robot on which it has to move. The micro-controller will also decide the interval for which the sprayer sprays the paint and for what time it has to stop.



Like in the above diagram if user set the reference point to bottom left coner then the robot will move first 90m straight then take a 90deg left turn and move 45m straight, then again take 90deg left turn and move 90m straight. Once the outline of the project is formed. Now, it will mark the penalty area of the left side. Now the bot will come to the center and mark the center line, then at the center of the half-line it will move on a circular path to mark the circle at the center.

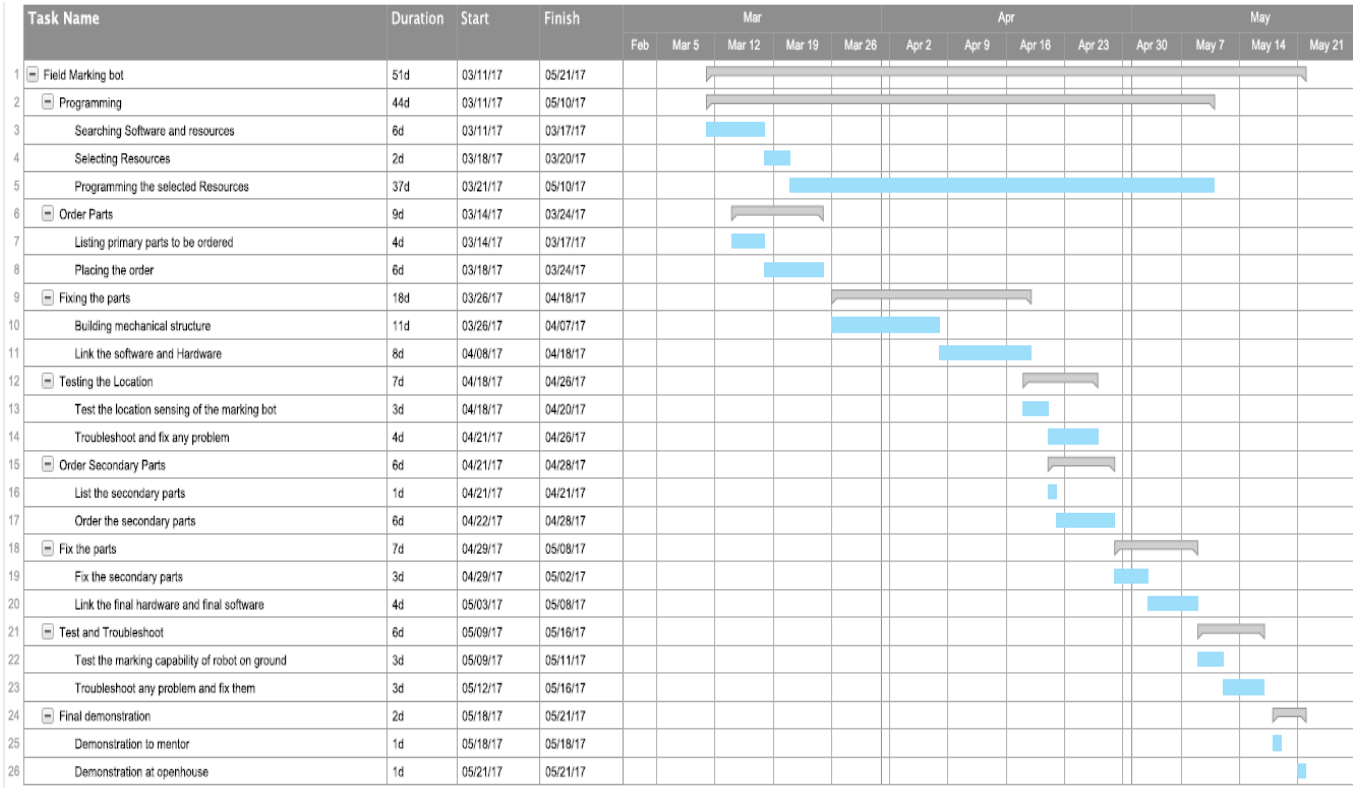
Pros:

- No encoders will be required.
- It can work with more precision.
- User do not have to feed the input manually.

Time-line

	Task Name	Duration	Start	Finish
1	Field Marking bot	51d	03/11/17	05/21/17
2	Programming	44d	03/11/17	05/10/17
3	Searching Software and resources	6d	03/11/17	03/17/17
4	Selecting Resources	2d	03/18/17	03/20/17
5	Programming the selected Resources	37d	03/21/17	05/10/17
6	Order Parts	9d	03/14/17	03/24/17
7	Listing primary parts to be ordered	4d	03/14/17	03/17/17
8	Placing the order	6d	03/18/17	03/24/17
9	Fixing the parts	18d	03/26/17	04/18/17
10	Building mechanical structure	11d	03/26/17	04/07/17
11	Link the software and Hardware	8d	04/08/17	04/18/17
12	Testing the Location	7d	04/18/17	04/26/17
13	Test the location sensing of the marking bot	3d	04/18/17	04/20/17
14	Troubleshoot and fix any problem	4d	04/21/17	04/26/17
15	Order Secondary Parts	6d	04/21/17	04/28/17
16	List the secondary parts	1d	04/21/17	04/21/17
17	Order the secondary parts	6d	04/22/17	04/28/17
18	Fix the parts	7d	04/29/17	05/08/17
19	Fix the secondary parts	3d	04/29/17	05/02/17
20	Link the final hardware and final software	4d	05/03/17	05/08/17
21	Test and Troubleshoot	6d	05/09/17	05/16/17
22	Test the marking capability of robot on ground	3d	05/09/17	05/11/17
23	Troubleshoot any problem and fix them	3d	05/12/17	05/16/17
24	Final demonstration	2d	05/18/17	05/21/17
25	Demonstration to mentor	1d	05/18/17	05/18/17
26	Demonstration at openhouse	1d	05/21/17	05/21/17

Gantt Chart



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Cost Estimation

Item	Quantity	Cost/piece	Total cost	reference
Wheels	4	80	320	http://www.ebay.in/itm/112029326886?aff_source=Sok-Goog
Stepper motor Driver	2	260	520	http://www.ebay.in/itm/302150030348?aff_source=Sok-Goog
Raspberry Pi	2	3000	6000	http://www.amazon.in/RASPBERRY-MODEL-INBULT-BLUETOOTH-WIFI/dp/B01MQX4I3G?tag=googinhydr18418-21&tag=googinkenshoo-21&ascsubtag=3aeb9502-0b75-483c-acb0-8ca734237c29
Digital Compass	1	1000	1000	http://www.amazon.in/HMC5883L-Electronic-Compass-Magnetometer-Arduino/dp/B00P7QBS12?tag=googinhydr18418-21&tag=googinkenshoo-21&ascsubtag=3aeb9502-0b75-483c-acb0-8ca734237c29
Stepper Motor	4	700	2800	http://www.nex-robotics.com/products/motors-and-accessories/stepper-motors/high-torque-bipolar-stepper-motor.html
Motor Encoders	4	200	800	
Electric Spray	1	250	250	http://www.amazon.in/Garden-Pressure-Sprayer-1-5L-naturals/dp/B01JDC6HXY?tag=googinhydr18418-21&tag=googinkenshoo-21&ascsubtag=3aeb9502-0b75-483c-acb0-8ca734237c29
Jumper Wires	120	-	210	http://www.amazon.in/dp/B01H4YB47M?psc=1
GPS Module	1	1300	1300	http://www.ebay.in/itm/331757723713?aff_source=Sok-Goog
Li-Po rechargable	1	2000	2000	http://robokits.co.in/batteries-chargers/lithium-polymer-

battery				battery/lithium-polymer-li-po-rechargeable-battery-11.1v-2200mah-40c
Bread Board	2	100	200	http://www.amazon.in/Campus-Component-BREADBOARD-Quality-Solderless/dp/B01N9UNGE6?tag=googinhydr18418-21&tag=googinkenshoo-21&ascsubtag=3aeb9502-0b75-483c-acb0-8ca734237c29
Building structure with(Aluminium sheet)	-	-	Approx 500	

Total Cost (Approx) : 15900 Rs

Major Concerns

- One of the hurdle is the homogeneous and proper distribution of the spraying of paint.
- Moving the bot on curves, say we have to make a circle then controlling the directions of all motor and their speed is a major issue.
- We also need to make sure that our robot moves on the exact path using raspberry pi, GPS module and encoders. It should not deviate from its path as a small deviation can spoil whole shape of the ground.
- Making the spraying system mechanism is also a challenging part. The sprayer has to open exactly for a given time interval and then it has to close.

Conclusions

Automatic ground marking aims towards reducing human efforts as well as saving precious time. There will not be any need of instructor and labor separately. It also aims to reduce the human error.