Intelligent Line Marking Bot

Team member details:

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Abstract:

Nowadays, robots are used in different areas for different applications. The problem is to mark field lines manually in a sports field, especially on gravel or sand fields, which can lead to errors and high time consumption. This project thus focuses on a stand-alone line marking robot, which can easily complete this process. This robot is intended to provide accurate marking of any field within a shorter time frame by using sensor fusion algorithms to fuse various sensors to pinpoint the location of the robot. The simulation of the robot is performed in the Matlab - Simulink software with the help of existing libraries. After the simulation, the code is checked on a real robot. The mechanical team developed the design. Adequate suspension and steering mechanisms will be provided to overcome the unequal nature of ground or soil. Finally, the code has been optimised and tested in the field to achieve the desired precision.

YouTube Link and Website Link:

Bot | CTF Projects | Kurukshetra '21 - YouTube

Link to the LOA folder:

Timeline:

DECEMBER	Simulation on MATLAB - SIMULINK software.
JANUARY	Initial Design and Testing iterations of the bot in CAD software

FEBRUARY	Final Design and Testing iterations of the bot in CAD software
MARCH	Assembly and Testing of the Bot

SPLIT UP WORKS: -

We, the team members, had a number of brainstorming sessions on G-Meet. Analysed the pros and cons of different components and concepts used in the bot.

We internally split up our work as two parts

a) Design Team
b) Simulation and Coding Team

Though we split work among ourselves, we consistently had many meetings during weekdays and weekends to share our work process and had many discussions on the improvement of the bot.

DECEMBER (SIMULATION): -

WEEK 1: -

The Problem statement was further analysed and tried to formulate the most feasible solution with the team. Discussed about the essential works to be done for the bot's successful operation.

WEEK 2: -

Initial iteration of the pre-path planning algorithm was done. This includes creating way points for the bot to trace.

WEEK 3: -

The code for the pre-path planning algorithm was successfully finished.

WEEK 4: -

Initial iteration of Sensor fusion of Magnetometer, Gyroscope and Accelerometer was simulated in MATLAB.

JANUARY (DESIGN AND TESTING): -

WEEK 1: -

Sensor fusion was successfully simulated in MATLAB. Noise of the sensor was reduced by different filters.

WEEK 2: -

Analysed and discussed with the team about the designing works of the bot and initial iterations of design were formed.

Potential components required were drafted.

WEEK 3: -

1. Finished the CAD design works of iLMBT.
2. Analysed the CAD model and its performance on the track.
3. Done important calculations and analysis in kinematics.

WEEK 4: -

1. According to the calculation the bot was completely redesigned.
2. Finalize the chassis, wheelbase, knuckle type
3. And materials were selected for each and every major component.

FEBRUARY (DESIGN AND TESTING Contd.): -

WEEK 1: -

Many design iterations were made to rectify all the minute corrections.

WEEK 2: -

Studied about the closing and opening of the powder entrance. And finalized to use the Hopper mechanism and studied it further.

WEEK 3: -

1. Finalized the components required and suitable for the Hopper mechanism like N20 motor (to open and close the hopper slot) and calculated the dimensions of the slots needed.
2. Servo motors were used for steering of each wheel, it can make upto 45 degrees of rotation.

WEEK 4: -

Finalised the materials and dimensions suitable for the chassis tank. Did some mass calculations on the hole (where the powder will be deployed) of iLMBT.

MARCH (ASSEMBLY AND TESTING): -

WEEK 1: -

- Electronic component mounting design was added to the existing design of the bot.
- Several iterations of the design were done for effective placement of the electronic components.

WEEK 2: -

- The layout design for laser cut was done and it took a week to get all the material for laser cutting.
- All the electronic components of the bot arrived. Such as Arduino mega, Raspberry pi, Motor drivers, GPS Module, MPU 9250, Gyro, Servo motor for steering and wheels.
- Meanwhile the code was uploaded in Raspberry pi and Arduino and checked for errors and corrected.

WEEK 3: -

- The chassis of the bot was laser cut.

- The fit and tolerance of the electronic component was tested with the chassis of the bot.
- Initial assembly of the electronics was made and all the parts were tested. Such as a GPS module.
- All necessary parts of the bot arrived such as Wheels, rechargeable batteries.
- The holes in the chassis were 2.7mm but the actual diameter needed was 3mm. So, the chassis was drilled to enlarge the dimensions.
- The wheels were attached to the chassis with servo to check the camber of the wheels and the deflection of the chassis.

WEEK 4: -

- The casing of the bot was done.
- The bot was checked for steering and GPS status.
- The initial testing of the bot was done on the field.
- All the wires are disassembled and proper soldering was done.
- Hopper mechanism was fixed and the top case was attached to the bot.
- The bot was finished with all required parts and assembly.

Budget:

S.No.	Component Name	Shop Name with Location	Per Unit Price	Quantity	Net Price
1.	MPU 9250	Mercy Electronics	Rs.661.02	1	Rs.661.02
2.	P.Kit GPS Flight Control	Mercy Electronics	Rs.406.78	1	Rs.406.78
3.	Triple axis Gyro Accelerometer Module	ElectronicsComp.in	Rs.83.00	1	Rs.83.00

4.	Triple axis Compass Magnetometer Sensor Module	ElectronicsComp.in	Rs.210.00	1	Rs.210.00
5.	Arduino Mega	ElectronicsComp.in	Rs.695.00	1	Rs.695.00
6.	Raspberry Pi 4 Model B with 2GB Ram	ElectronicsComp.in	Rs.2,895.00	1	Rs.2,895.00
7.	GA12 N20 12V 140RPM All metal Gear Micro DC Encoder Motor	Dazzle Robotics	Rs.380.00	6	Rs.2,280.00
8.	Charger for Rechargeable batteries	Amazon.in	Rs.675.00	1	Rs.675.00
9.	TS10A 2P2W	Ponniie Electrical and Electronics	Rs.60.00	3	Rs.212.40
10.	Rhino GB37 12V 110RPM 6.5KGCM DC Geared Encoder Servo Motor	Dazzle Robotics	Rs.810.00	4	Rs.3,240.00
11.	Li-ion 11.1V 2500mAh (2C) with inbuilt charger protection	Dazzle Robotics	Rs.713.00	3	Rs.2,139.00
12.	Bracket for High Torque/Side shaft Motor	Dazzle Robotics	Rs.120.00	4	Rs.480.00
13.	Jumper Cable Male to Male	Mercy Electronics	Rs.135.69	1	Rs.135.69

14.	Jumper Cable Female to Male	Mercy Electronics	Rs.5.60	10	Rs.50.60
15.	Jumper Cable Female to Female	Mercy Electronics	Rs.5.60	10	Rs.50.60
16.	Battery 9V	Mercy Electronics	Rs.12.71	1	Rs.12.71
17.	Battery Snap 9V	Mercy Electronics	Rs.4.24	1	Rs.4.24
18.	Rhino DC Servo Driver 50W	Dazzle Robotics	Rs.478.00	4	Rs.1912.00
19.	Hopper Made of Aluminium Sheet	JNS Metals	Rs.275.00	0.95Kg	Rs.275.00
20.	Chassis Laser cut	Dhanalakshmi Industries	Rs.1391.00	1	Rs.1391.00
21.	Stud and M8 Bolt and Nut	Sri Velavan Engineering Works	Rs.130.00	4	Rs.520.00
22.	M6 Bolt and Nut	Raj Industrial Enterprises	Rs.90.00	1	Rs.90.00
25.	M2 Bolt and Nut	Raj Industrial Enterprises	Rs.3.00	10	Rs.30.00
26.	Tracked Wheels of 110mm Diameter 45mm Width and 6mm ID	Dazzle Robotics	Rs.130.00	4	Rs.520.00

27.	6 SS Allen Bolt	AR Traders	Rs.2.15	60	Rs.129.00
28.	8 SS Allen Bolt	AR Traders	Rs.2.20	25	Rs.55.00
29.	12 SS Allen Bolt	AR Traders	Rs.2.25	20	Rs.45.00
30.	P.Kit Robot Chassis	Mercy Electronics	Rs.338.00	1	Rs.338.00
31.	15 SS Allen Bolt	AR Traders	Rs.4.50	20	Rs.90.00
32.	3mm GP Nut	AR Traders	Rs.0.25	40	Rs10.00
33.	Memory Card 32GB	Poorvika Mobiles	Rs.600.00	1	Rs.600.00
34.	Material Milling and Lathe Work	Skilled Engineering	Rs.600.00	1	Rs.600.00
35.	Electric Soldering Iron Kit	Amazon.in	Rs.799.00	1	Rs.799.00
36.	P.Kit Board	Mercy Electronics	Rs.161.00	1	Rs.161.00
Total					Rs.21,795.64

Technical Explanation:

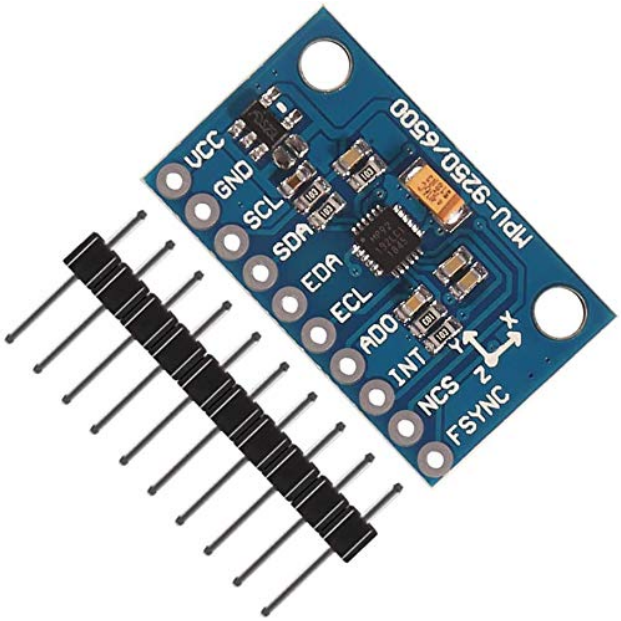
The Intelligent Line Marking bot (iLMBT) uses dynamic path planning algorithm, to plan the path in real time by avoiding obstacles and decreasing the time of line marking.

The bot uses Kalman filter which is a digital filter that filters error by accounting the probabilistic error of the GPS sensor (which has an accuracy of only 2.5m), IMU sensor which estimates to increase the accuracy to centimeter scale.

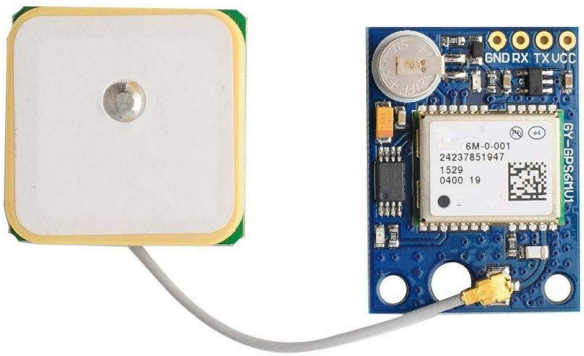
The bot has three sensors, they are GPS module, MPU9250 (which measures the angular velocity hence the rotation of the bot), and inbuilt compass to assess the orientation of the bot. The bot uses Akermann steering and Differential steering for kinematics of the system. It has a hopper tank with a capacity of 1.5 Kg, which helps in storage of line marking powder with minimal human interference. And this bot also has a ground clearance of 4.5m, which helps the bot work in uneven terrain. The bot uses N20 motors for smooth deployment of the powder in the field.

Photos of Components:

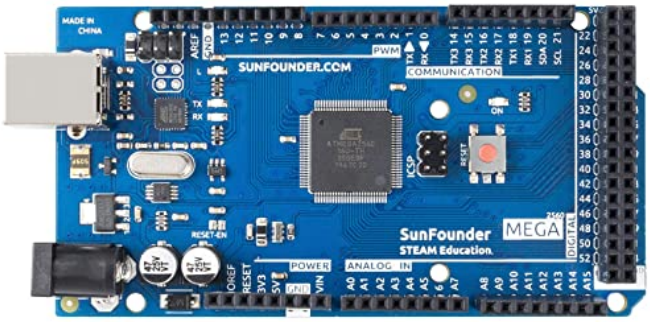
MPU 9250:



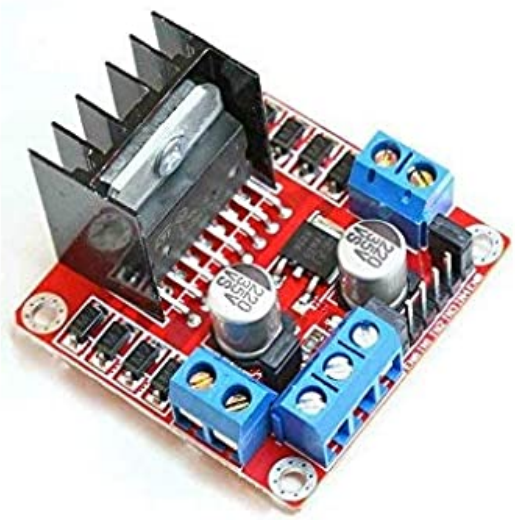
GPS module:



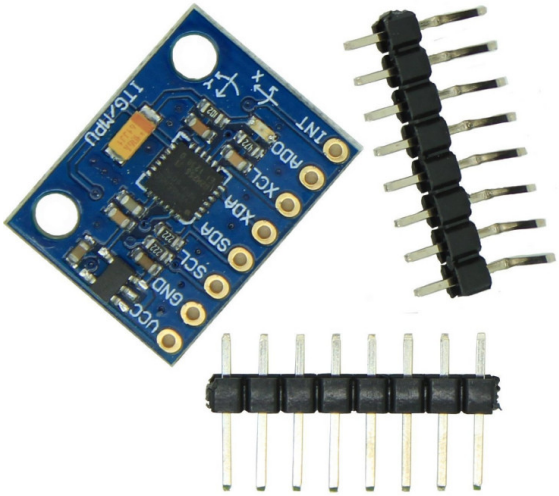
ARDUINO MEGA:



MOTOR DRIVER: -



Triple axis Gyro Accelerometer Module: -



Analysis and Obtained Conclusions:

A1. The Kalman Filter has a large error to correct then usual mostly due to the present of trees

A2. There was a lot of vibration in the bot in general which should have been due to the lack of weight of the bot which lead to slipping of the wheel

Problems and Obtained Solutions:

P1. Actual dimension of the bot was not built.

P2. The deployment of line marking powder was not demonstrated.

P3. Obstacle detecting sensor was not added.

P4. Kalman filter was not tuned to full efficiency

Result:

The iLMBT was able to locate and move to two points successfully

Future Work:

- The iLMBT would be upgraded in size
- The steering motors will be upgraded due to less resolution in the present one
- Suspension systems are yet to added
- IOT code for the bot has to be done
- proper ventilation
- user interface

Attachment Details:

Team Folder -
https://drive.google.com/drive/folders/1LOc3MQuMsQAj66ATGowux1fOUP3XBcpq?usp=sharing

Media Folder -

https://drive.google.com/drive/folders/1bKW9zVyGzebHwZNid_FVrjj-9Q9dmMdC?usp=sharing

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