MULTI-FUNCTIONED FARMING VEHICLE USING LOCAL POSITIONING SYSTEM AND ADVANCED PATH PLANNING ALGORITHMS

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Abstract - *The multi-functioned farming vehicle using local positioning system and advanced path planning algorithms should be used to improve the issues in farming. The vehicle uses local positioning system with four ultrasonic sensors at the extreme ends that is at the corner of farm which detects boundary of farm. Vehicle is having one sensor on it which shows its location. Vehicle is run by advanced path planning algorithms implemented in LabVIEW software and operated through dc motor. In farm there are six columns of different farming techniques like seeding, spraying, cutting and collecting of crops. Vehicle is having interchangeability of tools according to different techniques of farming. Work estimation is done by parameters like number of seeds, ml of water, weight of crop collected .The obstacle is detected by vehicle through ultrasonic sensors. Its indication is given by alarm of sound or light that is LED. Vehicle stops after obstacle detection and after finding resolved path it starts and run accordingly. Thus multi-functionality, LPS technology and obstacle detection by path planning algorithms used in vehicle makes it compact device for farming.*

***Key Words*: local positioning system, ultrasonic sensors, LabVIEW software, work estimation, LED, obstacle detection**

1. INTRODUCTION

The agricultural rate in India's economy is decreasing. Poor yields are obtained due to natural calamities, improper management during agriculture practices and failure of operation due to insufficient field information for effective path planning. Tremendous amount of energy loss due to improper working of costly and time consuming individual farming equipment. The multi-tasking farming vehicle using local positioning system and advanced path planning algorithms should be used to improve the issues. Suicide rates in India are increasing rapidly. In 1995, suicides per year in India were 10500-10700, now in 2016-17 it is increased up to 14500-15000. Agriculture rate of India is also decreasing year by year. India's GDP from agriculture was 5460 INR Billion in 2014, now it is decreased to almost 4300 INR Billion in 2017 which is very less as compared to other countries. Tremendous amount of energy is lost by different farming vehicles and in various processes. In India, Animals and manual labour work is used mostly farming. The challenge is to provide customers multi-functioned vehicle which can be cheap and easily available. Vehicle should satisfy all needs of farmer .The vehicle should obtain goals such as decreasing suicide rate, increasing agriculture rate, higher yields and energy utilization. It should reduce animal and labour work through its multi-functionality.

2. SYSTEM ARCHITECTURE (Considering Prototype of System)

System architecture includes physical structure of vehicle and farm, detection by sensors, path planning, interchangeability of tools, obstacle detection and work estimation.

2.1 Physical structure of vehicle

- ✓ Vehicle dimensions:
  - Length = 0.5 m
  - Width = 0.3 m
  - Height = 0.25 m
- ✓ Total weight of vehicle = Weight of chassis + Weight of tools
  = 8 kg + 4 kg = 12 kg
- ✓ Motor: 12 volt dc motor is used for running and all functions.

2.2 Physical structure of farm

- Farming area = 3 m * 3 m = 9 m^2
- Six columns for various operations to be performed as follows:
  Column 1 & 2: Seeding and obstacle detection with processing in resolved path
  Column 3 & 4: Spraying
  Column 5 & 6: Cutting and collecting after reversal
- Clearance of 0.2 m for vehicle rotation after LED blinking on each side i.e. at starting and stopping end

- Total LED's = 2 LED's per column
  = 2 * 6
  = 12
- Distance between two columns = 0.43 m (approx.)

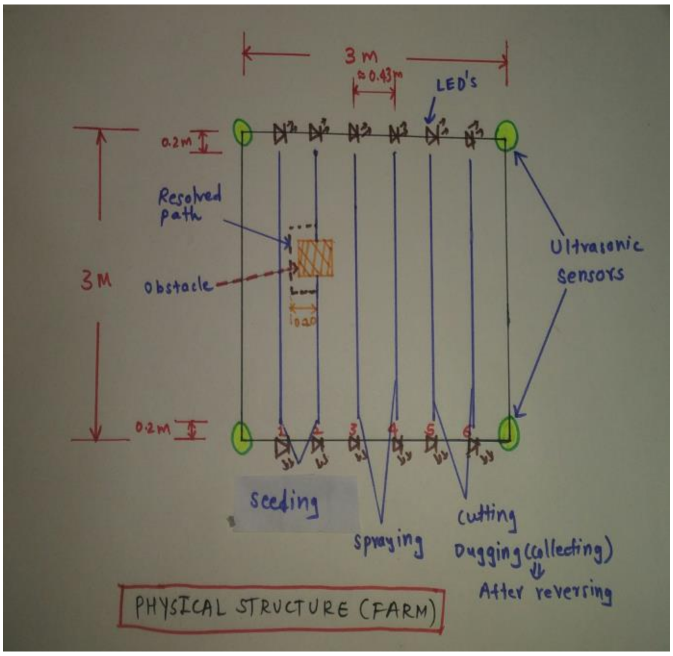

Fig – 1: Physical structure of farm

2.3 Detection by sensors

- ❖ Total ultrasonic sensors = At the corners of farm + On the vehicle
  = 4+1 = 5
- ❖ Maximum range = 3 m

2.4 Interchangeability of tools

Tools like cutter, sprayer, seeding equipment, bucket, spraying tank are mounted on vehicle according to operation to be performed.

Fig – 2: Farming tools

2.5 Obstacle detection and processing in resolved Path

- Taking Square / Rectangular shaped obstacle
- Obstacle Dimensions = 0.15 m * 0.15 m = 0.0225 m^2
- Resolved path = 0.20 m distance covered per rotation in linear direction

2.6 Work estimation

- ❖ Work estimation is done by seeds bowed, pesticide sprayed, weight of crop
- ❖ Pesticide Capacity = 2 litre = 1 litre per line = 100 ml per crop
- ❖ Seeding Capacity = 20 seeds = 10 seeds per line = 1 seed per 0.26 m
- ❖ Weighing Capacity = 3 kg = 1.5 kg per line

3. DESIGN OF VEHICLE

Fig – 3: Inclined view showing front body with tools

Fig – 4: Inclined view showing rare body with tools

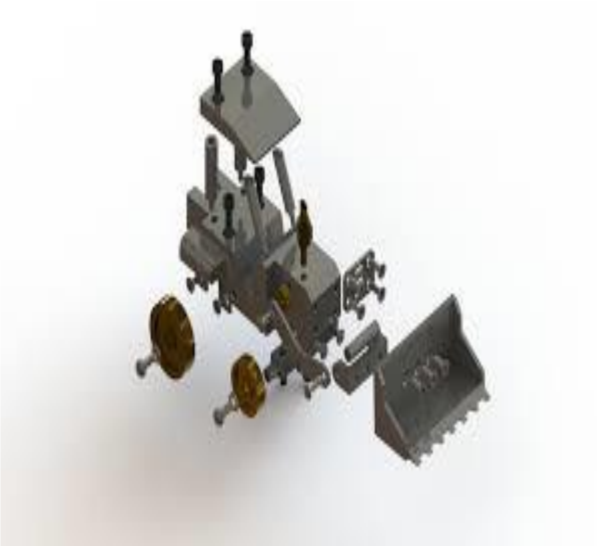

Fig – 5: Exploded view of vehicle

4. HARDWARE AND SOFTWARE (Considering Prototype of System)

4.1 Hardware

No.	Component	Model No.	Specifications
1	Chassis	4WD All Terrain Chassis	10 mm allowance for mounting of PCB's sensors, brass fitting, nickel plated suspension springs
2	Motor	-	Operating voltage-12 volts
3	Motor Controller Circuit a. Diode b. n-channel enhancement mode MOSFET p-channel enhancement mode MOSFET	1N4001 ZVN2110A IRF510 ZVP2110A	General Purpose n-channel n-channel p-channel
4	Actuators	SH-T2551Z	○ Type: Solenoidal pull push type ○ Operating Voltage: 12 volts Power: 10 watt
5	Ultrasonic Sensor	Series 7000	Size : 2 cm to 3 cm
6	Battery	Battery pack 41135	1x 10-cell AA NiMH

Other hardware parts

- Cutting Tool
- Bucket
- Sprayer
- Spraying Tank
- Seeding Device
- Wheels
- Required parts of vehicle

4.2 SOFTWARE

I. LABVIEW 2017
II. myRIO toolkit 2017
III. Real Time Module 2017
IV. JKI State Machine

5. IMPLEMENTATION

I. At start, vehicle is at one of the corner of farm leaving 0.20 m distance from boundary. Ultrasonic sensors are mounted at the corner of farm and one on the vehicle. Before starting of vehicle system detects vehicle location and also boundary detection is done by local positioning system.

II. Vehicle is operated by DC motor and path is given by advanced path planning algorithms in LabVIEW.

III. In column 1, seeding operation is done by using seeding tool. In which vehicle bows 1 seed per 0.26 m distance throughout the column. Vehicle covers almost 2.6 m distance and rotates for going in next column. If vehicle goes in clearance area (i.e. >2.6 m) then LED glows for indicating incorrect path.

IV. In column 2, seeding is done same as last step. Obstacle is detected by LED mounted on vehicle in this column after almost covering 1.25 m distance from boundary. Vehicle determines resolved path that is 0.20 m distance per rotation in linear direction and proceed in resolved path to achieve original path. Rotation is done by same principle as before.

V. In column 3 & 4, spraying operation is executed by using sprayer and tank filled with pesticide. In this operation vehicle sprays 100 ml of pesticide per 0.26 m distance. It uses total 2 litre of pesticide i.e. 1 litre per column. By LED sensing rotation is done as before.

VI. In column 5 & 6, cutting operation is performed by using cutter. For that required RPM are set for the cutter.

VII. After cutting operation, collection of crops is done by bucket. For that vehicle reverses its direction and moves in column 6 for collection. Vehicle cut 1.5 kg of crop per column by using bucket.

VIII. Work estimation is done by considering number of seeds bowed per column, ml of pesticide sprayed per column and by weight of crop cut per column. It is done after each operation simultaneously.

6. CONNECTION DIAGRAM

This wiring or connection diagram shows how hardware can be connected to myRIO toolkit for actual working of vehicle by connecting different wires.

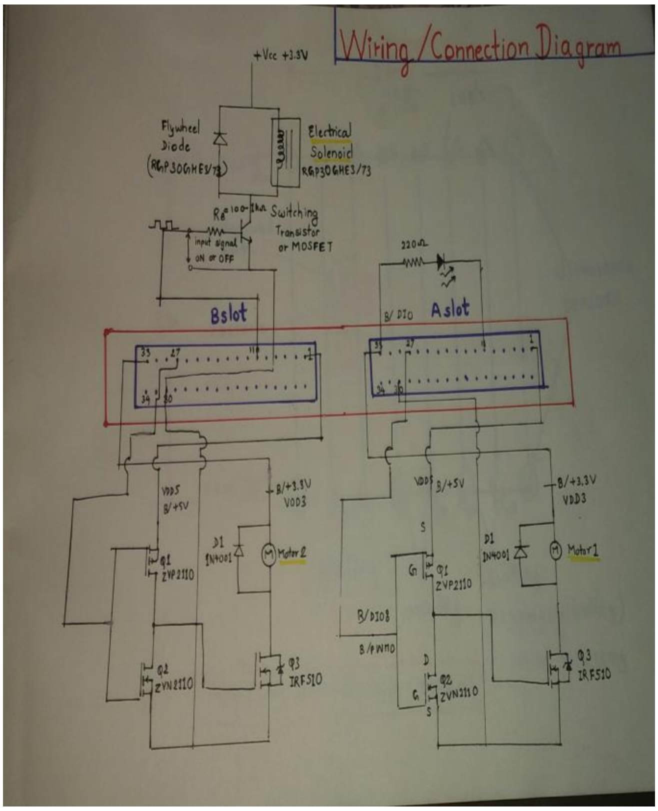

Fig – 6: Connection diagram

7. IMPLEMENTATION IN LABVIEW (JKI STATE MACHINE)

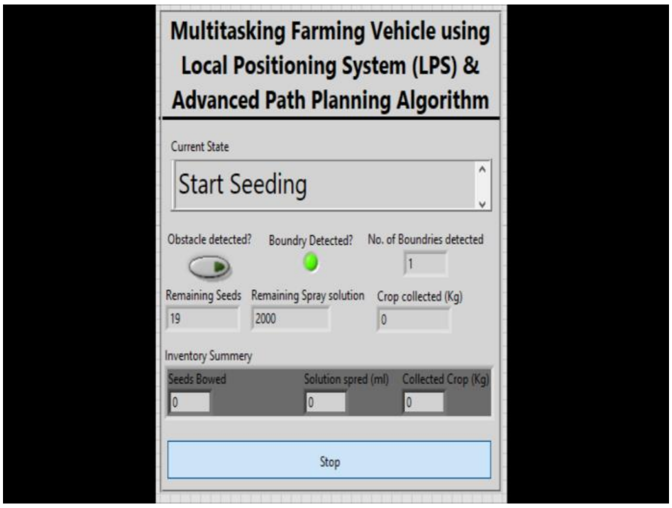

Fig – 7: Front panel

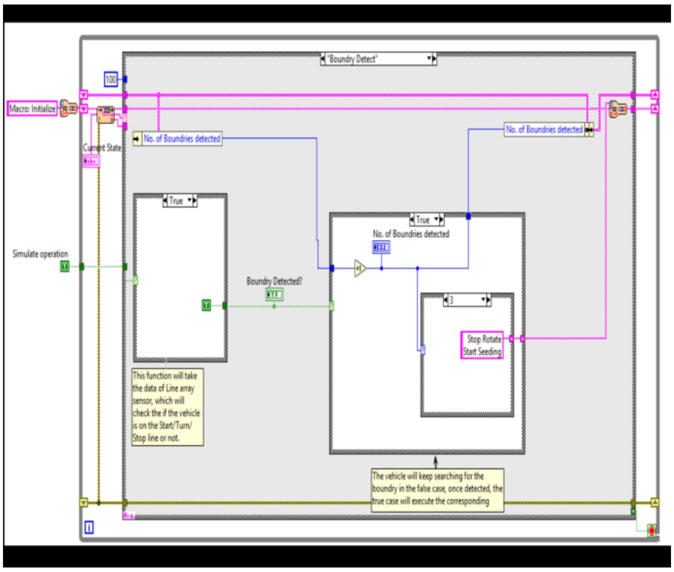

Fig – 8: Boundary detection

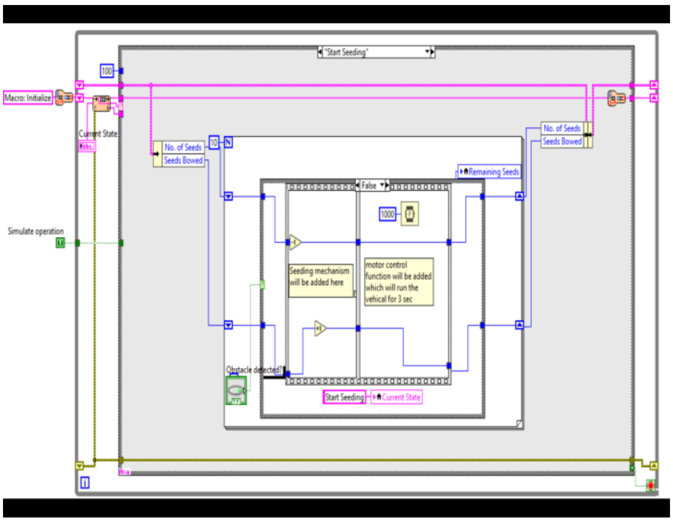

Fig – 9: Seeding

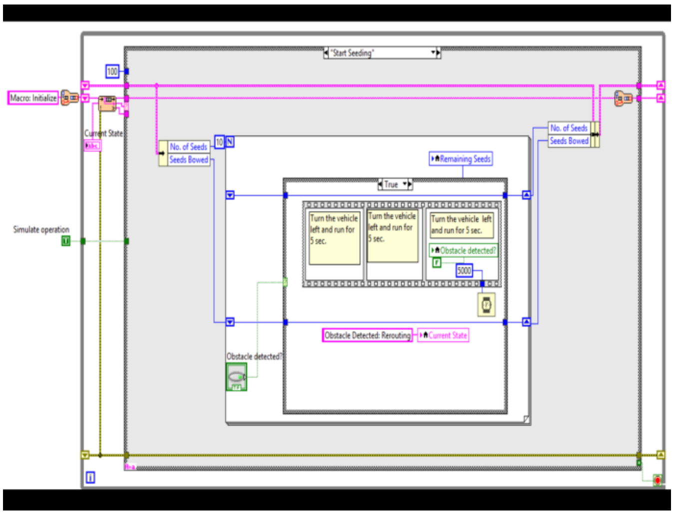

Fig – 10: Obstacle detection

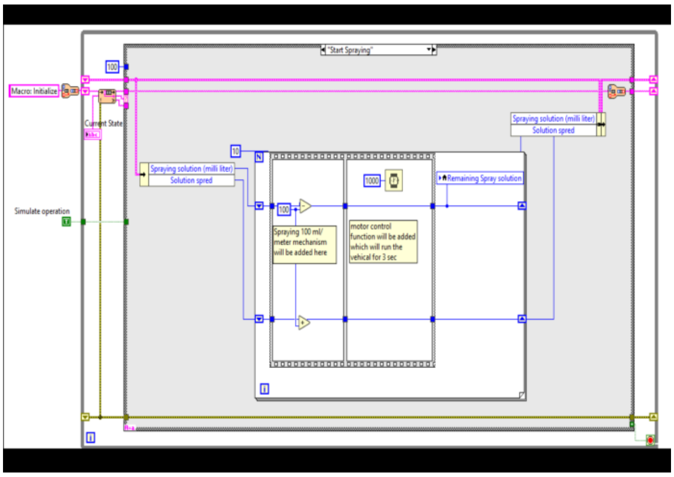

Fig – 11: Spraying

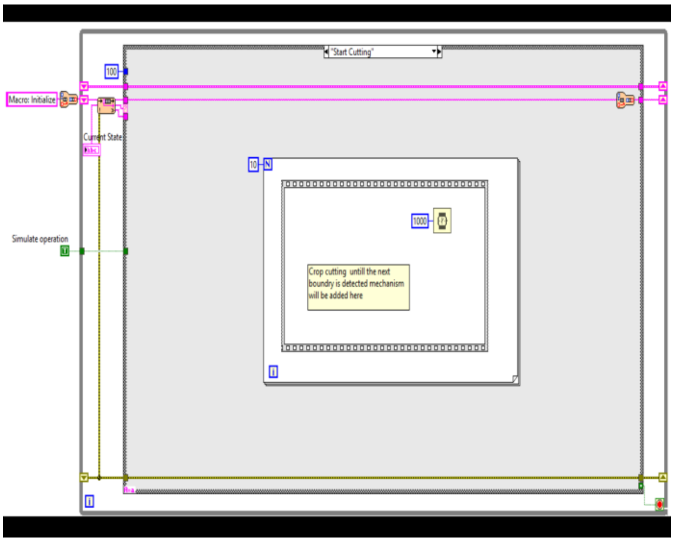

Fig – 12: Crop cutting

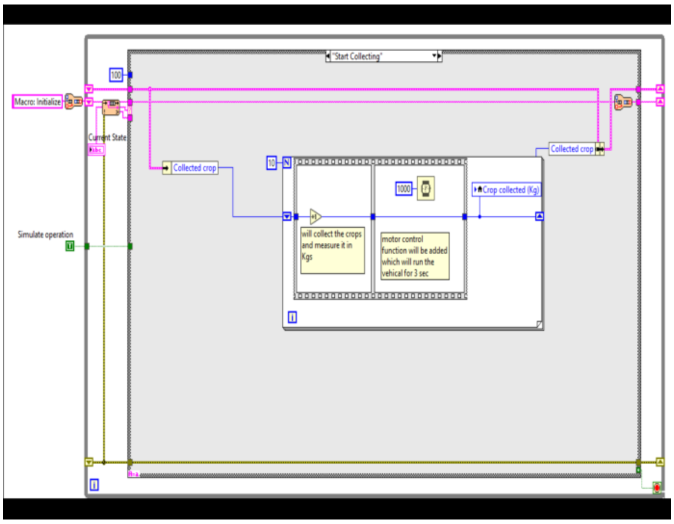

Fig – 13: Collecting crops

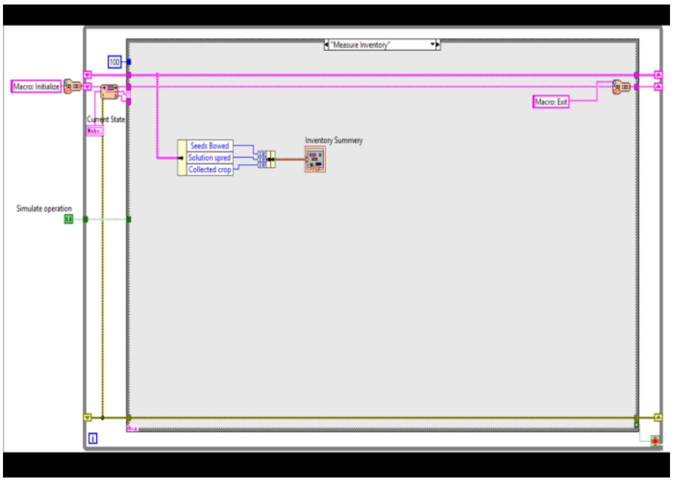

Fig – 14: Work estimation

8. FEATURES

This includes customers, logistic feasibility, feedback, scope, existing system.

8.1 Customers

- Farmers
- Automobile companies

8.2 Logistic feasibility

If customer is desired to use it for farming purpose then there is no need of permission by government, he can operate it individually. But it can be also used for acts like terrorism in that case permission by government would be important.

8.3 Feedback

Feedback concludes that it is helpful to the farmers whom have less manpower, having big farms. Farmers can easily take care of their farm without actually going into the farm. For farmers who live little away from their field it is beneficial for them.

8.4 Scope

- Decrease in suicide rate
- Energy utilization
- Higher yields
- Increment in agriculture rate
- Vehicle using LPS technology

8.5 Existing system

- There exists Kalman's filtering technique which uses supplementary measurements like odometry and altitude for improving accuracy of GPS-receiver which is not so accurate. It also uses GPS technique which is not affordable to everyone.
- There exists robots which can analyze moisture content of soil and parameters like that for farming operations. This system also uses GPS in it.

9. CONCLUSION

The study concludes following points:

- Vehicles or devices with similar type may be available but either they are not multi-functioned or they are using GPS for detection.
- Vehicle uses local positioning system for detection and advanced path planning algorithms in LabVIEW software which are easy to use and affordable.
- System includes obstacle detection and path planning in resolved path which is very important considering different farming conditions.
- Vehicle is less expensive, easily available and multi-functioned so useful for farmers and respective customer.

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