GPS-Directed TED Smart Agri Bot (G-SAB)

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Abstract— **With the advent of technology, agriculture has reached peak levels of performance. In spite of several advancements, the concept of cost remains an issue. Tractors with advanced technology integrated into them remains unattainable for the common Indian farmer. Moreover these technologies are aimed at large scale farming and consume much energy of the farmers. Our project aims to overcome these difficulties by introducing an affordable and efficient farming robot G-SAB. It involves a user friendly mechanism which allows farmers to perform the three essential activities of farming namely ploughing, sowing and fertilizing. It has minimal space requirements since the sowing and fertilizing modules are incorporated within the frame. This project employs Zero tillage technology which eliminates the need for prior seed bed preparation thereby increasing efficiency. G-SAB is a small step in technology but a giant leap for Indian farmers.**

***Index Terms*— farming robot, ploughing, sowing, fertilizing, Zero tillage technology.**

I. INTRODUCTION

The field of agriculture has gone through innumerable advancements in the past decades. In spite of many inventions the concept of "cost" of the technology used in agriculture still remains at peak. It makes it unavailable for most of the agriculturists. There was once a time when farmers used to plough the land manually and it was one long hard task stretching from dawn to dusk. So they put their heads together and came up with the tractor.

Tractors which include multifunction modules cost in lakhs which is not affordable in developing countries like India. Current agricultural practices are neither economically nor environmentally sustainable and India's yields for many agricultural commodities are low. Poorly maintained irrigation systems, lack of skilled man power and almost universal lack of good extension services are among the factors responsible for the decline in agriculture. Evolution of agricultural practices has meant that there's greater productivity and hence prosperity in the farming circles and a variety of healthy food options for the consumers. With the inclusion of robotics in almost all fields, it is also possible to replace the manual work in agriculture with the use of robots. The project "G-SAB" mainly focuses on reduction of cost and labour. This project seeks to remedy a few issues which in turn would encourage the use of various techniques and policies that would promote competition in the agricultural market thereby bringing better prices for the farmers. Based on these constraints, we have come up with a more economical and multifunctional robot which is dedicated for the purpose of agriculture practices in India. The robot would be able to autonomously till (plough), sow and fertilize crop fields.

II. PROPOSED SYSTEM

The proposed system-'G-SAB' performs three major agricultural processes, namely, ploughing, sowing and fertilizing for wheat cultivation. Wheat cultivation is based on the zero-tillage technology, which increases the amount of water and organic matter (nutrients) in the soil and decreases erosion. Initially, the bot begins with the ploughing activity. The purpose of ploughing is to turn over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds, the remains of previous crops, and both crop and weed seeds, allowing them to break down. Ploughing module involves arm depth control. Arm control deals with the control of plough arm during the ploughing time, which in turn provides the required depth. Plough ends when the bot reaches the end of the pre-defined area for the given plough count. Sowing in its simplest term is the process of planting seeds. This section consists of a seed box to store the seeds and a rotating dispenser for seed distribution. Fertilizer is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of plants. Fertilizer module involves storage and spraying of fertilizer through a nozzle. Spraying requires pressure t

be applied which done by means of a suction pump. The Microcontroller is the focal point of all the operations taking place in G-SAB. Arduino Mega is a microcontroller board based on the ATmega2560 which has 54 digital Input/output pins which are used in G-SAB. The inputs given to the microcontroller include GPS data, position of the bot using sensors, plough count. The motors for locomotion and plough depth control are interfaced through the controller. The entire system is

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powered by a 35AH car battery. User interface is provided by a 16x2 LCD for display and a 4x4 keypad for user input.

III. CHALLENGES

It was a huge challenge to design a user-friendly system and GUI in various languages. Scaling the GPS data to screen size and mapping the real time coordinates along with the animation were amongst the most challenging parts of the project. Tract robot appears to be complicated.

IV. BLOCK DIAGRAM

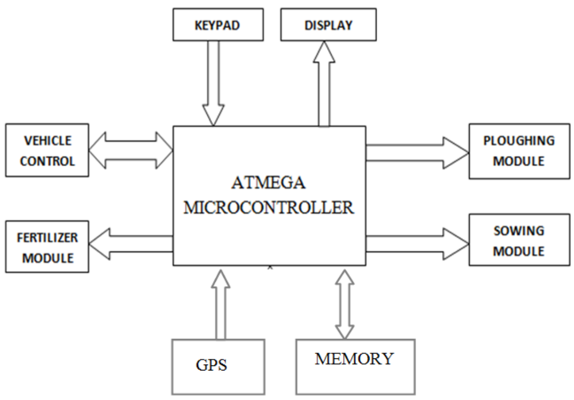

Fig 1.System Blocks Overview

V. DESCRIPTION

The three main functionalities of ploughing, sowing and fertilizing are performed with the help of wiper motors which are interfaced to the At mega 2560 microcontroller. The input to the controller is given via the keypad. The choice of function to be performed is displayed on the LCD.

These blocks are briefly explained below:

A. Ploughing Module

The ploughing module consists of three plough wheels and plough blades which are attached to the front of the robot. A wiper motor is used for the plough depth control since it provides sufficient torque to for the lifting up and down of the plough unit .For the purpose of locomotion, two wiper motors are attached to the rear end wheels of the robot. When the plough unit is initiated the motor activates, thereby rotating a set of gears which are connected to a screw-jack mechanism, lowering the plough module to touch the soil. When the entire area has been covered the motor reverses its direction and hence the plough module is uplifted.

B. Sowing Module

Sowing unit consists of a seed storage box and a rotating dispenser through which seeds are distributed. Seed distribution is achieved by use of a DC motor which has a speed of about 1000rpm. When the seed dispenser rotates at high speed, seeds are distributed through the holes provided in the rotating dispenser.

C. Fertilizer Module

Fertilizer section makes use of a suction pump to pump water to the fields. This pump has a capacity of about 1 litre/min. Suction is the flow of a fluid into a partial vacuum, or region of low pressure. The pressure gradient between this region and the ambient pressure will propel matter toward the low pressure area. Pumps typically have an inlet where the fluid enters the pump and an outlet where the fluid comes out. The inlet location is said to be at the suction side of the pump. The outlet location is said to be at the discharge side of the pump. Operation of the pump creates suction (a lower pressure) at the suction side so that fluid can enter the pump through the inlet. Pump operation also causes higher pressure at the discharge side by forcing the fluid out at the outlet.

D. Gps Module

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include:

- the time the message was transmitted and,
- Satellite position at time of message transmission.

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. Each of these distances and satellites' locations defines a sphere. The receiver is on the surface of each of these spheres when the distances and the satellites' locations are correct. These distances and satellites' locations are used to compute the location of the receiver using the navigation equations. This location is then displayed, perhaps with a moving map display or latitude and longitude; elevation or altitude information may be included, based on height above the geoid. The GPS module is used to provide input data to the control system which in turn guides the bot's movement in the field.

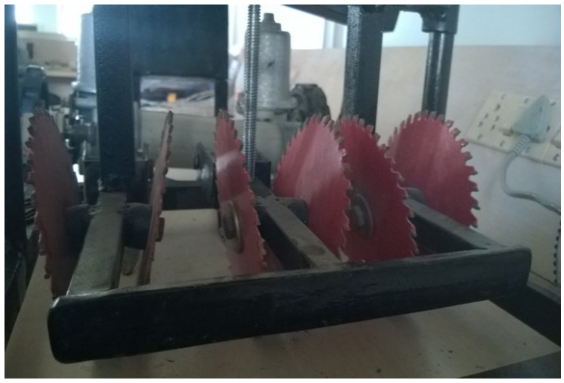

Fig 2.G SAB

VI.MECHANICAL STRUCTURE

A. Material

The G-SAB structure is constructed using mild steel material. Mild steel is a type of steel that only contains a small amount of carbon and other elements. It is softer and more easily shaped than higher carbon steels. It also bends a long way instead of breaking because it is ductile. Mild steel, also called plain-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications, more than iron. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can however be increased.

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B. Units And Dimensions

The Plough unit is designed as that of a no-till drill which consists of circular blades to loosen the soil, followed by flat metal blades to form a furrow. G-SAB uses six circular blades which are 4" in diameter and three flat metal blades at the end of the plough structure. The length of the plough arm is 11" with a width of 8" such that the inter-plough spacing is about 3".

The seeder unit is a rectangular storage box with a length of 7" width of 3".It has a depth of about 4" to provide sufficient storage of seeds.

The fertilizer unit is equivalent to the seeder unit with a length 6" and width 3.8". It has a depth of 4" and the liquid content is pumped through pipes onto the field. Holes are nailed into the pipes in order to allow liquid flow, i.e., to enable water or fertilizer distribution. The following Fig. 4.3 shows the fertilizer unit. The rectangular frame onto which the seeder and fertilizer units are attached along with the associated motor and pump mechanisms has a length of 21.26" (54cm) and a width of 12.01" (30.5cm). The wheels used for locomotion are 4" in diameter and has a thickness of 1.77" (4.5cm).

VIII.HARDWARE MODULE

A. Arduino Mega 2560

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing).

The Arduino Mega 2560 which is shown in Fig. 5.1 is a microcontroller board based on the ATmega2560. The At mega 2560 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the AT mega 2560 achieves throughputs approaching 1 MIPS per MHz .It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC- to-DC adapter or battery to get started.

B. Liquid Crystal Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

C. Motors

G-SAB uses wipers motors for locomotion; and for raising and lowering the plough structure. A 1000 rpm DC motor is used as a vibrator for the seeder unit. Relay circuits are used to power the motors. The motors are connected to pins 2, 3, 4, 5, 23, 25, 27 and 29 of the Arduino via the relay circuits.

D. Wiper Motor

A wiper motor is a DC motor with two permanent magnets that serves as a field for the motor, arranged around the armature where the power is connected to the commentator of the armature with two brushes. The armature is a set of electromagnetic coils that is each connected to its own two segments in the commentator so that the power is connected to only one coil at a time to generate a magnetic field in the armature. This field will oppose the field of the permanent magnet field, where the one field will push the other away and make the motor to turn. This motor is also called a "gearhead" or "gear motor" and has the advantage of having lots of torque. It is found that at 12 volts, on high speed, the motor has 13.5 pound-feet and on low speed, has 17.5 pound- feet of torque.

E. Dc Motor

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore it's current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque. DC motors have a rotating armature winding (winding in which a voltage is induced) but non-rotating armature magnetic field and a static field winding (winding that produce the main magnetic flux) or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics.

The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives. The introduction of DC motors to run machinery eliminated the need for local steam or internal combustion engines, and line shaft drive systems. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines

F. Sharp Sensors

Sharp sensor is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. Sharp sensor is connected to pin 22 of the Arduino . The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced easily to the distance detection because of adopting the triangulation method. This device outputs the voltage corresponding to the detection distance. So this sensor can also be used as a proximity sensor.

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IX.FLOW CHART

The user chooses one operation from 3 choices – Plough, Sow or Fertilize which is displayed on the LCD. This is done by entering numbers 1, 2 or 3 from the keypad. According to the operation chosen the robot moves and either the plough, sow or fertilize operation is performed.

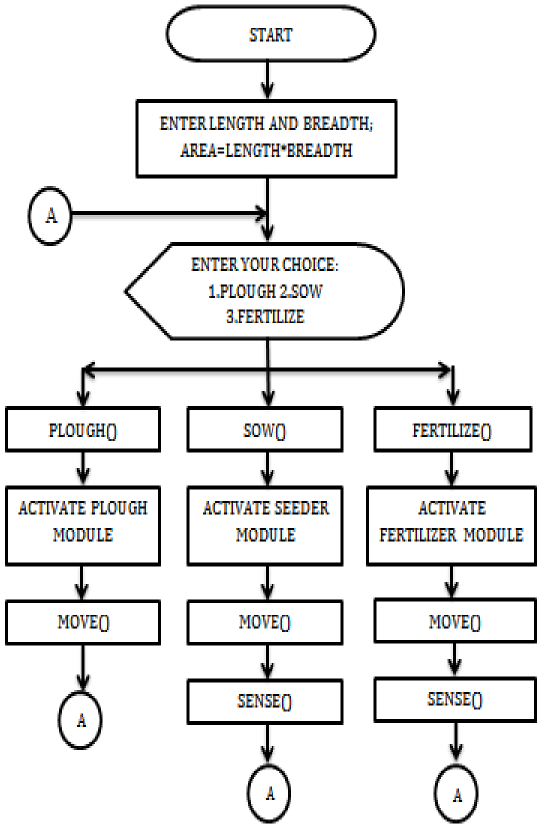

Fig 3.System Algorithm

A. *Move Function*

The robot's turning mechanism is based on calculation of area coverage. Also the turns are based on the first turn. If the robot turns right first then it would turn left at the next turning and so on

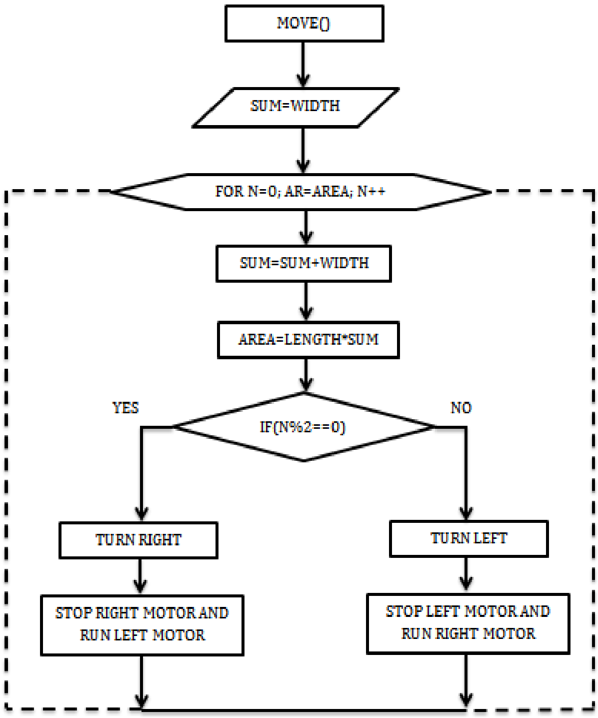

Fig4.System Flowchart

X.CONCLUSION

The basic idea of this project germinated from the hardships faced by the farmers in India. The concept of making technology available to each and every farmer led to the design of G-SAB. G-SAB has proved to integrate technology with traditional farming techniques by combining the three fundamental process (plough, sow, fertilize) in a single machine. The plough structure is designed as that of a no-till seeder used for wheat cultivation. However it can also be designed for other crop varieties depending on the requirement. Manual supervision is required only in the beginning to initiate the process, thereby reducing the time they spend on-field.

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