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The Design of General Purpose Autonomous Horticultural Mobile-Robot: "AGROBOT"

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ABSTRACT

The purpose of this work is to build the creation effectiveness in the horticultural field by fostering a versatile independent robot that has the capacity of handling and checking field activities like showering solutions for accuracy cultivating, preparation, sickness determination, yield investigation, soil examination, and other farming exercises. Here, significant requirements are dependability and solidness against field conditions versusbringing down the unit cost of the robot for high volume production. Another plan objective is to involve homegrown assets for the transporter

stage, circuit sheets, and coordinating normal creation leaves behind planned or locally accessible parts. Different points of the work are altogether gadgets on the organization will want to convey over Environmental Agriculture Informatics Applied Research Center (TARBIL) cloud administrations and application programming will want to move information to ranchers sell phones, farm haulers and cultivating vehicles. Subsequently, it is meant to decline co-contributed endeavors expenses for the least level. This is isolated into two fundamental stages. The primary stage combination of drivers, actuators, control framework, correspondence framework, energy the board framework, task the executive's framework furthermore, sensors on an appropriate stage as per these standards. The subsequent stage: Integration of undertaking the board with TARBIL framework.

INTRODUCTION

Today, automated ground, ocean, and air vehicles are startingto enter our lives in numerous areas. Like agribusiness, military,transportation, and space investigations. Since portable robotsare relentless laborers except charging which could be diminished later on. Likewise, versatile robots are more beneficial and that's just the beginning powerful than the human workforce. For this reason,independent robots will supplant the labor force of things to come Similarly as with every mechanical turn of events, scholarly exploration acts as an ever-evolving force in the advancement of independent robots.This work is centered around a portable independent robot stage that is created for farming applications. In this stage of work, by and the large, round independent versatile robot is planned and executed. This paper presents the initial step of the independent farming robot framework. In later stages, it is planned to add capacities to a robot which is utilized in accuracy cultivating like checking crop status or weeding for taking example from field. The last condition of the framework will be a robot swarm which can be fit for checking, furrowing, planting, and gathering crops from fields.In the writing, there isa lot of instances of versatile robots.In 2013, Yaghoubi et al. demonstrated another audit about independent robots for horticultural errands and homestead tasks what's more, future patterns in agro robots [1]. Furthermore, to make a foundation for the plan and execution of the independent versatile robot stage, the following robots have been investigated: Bonirob [2], Fitorobot [3], Agribot [4], Grover [5], and other independent versatile robots [6][7][8].In this work, Agrobot which is an independent portable robot is planned. This article contains the Agrobot framework outline,equipment, and programming design of the robot.

AGOBOT OVERVIEW

At first, Agrobot was intended to work as an independent portable robot stage for various applications. Later undertaking point is changed to foster an independent portable robot that can have the option to move in rural plain fields, field lines, or nurseries. In this segment, plan standards and framework outlinesare portrayed.

Design Criteria

There were five significant requirements which are impacted the planning stage. These variables are illustrated beneath:

• Particularity: In request to have the option to add units or parts on the robot, the robot stage must be secluded. These units or parts can be robot arms, sprayers,weeding apparatuses, or different gear utilized in farming field.

• Minimal expense creation: Even though portable robots are accessible on the lookout, they will generally be pricy, Hence rising innovative work costs. There is additionally a separate variable that builds the expense of creation by instant robot assuming that it goes into mass volume creation.

• Homegrown creation: Domestic creation decreases expenses, and increments creativity. First planned cards, robot' acrylic covering, and program code is ready in the country.

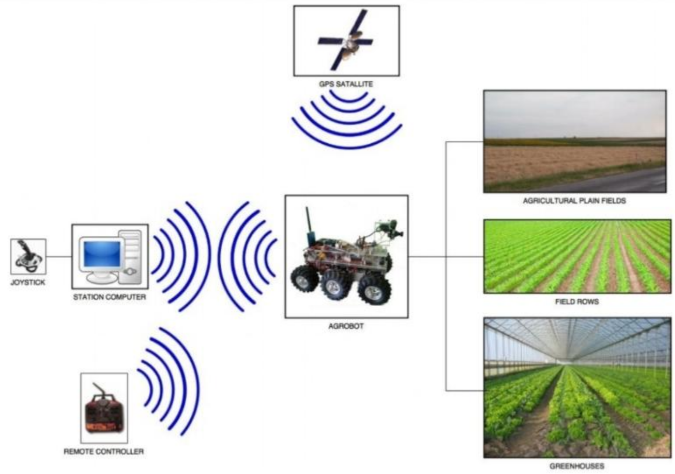

Fig. 1 Overview of Agrobot system.

• Reasonableness of ecological circumstances: The robot is intended to be utilized in agrarian fields, and that implies that the robot needs to move rough terrain and have the option to disregard little hindrances. Moreover, electronic hardware on the robot should be secured.

• Innovation: To contribute logical exploration and improvement, the robot must be unique and new.The equipment and programming construction of the robot have been planned by thinking about the above measures.

System Overview

As seen from Fig.1, the Agrobot framework comprises station PC, far, and the actual robot. Station PC was added to the framework to control the robot physically, to get the sensor information, to explore different avenues regarding sensors on the robot, and to send errands to do as an independent. By utilizing the distant regulator, the robot can be physically controlled at a visual distance. In plain fields or field columns, Agrobot utilizes GPS sensors to track down its situation. In nurseries, it is intended to plan inside the nursery or move comparatively with certain articles.Agrobot is the principal part of this framework. This concentrate fundamentally covers the plan and execution of Agrobot, and it was separated into two sections. The initial segment comprises of equipment design of Agrobot, and the subsequent part is the programming structure of Agrobot and the station PC.

HARDWARE STRUCTURE

Hardware Overview of this framework. This concentrate fundamentally covers the plan and execution of Agrobot, and it was separated into two sections. The initial segment comprises of equipment design of Agrobot, and the subsequent part is the programming structure of Agrobot and the station PC.

Hardware Overview

The equipment design of the robot was made by considering the plan necessities. Fig. 2 shows the equipment design of the robot. This outline shows the life systems of the robot. In Fig. 2, dark lines represent sign and correspondence associations, red lines are fundamental power associations and blue lines are engine drivers to engine associations. In this part, all aspects of the robot will be depicted by the configuration progress.Initially, the movement framework was planned. The movement framework comprises the body of the robot, outfitted engines, quadrature encoders, and wheels. The pre-assembled suspension was utilized to speed up the plan and execution steps. Undercarriage comprises the aluminum skeleton, spring suspension, and equipped engines. Six equipped engines are found three on the left and three on the right half of the body. Subsequently, slide - controlling technique was utilized to explore the robot. Slip guiding technique is like differential controlling.In the slip guiding technique, the right three engines and left three engines are driven independently. Quadrature encoder sensors are fitted to the center both ways engines. By utilizing quadrature encoders, engines' shaft position and wheel position can be estimated. Along these lines, engines can be driven by utilizing a PID regulator. Likewise, progressed control strategies and odometry calculations can be carried out on robots by utilizing criticism. The energy framework was planned by the necessities of the drive framework. The energy framework has three parts. These parts are a battery pack, power board, and charger.Agrobot has a lithium polymer (lipo) battery pack to control its framework. Lipo batteries have a higher limit contrasted with other battery types ofthe same size and weight. In any case, lipo batteries have security issues. Therefore, lipo batteries must be observed while charging and releasing. A Powerboard is added to Agrobot to control lipo batteries, which goes about as a battery the executive's framework. Battery the executive's framework screens battery status by estimating battery voltages, battery temperatures, and the current which is drawn from the battery pack. Besides, battery the board framework controls the yield control unit (OCU), which is introduced on the power board. The power board MCU cuts the power in case of a perilous circumstance, for example, overvoltage or cut-off, charging, or releasing batteries. The power board's MCU is LPC1343 which is controlled by an ARM Cortex - M3 microchip. This MCU has a high handling speed and high sensor perusing rate both are vital for acting rapidly. One more undertaking of the power board is to speak with the mainboard. Correspondence with the mainboard is depicted in the product structure. To drive the movement engines of the robot, an engine driver board was chosen by thinking about the engine prerequisites. The mainboard is the cerebrum of the robot. The mainboard is controlled by ARM Cortex - M3 microchip is fueled LPC1769 MCU. Choice of the mainboard's MCU was vital since the mainboard peruses every one of the sensors' information, conveys with the power board, point and position sensors board, station PC and beaglebone, and controls the engines using engine regulator as indicated by computations. Consequently, further phases of the work control strategies and sensor combination calculations will be carried out on the mainboard. Moreover, the mainboard has information and result connectors, controllers, and a power control unit. By controlling the power control unit, the mainboard initiates or deactivates specific sheets or sensors. The remote correspondence board is associated with

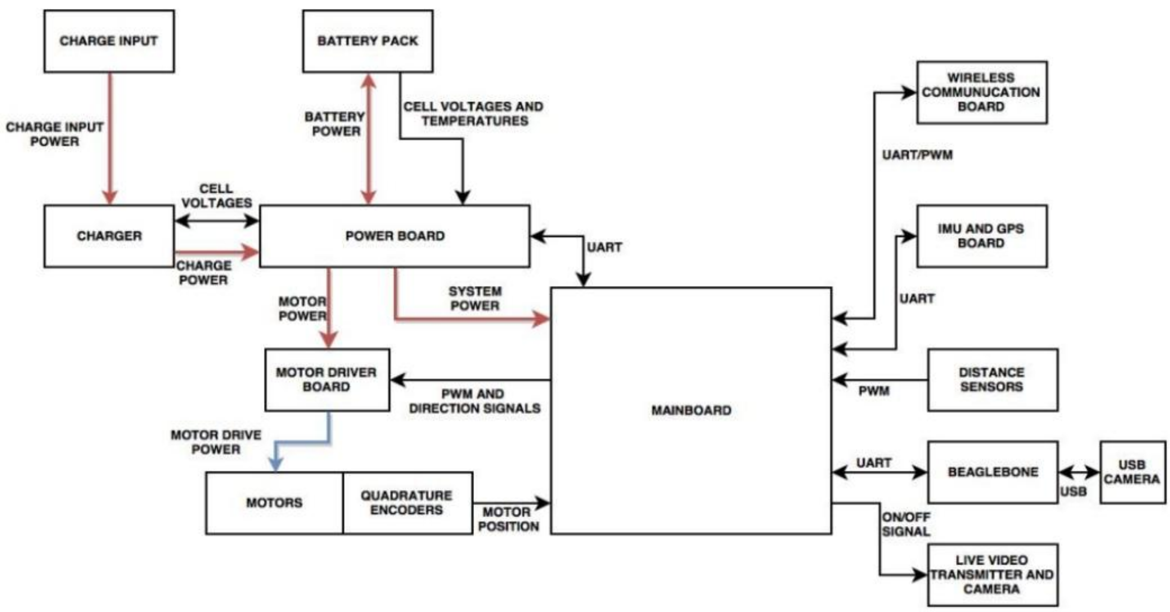

Fig. 2 Hardware structure of Agrobot.

the mainboard. By utilizing remote correspondence board mainboard communicates furthermore, gets information from the station PC. The inertial estimating unit (IMU) and worldwide situating framework (GPS) board comprise three sections. The initial one is the inertial estimating unit (IMU) sensors board. IMU board has three pivot gyrator, three-axis accelerometer, and three-axis

Fig. 1 Overview of Agrobot framework. magnetometer chips. The position sensor is notable (GPS), which tracks down the longitude and scope of the robot's situation. The third part is the MCU breakout board. On this board, there is an ATMEGA328P MCU, which can be customized by Arduino. This board finds robots' area and direction comparative with the Earth and sends this information to the mainboard. SONAR sensors were introduced on the robot to gauge distance at certain points. Distance sensors' field of view covers all bearing of development of the robot. These sensors are associated with the mainboard. Mainboard estimates all sensors by utilizing affixing calculation. The second phase of this work is a reconciliation of errandsfor the executives with TARBIL. To do this, the robot must have the option to convey +over 3G or Wi-Fi organization. Additionally, for snag evasion, line-following, and so on, calculations require picture handling. To satisfy these errands minicomputer board beaglebone is introduced to the robot. Live video transmitter and camera framework were added to the robot for manual driving purposes or noticing the robot'sinactivity. The camera framework has two servo engines to change the perspective of the camera.

Level Design

The equipment plan of the robot is acted in three levels. Since, as seen from Fig. 2 there are such a large number of parts on the robot and one of the plan measures is particularity. These levels are as per the following: 1. Body level: This level comprises the robot body,engines, batteries, temperature sensors, and quadrature encoder sensors. Parts in the body level are fixed and extraordinary to the robot stage. 2. Control unit level: Powerboard, mainboard, beaglebone, engine driver board, and distance sensors are set at this level. This level is separable so that changes can be made. Control unit level can be utilized on any other stage, as long as the engine driver and the battery are fitted.

3. Extra units' level: This level is planned application explicit. For example, IMU and GPS board added to this level to explore independently in open regions. Additionally, live video transmitters, chargers, and cameras for picture handling are added to this level. In later phases of this work, robot arms and application explicit supplies can be added to this level.

SOFTWARE STRUCTURE

The programming design of the Agrobot framework was displayed in Fig.3. In the figure, straight lines represent correspondence lines on the robot and run lines represent remote correspondence connect. Programming is composed of four isolated cards on the robot what's more, for the station PC. In this segment, all projects are portrayed.

Power Board

As recently depicted, the power board functions as a batter of the executive's framework. Powerboard estimates battery voltages what's more, temperatures, drawing current from the battery pack, and charge input voltage by utilizing LPC1343 MCU's simple to advanced converter (ADC) fringe. To act rapidly in a hazardous circumstance, the power board needs to quantify and channel all sensors' information as quickly as could be expected. Along these lines, for the power board, all library programs are changed or reconsidered to advance execution and similarity with project needs. The power board has two significant assignments: controlling and observing release state and charge state. In the release Fig. 2 Hardware construction of Agrobot. state, MCU sets OCU to release mode.

This activity powers up the mainboard. Then, at that point, it begins a correspondence with the mainboard. In the event of a disappointment, for example, over-temperature or correspondence break, the power board cuts the power and enters mistake mode. While in the release mode, MCU sends information to the mainboard. In the charge mode,MCU looks at all sensors and opensthe charger transfer. The battery will be charged to foreordained limits, then, at that point, MCU will remove the charge input. If there should be an occurrence of peril, the power board will enter blunder mode

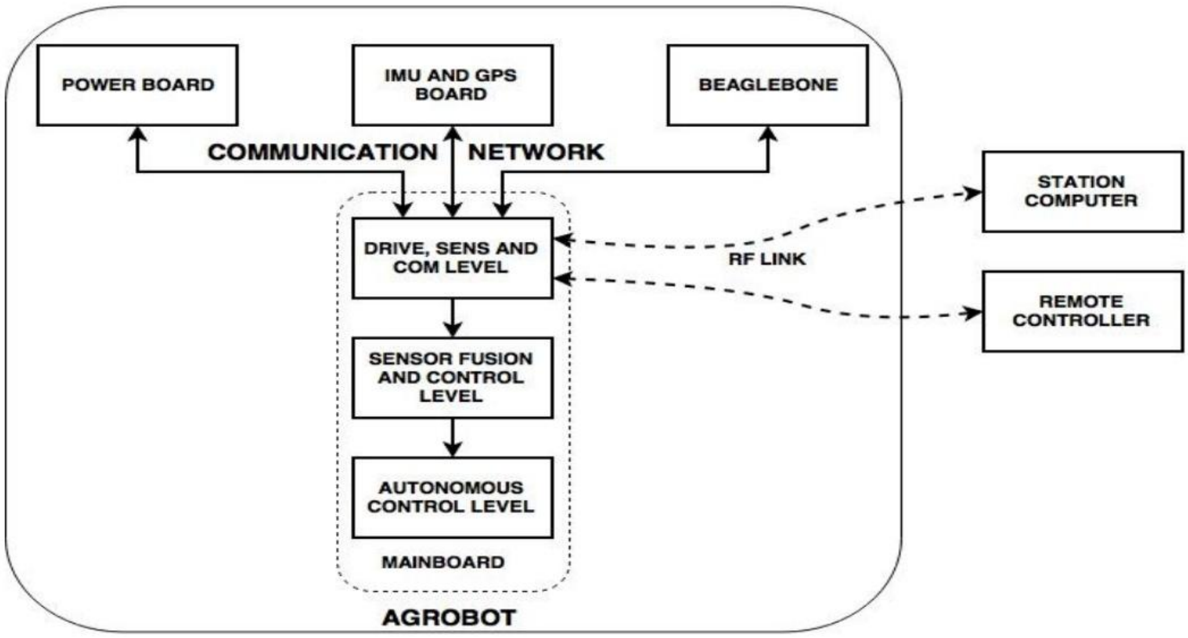

Fig. 3 Software structure of Agrobot system.

IMU and GPS Board

This board was added to the framework to track down the robot's area furthermore, direction comparative with Earth. Euler points of the robot are determined to find the robot's direction comparative with Earth. To acquire Euler points, ATMEGA328P MCU understands spinner, accelerometer, and magnetometer information from the IMU sensor. Then, at that point, peruse sensor information is utilized in sensor combination calculation. The position of the robot is acquired from the GPS sensor. Ultimately, MCU moves determined and assembled information to the mainboard.

Beaglebone

Beaglebone was added to the robot for picture handling and 3G correspondence undertakings. These undertakings will be executed in the next phase of this work. Just demo picture handling program is executed on board to test correspondence and picture handling capacities. In this demo program, beaglebone observes pink items from the camera feed and tracks down the article's area furthermore, a region in pixels. Then, at that point, beaglebone sends information to the mainboard. The mainboard drives the robot to follow the object.

Station Computer

Two primary projects are composed for the station PC. The first program is the station interface program. This program is planned and executed to control the robot physically, to show sensor information and live video feed from the robot, and to send the independent undertakings to the robot. For manual control purposes, a gaming joystick is utilized as a control input. The second program is in MATLAB code. This program is composed for exploratory purposes, like running control calculations on station PC to make visual plots. This program was used to change PID control coefficients.The robot can likewise be physically controlled through the remote regulator. Far off regulator which is utilized in the work is a nonexclusive RC model regulator.

Mainboard

As seen from Fig. 3, the programming design of the mainboard is planned in three levels. In this part, these levels will be talked about.

1) Drive, Sens, and Com Level: Drive, sens, and com level is the most minimal level of the mainboard programs. This level comprises engine driving, sensor perusing, and correspondence capacities. Besides, peripherals and pins which are utilized by MCU are introduced at this level. a) Motor driving capacities: Discrete-time PID regulator
is carried out independently for driving both ways engines in request to drive movement engines. As referenced previously, quadrature encoders are fitted to left and right center engines. Quadrature encoder sensors are utilized as input for the PID regulator. To drive engines at specific speed beat width Fig. 3 Software design of Agrobot framework.
adjustment (PWM) was utilized. The camera course framework has two servo engines. To drive these servo engines, programming PWM is executed by utilizing a clock peripheral. b) Sensor understanding capacities: Distance and quadrature encoder sensors are associated with the mainboard. The mainboard triggers distance sensors to begin the estimation. Then, at that point, it peruses the PWM sign and converts the sign width to separate. SONAR sensors can meddle every others' sign. To forestall this, an affixing algorithm is utilized to quantify distance. Quadrature encoder sensors have two channels, An and B. Quadrature encoder sensors partition one upset to 48 counts. Each count is a signal level change on the An or B channels. By controlling which channel is following the other, the engine shaft's course of pivot can be estimated. c) Communication with different sheets: Mainboard speaks with the power board, IMU and GPS board, beaglebone, and station PC by utilizing general offbeat collector and transmitter (UART) sequential convention.UART convention takes time and produces hinders on each occasion. To conquer this situation, direct memory access (DMA) unit is utilized. DMA unit goes about as the second processor center. DMA unit gets and communicates information exhibits without principle ARM Cortex-M3 center. DMA channel just produces hinder whenever correspondence is finished. All correspondences are sped up by utilizing DMA. UART convention sends information exhibit without beginning and halting character. Likewise, numbers are typecast to character exhibits, so there should be a divider between numbers. In conclusion, to determine information exhibit, it needs particular a person. On account of these reasons, correspondence conventions are planned and carried out for every correspondence between mainboards. 2) Sensor Fusion and Control Level: This level is framed by consolidating and further developing drive, sens, and com level capacities. Sensor combination and control level comprises manual control, object evasion, IMU-GPS directed route, and control methods. Just manual control is completely planned and carried out at this phase of the work. a) Manual control: In manual control, the robot is driven by the administrator by utilizing joystick sources of info or a remote regulator. The robot sends sensor readings to the station PC while in the manual control. Assuming the robot is driven by a station interface, a live camera feed can be turned on. 3) Autonomous Control Level: This level is the last advance of the mainboard programs. Instantly, the reason for this level is to do "Go this highlight, that point and keep away from any obstructions on the way". Moreover, line following calculations will be executed at this level. At this phase of the work, this level isn't planned and carried out.

CONCLUSION AND FUTURE CONSIDERATIONS

All in all, Agrobot which is found in Fig. 4 is planned also, worked by plan standards and open field tests are begun. In any case, natural contemplations are not met since the robot configuration was changed during the execution stage.

Fig. 4 Final version of Agrobot in the field.

The robot was worked for under 2000$.Later on,the programming design will be finished.Also, the second phase of this work which is the coordination of assignment the executives with TARBIL will be begun.

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REFERENCES

[1] Sajjad Yaghoubi et al., "Autonomous Robots for Agricultural Tasks and Farm Assignment and Future Trends in Agro Robots," International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS, vol. 13, no. 03, pp. 1-6, June 2013.

[2] Peter Biber, Ulrich Weiss, Michael Dorna, and Amos Albert, "Navigation System of the Autonomous Agricultural Robot "BoniRob"," in Proceeding IROS Workshop on Agricultural Robotics, 2012.

[3] R. Gonzáles, F. Rodríguez, J. Sánchez - Hemosilla, and J. G. Donaire, "Navigation Techniques for Mobile Robots in Greenhouses," American Society of Agricultural and Biological Engineers, vol. 25, no. 2, pp. 153- 165, 2009.

[4] A. Gollakota and M. B. Srinivas, "Agribot — A Multipurpose Agricultural Robot," in India Conference (INDICON), Hyderabad, 2011, pp. 1-4.

[5] Tu, Xuyong, "Robust navigation control and headland turning optimization of agricultural vehicles" (2013). Graduate Theses and Dissertations. Paper 13188.

[6] Hyun Min Ko, Chul Kyoung Kim, Beom Sahng Ryu, Abhijit Supreme, and Nitaigour P Mahalik, "Development of Autonomous Traveling for Agricultural Robot Drive Platform by Using a Single Camera," in Proceedings of the World Congress on Engineering and Computer Science, vol. 1, San Francisco, 2013.

[7] Jinlin Xue, Lei Zhang, and Tony E. Grift, "Variable Field-of-View Machine Vision-Based Row Guidance of an Agricultural Robot," Computers and Electronics in Agriculture, vol. 84, pp. 85-91, June 2012.

[8] Xue Jinlin and Xu Liming, "Autonomous Agricultural Robot and Its Row Guidance," in International Conference on Measuring Technology and Mechatronics Automation, Changsha City, 2010, pp. 725 - 729.