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Multipurpose Robot for Agricultural Automation

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Abstract: Farmers today spend a lot of money on machines that help to decrease labour and to increase the yield of crops but profit and efficiency are less. Agricultural automation is the only method to overcome this problem. The robot proposed here is capable of performing operations like automated ploughing, fruit picking and pesticide spraying. The controlling technology is Raspberry Pi which is the brain of the system that supervise the entire operation. Manual control can also be provided with the help of GSM. The main aim is to increase the crop production with increased efficiency.

Keywords: GSM, Raspberry Pi

I. INTRODUCTION

Agricultural robotics is the use of automation in bio-systems such as agriculture, forestry and fisheries. It is replacing the conventional techniques to perform the same task with efficiency. Applying automation to agriculture has helped create several advancements to the industry while helping farmers save money and time. The agricultural robots are the robots deployed for the agricultural purposes. In the agriculture, the opportunities for the robot-enhanced productivity are immense and the robots are appearing on the farms in various forms and in increasing numbers. The robots can perform the agricultural operations autonomously such as the ploughing, spraying, the fruit picking etc, allowing the farmers to reduce the environmental impact, increase the precision and efficiency, and manage individual plants in novel ways. The robotics are spreading every day to cover further domains, as the chance of replacing the human operators provides the elective solutions with return on the investment. The robots do the difficult tasks that are harmful to the health of the workers. So they offer the safety for the workers. Conventional techniques depend on human power for lifting, dragging, weed control, fruit picking. Humans are prone to work in hazardous environment while spraying chemicals and pesticides. The tractors compact the soil, as they are larger in weight. They cannot move in terrain conditions. These methods cannot identify the crop and soil in close proximity. An automated agricultural system (which uses field robots) is exemplified from above problems. Robots can work restlessly in all environments as they are programmed to perform the desired activities. Although, large sized wheels are required in muddy soils, robots small sized wheels perform well. The light weight of the robots is a major advantage, since they do not compact the soil as larger machinery does. Conventional method includes robots for seed sowing and pesticide spraying. This system design is achieved depending upon the requirements. The seeds are sowed in 4 rows at a single instance. This will reduce the amount of man power requirement. But it depends only on solar energy for working which fluctuates with time. Several systems like user friendly fuzzy logic based farm automation using arduino and lab view using x bee controller are being undertaken. Solar operated digging machines were there which works based on the availability of solar energy.

II. BLOCK DIAGRAM

The proposed robot is capable of performing multiple operations like automatic ploughing, pesticide spraying and fruit picking .It provides manual control when required with the help of GSM .The robots controlling technology is the Raspberry Pi. All other blocks are connected to this module. On the field, movement of the robot is guided by the signals being sent out from the Raspberry Pi controller in coordination with ultrasonic sensor placed on the robot. DC motors are used for the rotation of the wheels of the robot .These DC motors are driven by L293D motor driver to control the direction and speed of motors. For the process of fruit picking we use image processing along with hydraulic arm. Here, a Raspberry Pi camera which is fixed to the arm of robot is used for capturing images during robotic motion and we use a fruit gripper which is an arm tool to pick the fruit with intensive care.

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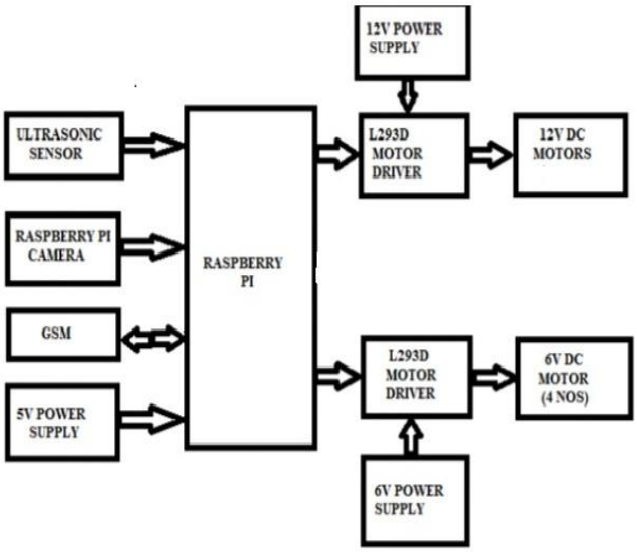

Fig 1: Block Diagram for proposed robot

Ultrasonic sensor: Ultrasonic is the sound wave beyond the human ability of 20KHZ. Ultrasonic transmitter emitted an ultrasonic wave in one direction and started timing when it launched. Ultrasonic spread in the air, and would return immediately when it encountered obstacles on the way. At last, the ultrasonic receiver would stop timing when it receives the reflected wave. As Ultrasonic spread velocity is 340m/s in the air, based on the timer record t, the distance(s) between the obstacle and transmitter, namely:

$$s = (340 \div 2)t$$

The ultrasonic waves are emitted and received continuously by the sensor which on encountering a wall or any obstacle sends signals to the controller that further conveys the robot to stop or else keeping moving.

III. PROCESS DESCRIPTION

Fig 2: Structure of the robot

Fruit picking: Image processing is the technique used in fruit picking. Raspberry Pi camera placed in the robot locate the fruits and plucks it with the help of a hydraulic arm. The camera continuously takes the images of the fruits and all the ripe fruits are identified with the help of image processing software. Then the ripened fruits are picked one by one. During the calibration of the system, the system has been trained to identify and differentiate the color of fruit and tree's leaves. The distance between the fruit and the camera is calculated by the process of triangulation.

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Fig 3: The robotic arm

Humidity measurement: Humidity sensors which are placed on the field are interfaced with the Raspberry Pi module. The humidity sensor continuously checks the humidity of the soil and if it is below the threshold value alerts the farmer about the condition through a text message. This is possible because GSM module is interfaced with Raspberry Pi controller. The farmer can choose to turn on the water sprinkler by some simple commands given to the controller through GSM module. The controller instructs the sprinkler to turn on or off.

Ploughing: Two DC motors are attached to the wheels of either side of the robot such that each side is driven by one motor each. Another DC motor which is attached to the plougher helps in the polar movement of the plougher. The DC motor is interfaced with the L293D motor driver. L293D is a quadruple H-bridge motor driver, as the name suggests it is used to drive DC motors. H-bridge is a circuit which allows the voltage in either direction to control the motor direction. There are 4 input pins for L293D. Motors directions depends on the logic inputs applied at this pins. When the instruction for ploughing is given, the plougher is raised and lowered and the robot starts moving. This loosens the soil bed.

Fig 4: Plougher

Pesticide spraying: Cameras and nozzle are installed on the end of the robotic arm. During the motion of the robot, on identifying a plant the robot stops and the arm inspects the plant. The infected area is identified and required amount of pesticide is sprayed with the help of sprayer.

Fig 5: Pest infected plant

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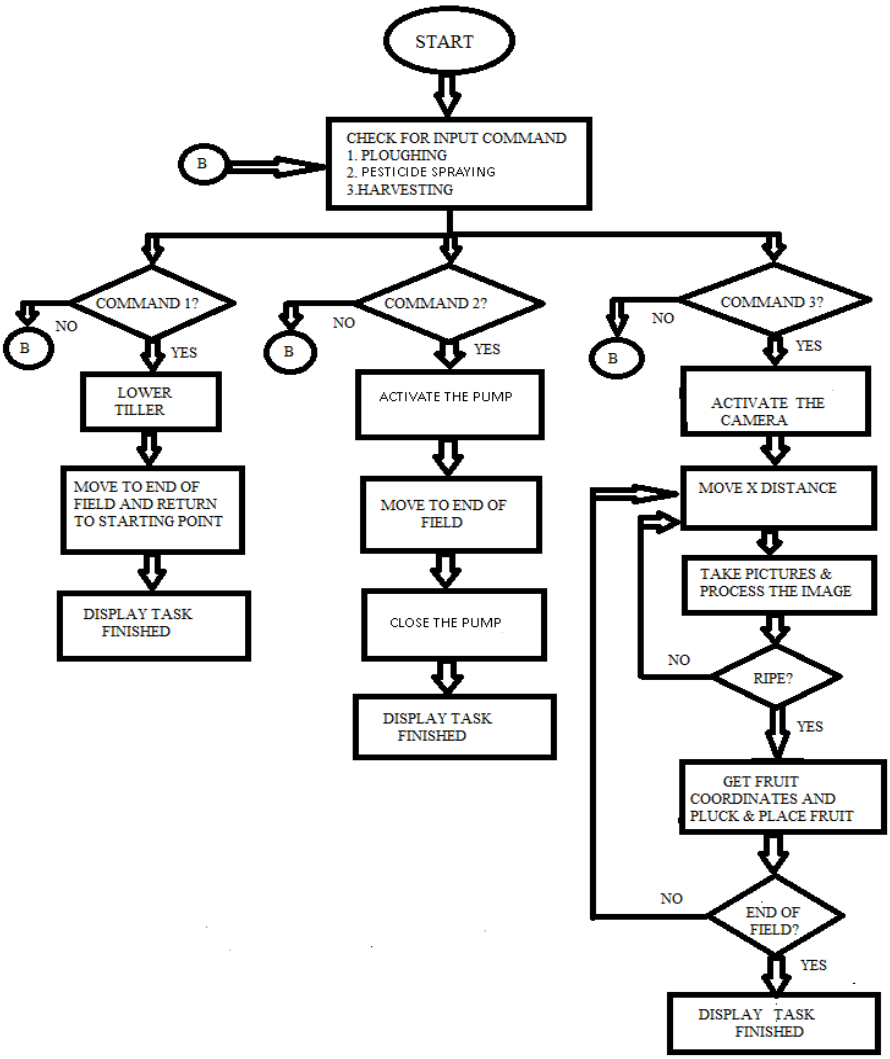
Flowchart



IV. RESULTS AND DISCUSSIONS

Fruit picking is accomplished with the help of image processing and the hydraulic arm. The image processing output is shown below. The colour identified fruit or object is plucked using the hydraulic arm. Ploughing is performed with the help of the tiller attached to the front end of the robot. The system performs the different functions of fruit picking, pesticide spraying and ploughing according to the given input commands from the farmer.

Fig 6: Detection of red fruit

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V. CONCLUSION

The paper presents the development and fabrication of a multitasking robot which can perform automatic ploughing, fruit picking and pesticide spraying. The technique of image processing in fruit picking helps to achieve high quality products. This paper intends to reduce the requirement of large man power and cost of equipment making it affordable to farmers. The system helps in the reduction of labour costs and restrictions on working hours can be significantly improved. The agricultural robot is designed to facilitate the farmers to ease their work. Once the concept of automation in agriculture is accepted the adoption rates will become high and the costs of technology will come down.

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