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Highly Precised Autonomous Operated Agriculture Robotic Machine to Fertilize Plants Selectively Controlled By Using PLC

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ABSTRACT: In recent decades, millions of dollars are spent every year on the developments of robots to be used in all sorts of field. The use of robots is more common today than ever before and it is no longer exclusively used by the heavy production industries. Robots are designed to remove the human factor from labor intensive and/or dangerous work. In modern farming applications, so many different types of automation techniques are used for easy and staff less operations that includes the important functions like seeding and spraying fertilizers. The system uses so many automatic methods, which require very less labor. The project intends to develop a prototype of an autonomous agricultural robot that includes an automated guidance system, and has applications in different stages of horticulture. A general concept for a field crops robotic machine is to selectively fertilizer and easily weeds the desired prototype. Future trends must be pursued in order to make robots a viable option for all agricultural operations such as to plough the field, saw the seeds, plant saplings, seed the seeds, water the plants, and spray insecticides and pesticides. PLC is used to intelligently monitor the robot. In this paper, we proposed an autonomous robot is a multi-purpose robotic platform for applications in agriculture. Its four independently steerable drive wheels and the ability to adjust its track width make its highly maneuverable. Robotics is one of the fastest growing engineering fields of today. We are going to develops the new methodology, first introduce the solar panel into this system to store the power in battery then it can be used to drive the drone system. The entire system controlled by PLC. The main functions of the system are that to fertilize, remove the weed and supply the water to the plants.

KEYWORDS: PLC controller, Human-Robot Interface & Adjustable Autonomy, solar energy, GPS system, Drone, Arduino.

I. INTRODUCTION

Our idea is to have an autonomous robot for applying fertilizers and weed control for the huge farm fields. A goal of autonomous robotic systems is to execute tedious or dangerous tasks, increase productivity, decrease production costs and preserve the environment. Robots are able to execute tedious work which would bore a human quickly with a steady performance. On the other hand, many tasks that are highly challenging for robots such as perception, situation awareness and intelligent decision making, can be easily handled by humans. Therefore, it seems to be a very promising approach to combine both the skills of a robot and that of a human in order to overcome restrictions which arise from a system design that purely focuses on autonomy. The combination of human and machine is able to incorporate the strengths of both sides and therefore increase the robustness of a system, decrease the development costs and offer the possibility that one can learn from the other. Along with that efficiency of our system has to be very high compared to other autonomous robots. On the whole our robot is to solve the farm fields' problems that includes manpower and involves high cost. The weed control and the fertilizer spraying were done by the man power in the older days. Now our robot will do that works without any human involvement. The combination of human and machine is able to incorporate the strengths of both sides and therefore increase the robustness of a system, decrease the development costs and offer the possibility that one can learn from the other. This idea is often referred to as Shared Autonomy, Human-Robot Cooperation, Adjustable Autonomy, and Human in the Loop or Mixed Initiative Control. We use the term shared autonomy in this thesis. As human input is cost-intensive, one optimization goal is to maximize the level of autonomy.

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Another goal is to obtain a system which is still reliable and robust. Furthermore, it is important to create an interface between human and robot which allows an efficient cooperation. This motivates the design of a system which focuses on an intelligent and user-customized communication between human and robot. This thesis aims to improve the functionality and reliability of an agricultural robot by using feedback provided by a human. We describe the design of a shared autonomy system for the discrimination between crops and weed plants. The main goal of our work is to evaluate human- machine interaction scenarios in order to understand the effects of a human user in the loop, to identify suitable points of application for a human in an autonomous object detection process and to evaluate different interfaces enabling the human-robot interaction. Therefore, we design an integrated framework that is built with the shared autonomy approach in mind from the very first step. The focus of this thesis is the optimization of the collaboration between the autonomous system and the user. As we are interested in an extensive evaluation of different interaction scenarios rather than the optimization of the overall system performance we employ out- of-the-box solutions for the autonomous processing pipeline whenever possible.

II. PROPOSED MODEL SPECIFICATIONS

For Use With	MELSEC IQ-F Series IQ Platform-Compatible PLC
Number of I/O	32
Manufacturer Series	FX5U
Number of Inputs	16
Input Type	Sink, Source
Voltage Category	100 → 240 V ac
Output Type	Relay, Transistor
Number of Outputs	16
Network Type	Inverter Communication, MELSEC Communication protocol (3C/4C Frames), MELSOFT Connection, Modbus RTUI, N:N Network, Predefined Protocol Support, SLMP (3E Frame), Socket Communication
Communication Port Type	Ethernet, RS485
Program Capacity	64 k steps
Programming Interface	RJ45 Connector (Ethernet Communication)
Maximum Inputs/Outputs	16
Scan Time	0.2 → 2000 ms
Dimensions	150 x 90 x 83 mm
Length	150mm
Total Memory Available	5 (Data Memory) MB, 64 (Program Capacity) k steps, 120 (Device Memory) kBytes
Number of Communication Ports	2

Table 2.1: PLC controller unit configuration

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Fig. 2.2: Mitsubishi FX5U PLC CONTROLLER

III. DIAGRAM OF PLC CONTROLLER AND INTERFACE UNIT

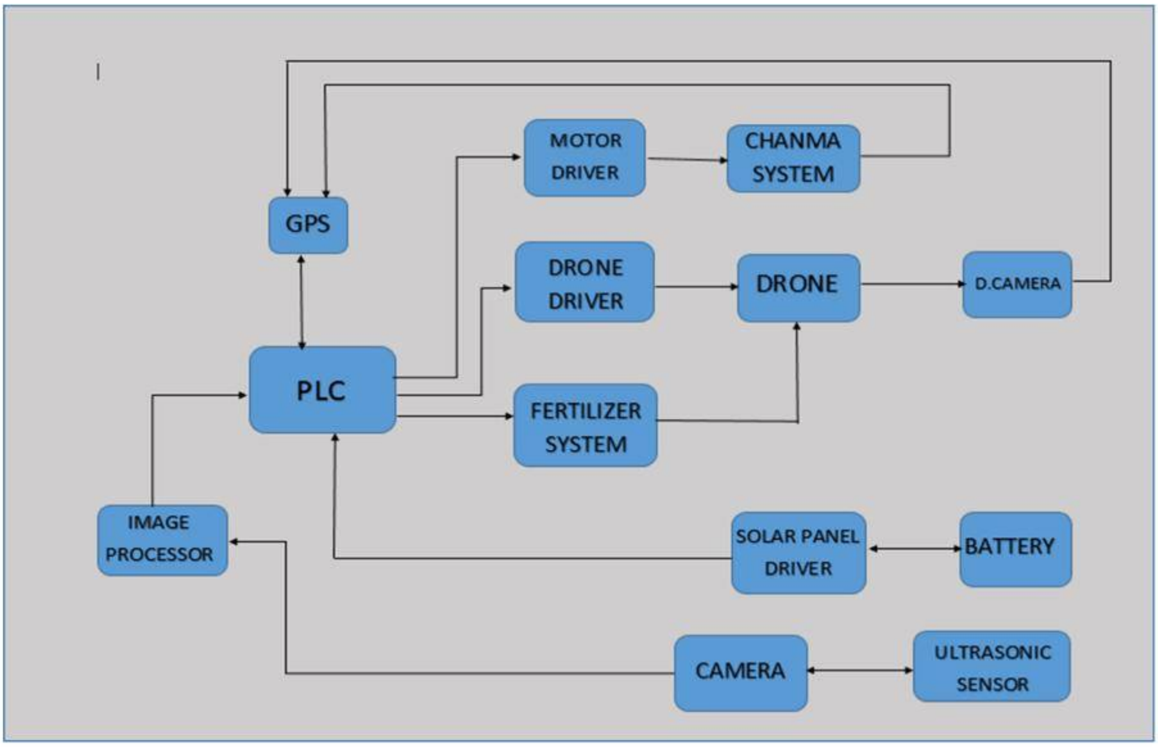

Fig. 3.1: Block diagram of autonomous robot System

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Fig. 3.2: autonomous robot System model

IV. FUNCTIONAL DESCRIPTION

First of all PLC will receive the signals from the camera and ultrasonic sensors through image processing unit and drive the motor driver circuit to place in the particular position(plant position). After reaching the position it will turn on the fertilizer unit to spray fertilizer on it. Timing circuit in the PLC is used to spray only sufficient or particular amount of fertilizer to plant. After spraying, the camera will detect the next position of the plant and that is also fertilized in the same manner. If the plant is so high or there is no path to move the system, Drone will activate automatically. The same fertilizing process was done by the drone similar to the land moving autonomous robot vehicle. The drone is also having the camera with an image processing unit so it can detect and spray the fertilizer in similar manner the location of the drone or the land moving autonomous robot system can be updated to PLC through GPS. Here the autonomous robot system has the solar panel driver along with the solar panel, to charge up the battery. The battery will power the PLC and all other things in the autonomous robot system.

Precision Agriculture:

On one hand, a growing world population, the employment of biomass as substitute for other resources and increasing food prices boost the demand for agricultural production in larger scales and with a higher efficiency. On the other hand, farming methods are expected to have less environmental impact and sometimes also to obey extended restrictions regarding the employment of fertilizers and herbicides. Precision Agriculture (PA) tries to moderate between these two demands by the employment of methods enabled by advances in information technology. Autonomous systems for active weed control are a typical Precision Agriculture application. Pierce and Nowak define Precision Agriculture as “the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production.

Trends:

A recent trend in precision agriculture which is currently also present in modern media is the employment of unmanned aerial vehicles (UAVs), also known as “farming drones”.

Autonomous Weed Control:

Robots for autonomous weed control do not only enable a higher productivity, but also reduce the amount of required herbicides. The technique is also highly interesting for organic farming, where current weed control methods

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rely on cost- and labour intensive human work. It is distinguished between inter-row and intra-row weeding. The latter one is more difficult because crop damage has to be avoided, but also more relevant as inter- row weeds can be managed by passive control techniques such as chemical or mechanical solutions

- Guidance
- Weed detection and identification
- Precision in-row weeds control
- Mapping

Weed Detection and Identification:

In their review on autonomous weed control systems, Slaughter et al.conclude that the greatest remaining challenge is plant detection and identification. Approaches to solve this problem are divided into three groups based on the employed information: Biological morphology, texture and spectral characteristics. In general, most of the plant detection studies do not consider temporal variability's over several growing seasons. Other sensing techniques employ ultrasonic sensors for plant height measurements with the goal to detect areas with a high weed density or a 3D LIDAR sensor which measures morphological information in combination with reflectance values

Texture:

Texture features are rarely used for plant classification and most of the studies are executed under lab conditions. Burks et al. are able to achieve an overall accuracy of around 90 % for the classification of five different weed types and soil with the Color Co-occurrence Method. Yet their experimental setup involves complicated artificial lighting conditions and the manual extraction of class samples.

Human Insertion Points:

We identify three promising human insertion points. The human input has the potential to increase the quality of ground truth information about image background and foreground data so that user-interactive segmentation algorithms such as grab cut can be applied. In terms of response usage, the main purpose of this input is to correct distinct failures in the weed detection process directly. However, there are also approaches to improve the segmentation algorithm based on user input with Machine Learning techniques. It is hard to establish selective query behaviour as at least standard implementations of segmentation algorithms do not include a way to detect the quality of a segmentation result. The main problem of a shared autonomy approach for segmentation is the high user interaction time and restricted learning possibilities. Moreover, experienced user skills are required to work with segmentation tools. As already mentioned above, a direct placement of stem markers in critical segmentation regions is a much more effective way of interaction for an approach like this, where the main focus is on the direct modification of processing decisions and not on learning.

User Interface:

The task of the graphical user interface is to visualize computational results of the weed detection process and enable the user to interact with the detection system by providing feedback.

V. RESULT AND DISCUSSION

Our autonomous robot system model consists of four hub wheel motors which controlled by ladder logic program and it is shown below Fig 5.1. Functionalities of wheel has been monitored by HMI and it also capability to change the movements of the wheel based on the GPS co-ordinates. MITSUBHISHI FX5CPU PLC has decision to produce the output voltage to the hub motor based on plant sensor. Fig.5.2 shows the entire set up of the system consists of PLC with HMI and it is connected through wire properly.

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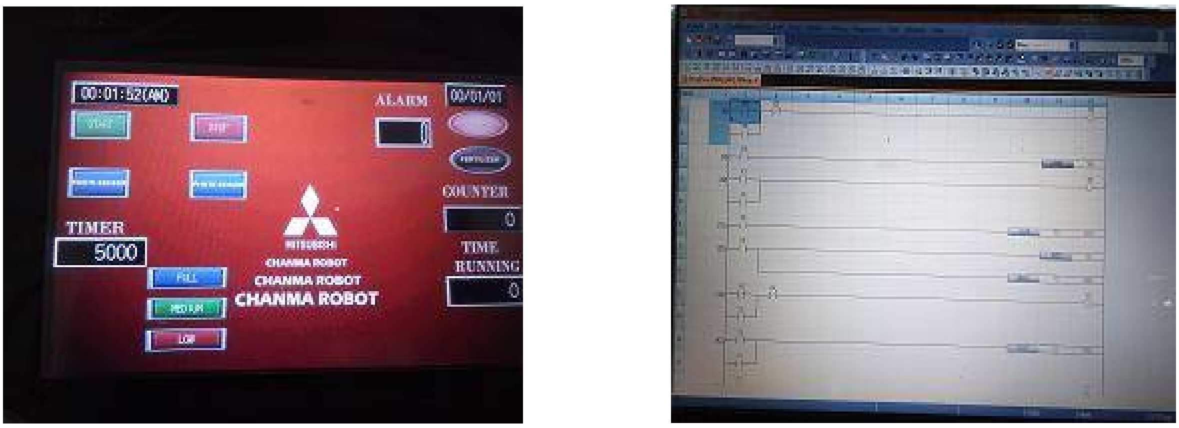

Fig. 5.1: HMI and Ladder logic diagram snap shot

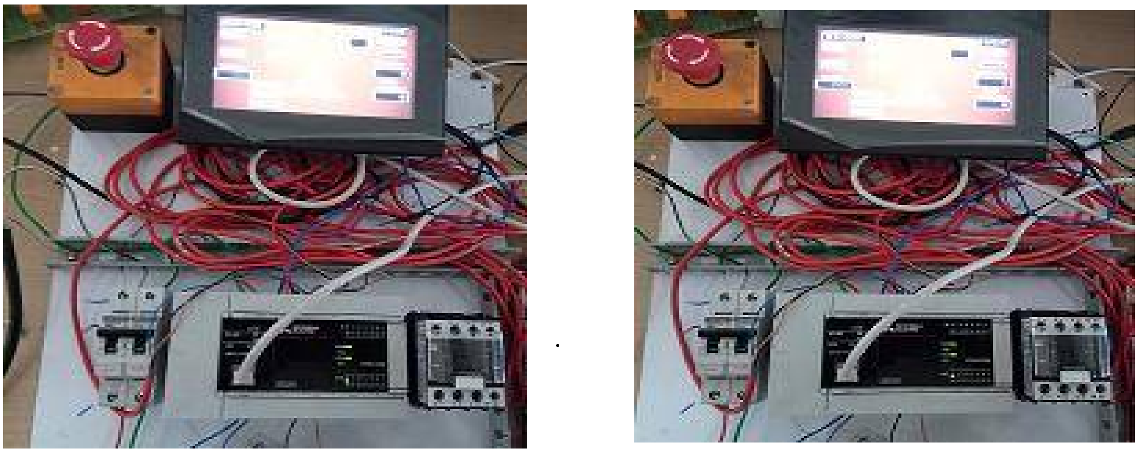

Fig. 5.2: Control system model snap shot

VI. CONCLUSION

The human accepts to work on a more abstract level of control and corporate with some machine intelligence, especially when he notices that this abstraction layer results in a reduced amount of necessary user input. However, the more we increase the level of autonomy, the higher are the demands regarding the performance of the autonomous processing system in order to maintain a stable overall system performance. There are potential sources for errors in all portions of the autonomous frame work; one of the main challenges is the segmentation of plants. Occluded areas yield under segmentation, fine plant structures lead to over segmentation. The cotyledons of carrot crops can be easily confused with leaves of weed plants; this seems to be the main source of classification.

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