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AUTONOMOUS E-AGRICULTURAL ROBOT

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ABSTRACT: The objective of our project is to design an agricultural robot. A row guidance method is presented to guide a robot platform which is designed independently to drive through the crops in a field according to the design concept of open architecture. It is mainly comprised of the rear and front cabins, the driving devices with wheels and the frame.

The power supply, motor controllers, and other controlled components are placed in the front cabin and IR laser is fixed in front of it for finding edge location of both sides. The rear cabin can be used for storage boxes to store some materials such as pesticides, insecticides, and fertilizers. The driving devices include DC motors, gear mechanism with sprocket and wheels.

To design a robot which is autonomous and self-sufficient requires enough energy to operate. But they have to be made parallel to optimize the robot energetically. In particular, a power supply solution that utilizes solar cells and a microcontroller have been chosen to power and control the robot.

1. INTRODUCTION:

Agricultural vehicle guidance for row crops is a skill and labour intensive task for manuvering equipment without overrunning crops. The adoption of new agricultural technologies, such as precision agriculture, makes the maneuvering even more difficult. The shortage and aging work force in agriculture results, in decrease in the skilled machine operators. Therefore, the development of automated or autonomous agricultural equipment is considered to be of commercial significance and societal importance.

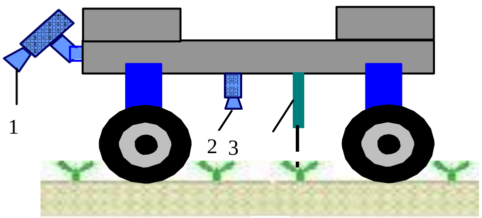
Agricultural robot is the autonomous agricultural equipment performing various agricultural operations. Automated navigation aims to guide the robot to follow a desired path automatically. It requires a guidance system be able to detect robot posture, create proper steering signal, and steer the robot according to the signal. The posture is the position and orientation of the robot (Kanayama and Hartman, 1989). Different guidance sensing systems, including mechanical, optical, radio, ultrasonic, and leader cable systems have been developed for agricultural vehicles during the past several decades (Richey, 1959; Kirk *et al.,* 1976; Tillet, 1991). In the past two decades, vision sensors and GPS sensors have been added to the list of available guidance sensors. Although each system uses different technologies to guide vehicles, most of the systems use the same guidance parameters, heading angle and offset, to control steering.
Stanford University demonstrated high accuracy carrier phase differential GPS for the guidance of a John Deere 7800 series tractor (O'Connor *et al.* 1996). A four antennae system provided a heading accuracy of 0.1 degrees and offset accurate to 2.5 cm in tracking parallel straight rows at 3.25 km/h. Carnegie-Mellon Robotics Institute developed an autonomous New Holland 2550 Speed rower for cutting forage using vision-based perception on the cut and uncut regions of the crop. The speed of operation was reported as 7.2 km/h. In addition to guidance, vision sensing provides inputs for "end-of -row" detection, correction of illumination due to shadows and obstacle detection. Sensor fusion methodologies were included to resolve conflicts from information coming from various sensor modules. Michigan State University has attempted to implement vision guidance on a Case 7190 MFD tractor. The camera was mounted 2.8 m above the ground on the left side of the vehicle with a tilt 15 degrees below the horizon and a view beyond the vehicle. The system was tested for straight row guidance at speeds on 4.8 and 12.9 km/h with maximum tracking errors of 6.1 and 12.2 cm, respectively.

This paper presents solution of the challenging problems on a developing agricultural robot using RTK-GPS and FOG. This solution includes a robot control algorithm and mission planning. In addition, some field tests were carried out for investigating a performance of the developed robot tractor.

AUTONOMOUS AGRICULTURAL ROBOT

The design concept of open architecture was applied to the agricultural robot described in this work, which includes open design on structure system and control system. As for openness of structure system, it reflects open design on hardware, which means that it should be taken into account by replacing the different actuators to adapt to different tasks during the design and the number of sensors can be appropriately increased or reduced. Meanwhile, the control system should retain sufficient interfaces to control the actuator and receives sensors signals. The sketches of agricultural robot based on the open architecture are shown in Fig.

1.The production tasks can be transformed in the same body by replacing the relative hardware and actuators. The operations of vegetables spraying (pesticides or water) and chemical weeding control are represented in subfigure a), while physical weeding operation in sub figure b) and harvest operation in sub figure c). Likewise, it reflects open design on software, which means that it is easy for second development and intelligent expansion .Especially, it can provide an ideal platform for the control of

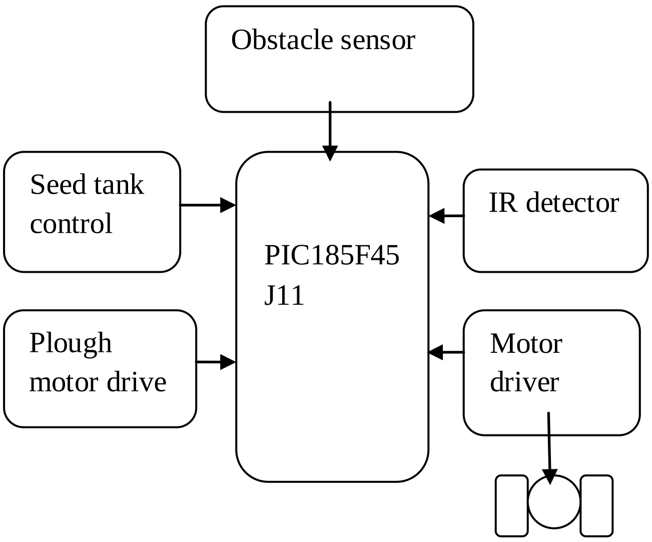


a)

A hierarchical structure was applied to the control system, as shown in Fig.2. The organization level is the decision-making system of the robot with highest level of intelligence to accomplish task planning according to operation tasks. It can construct model of the environment in the light of environmental information, maps knowledge and planning knowledge and make a global path planning with other information such as position and orientation of the robot. The coordination level is the interface between the organization level and the implementation level to receive planning information and provide the best control program on action commands of the decision-making system through the coordination mechanisms and information fusion algorithm. The implementation level, the bottom of the hierarchical control with high precision and low intelligence, will produce the control output to complete the corresponding action according to the expected value output from the coordination level. It also can sense and measure the environmental information, body status and information of position and orientation information and handle emergency of the system.

Fig.3 shows the platform of an agricultural robot designed on the basis of the design concept of open architecture mentioned above. This platform, its length is 1200mm, the width 600mm, the gap between the frame and the ground 550mm, the distance between the two front wheels 510mm.

General methodology



SOLAR SYSTEM:

There is a large variety of autonomous robots: these can be classified according to their structure, dimensions, maneuverability, main tasks, and so on.

In any case, every robot requires a power source to make all its functions, like mobility, control, measures, to mane just the most important. So we have seen that in most cases, robots have a storage system that self-recharges during the mission or at the beginning of the mission, by power stations.

This solution increases the robot weight and consumptions, then we are here exploring about the added value, in terms of increased autonomy, of an autonomous power source installed on the robot.

In particular, we concentrated our attention on the photocell technology (increase of efficiencies) that cheap (decrease of cost for Wp), as well as on the possibility to use cells on the flexible support, increasing the adaptability degree at any surface of every form.

The paper is organised as follows: the state of the art of the photocell application in the robots will be first presented; then a description of the robot and its energy characteristic will be given; subsequently a description of the project of an autonomous photocell system to apply on the robot will be discussed.

So far batteries and/or capacitors are used as power sources. The battery supplies only a DC voltage used for the control board of a robot; the capacitor supplies AC voltage for the control of the mobility of a robot by electrical servomotors.

The battery uses more time than the capacitors to charge and to discharge energy. There are two strategies for recharging batteries and capacitors: solar panels on the robot and power stations. Gary B. Parker and Richard S. Zbeda [1] [2] explain how to power and control the hexapod robot Servobot.

Matt Lister and Thomas Salem [3] deal with the DC battery system, since it is the main power source for the robot. Normally this system consists of a combination of switched mode DC power converters. Experimental results show the converter efficiency and voltage ripple at rated load. A discussion of lessons learned provide insight into the need for proper component selection and placement, printed circuit board fabrication, and ensuring a proper ground plane for successful implementation of a switched mode DC power converter.

Albert Esser and Hans-Cristoph Skudenly [4] explain a new system to supply energy for multilink robots.

It contains rotatable transformers placed in their joints, thus avoiding the use of movable cables. Mitsuteru Rimura, Nobuki Miyakoshi and Mesahiro Daibou [5] explain a miniature opto-electric transformer, consisting of a p-n junction photocell and a multilayer spiral coil transformer monolithically fabricated on a silicon substrate. It converts the optic energy, acquired from a photocell, into voltage.

Andrè Colens [6] explains a system for resupplying power to self-contained mobile equipment, including a fixed station having a external power source and consisting of a high-frequency generator and an induction coil as well as, on or in the equipment, a pick-up coil, a current filtering and rectifying device, a rechargeable battery pack and a microcomputer-controlled tracking system.

Sergio Hernàndez, Carlos A. Morales, Jesùs M. Torres and Leopoldo Acosta [7][8] deal with mobile robots for the localization by means of a transmitter-receiver system positioned on the robot and on a fixed point in the environment.

The transmitter is based on a red IIIA laser and the receiver is a cylinder having thirty-two photocells. The position and the orientation of the robot are obtained when the laser hits every photocell.

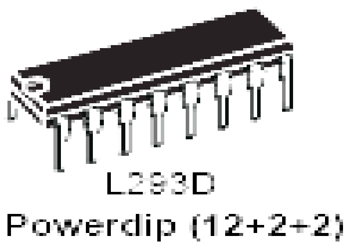
AUTONOMOUS SCENARIOS:

MOTOR DRIVER:

The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16 lead plastic package which has 4 center pins connected together and used for heat sinking

The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heat sinking.



MATLAB IDE:

- It is a integrated development environment for the development of embedded applications on PIC and dsPIC microcontrollers
- It supports project management, editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers.

PROTEUS ISIS:

It is a compilation of program design and simulation electronics , developed by Lab centre Electronics consisting of two main programs:

i. Ares and ISIS

ii. Vsm and electra modules

Intelligent **S**chematic **I**nput **S**ystem allows designing the wiring diagram of the circuit to be performed with components varied from simple resistors , even occasional microprocessor or microcontroller , including sources Power generators signals and many other components with different performance. Isis The designs can be simulated in real time, using the VSM module directly associated with ISIS.

CONCLUSION:

A preliminary analysis of the feasibility of a photovoltaic system with batteries to supply a mobile robot has been presented. By analyzing both the power drawn by the robot during the movement at various speed rates and efficiency of the most used PV cell technologies it is clear that the PV system can supply only the control, sensing and wireless transmission systems. However some qualitative evaluations on the possibility of using less power consuming motion system and at the same time the presence on the market of very efficient PV cells (i.e. triple junction) forecast the feasibility to extend the photovoltaic power to supply to whole robot. Further investigation is therefore needed in this direction.

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