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AGRICULTURAL ROBOTICS

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Abstract- The emerging applications of robots are fruit picking, weed control,harvesting, environmental monitoring and soil analysis.The autonomous vehicles eradicate the involvement of manual labor but require huge guidance, maintenance. Robots connected in fleet cannot be used since if one autonomous vehicle gets damaged, the whole unit becomes inapplicable in work field.However these agricultural robots require external computer to monitor (or) co-ordinate the arrangement.Development of Robotics & Automation in the field of agriculture will play a very important role for upcoming years.The only disadvantage is that a skilled labor is required inorder to monitor it time to time.Automation requires vision system, obstacle detection, harvesting, weed control etc.If the numbers of sensors, actuators used are large then it becomes expensive which cannot be affordable .Another important thing to be concentrated apart from monitoring is the cost efficiency and simple network.Automated vehicles can be used for various applications and also plays every important role in development of robotics especially in the field of agriculture.

Keywords –Robot, Automation Tractor, Agriculture.

1. INTRODUCTION

Robotics has started to play a very important role in agriculture.Farmers have started to realize the need for automated vehicle to reduce the risk and damage caused due to tremendous use of chemicals and also increases efficiency [1].

1.1 Development

The complete set up is divided into 3 subdivisions

- Vehicle
- Implement
- Controller

When comparing to manual labor, tractor, and the agricultural robots reduce the man power, time required, pollution, energy required and increase the productivity, efficiency [4]. The vehicle is required for movement and it should be suitable for crop that we are going to use and also for the various kinds of operation that is required for the crop.Vehicle should consist of 3 point hitch which is used for attaching ploughs and other implements attached tractor and also the vehicle must fulfill all the required agricultural standards followed by electric generators,hydraulic pumps .The agricultural robots can be used in order to improve the agricultural system and agriculture practice [5].
Instead of designing this vehicle which has to meet the stipulated conditions that are required it is better that we use tractor.

1.2 Advantages of using Tractor

When tractor is used it allows the designers to focus the time on safety,the efficiency and the outcome of AGBOT rather than concentrating on the design,assembly,the working condition etc.The vehicle that is selected for this operation -CNH BOOMER -3050 (51HP-37.3KW,1200KG).The empty cabin was used for computing the equipment, for recognition,communication,location.
The system also requires certain special elements outside the cabin:VISION, ANTENNA, and LASER, EMERGENCY EQUIPMENTS .India being an agricultural country this robotic vehicle can be more useful and helps in the development of agriculture. Robotics is not only implemented in military, industrial applications but also has started to play a vital role in agriculture. To overcome the problem of farmers this autonomous vehicle can be used as substitute which can perform various activities such as irrigation, fruit picking, pest control etc [2].

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Fig.1.Commercial vehicle with implements.

The overall equipment is further classified into subsystems-

- Weed Detection System: To identify the weed patches.
- Laser Range Finder: To identify obstacles in front of mobile units.
- Communication Equipment :To link the operator station, mobile unit and user portable units
- GPS: To accustom the vehicle in the mission field.
- Inertial Measurement Unit :To complete the GPS data and enable improved vehicle positioning
- A Vehicle Controller: In-charge of computing the steering control law, throttle and braking for path tracking purposes
- Central Controller: Decision making system. In charge of collecting required information from all perception systems and computing actions to be performed by actuation components and additional energy power supply-based on fuel cell-monitoredby central controller.

1.3 Implements

Device which is designed to perform agricultural action such as herbicide and pesticide ,thermal weed removers .The nozzles, burners which are found to be operated independently to focus the actuations in accordance with agricultural principles .

1.4 Boom Sprayer

Used for herbicide application in cereals. Figure 2 shows commercial vehicle and it contains 5.5m boom sprayer containing 12 nozzles separated by a distance of 0.5m .It also exhibits independent actuation .This tool is carried by the vehicle and also consists of 2 herbicide tanks with 200L and 50L capacity .These two can be mixed to apply for various treatments.The herbicide which flows through the nozzle as well as the boom folding/unfolding device is controlled by the MAIN CONTROLLER. Some othewr types of boom spayers are depicted in Fig. 4 (a) and Fig. 4 (c)

1.5 Mechanical-Thermal Machine

Used for weed control in crops which are capable of resisting flames such as maize, garlic and onion. The machine (thermal machine) has four couples of burners that are attached to the main frame that tackles four consecutive crop rows. The tool is towed by vehicle, on the other hand which is also responsible for controlling the relative lateral position with respect to the position of the vehicle. The intensity of flame coming out from each individual burner is identified by WEED DETECTION SYSTEM based on the machine vision [Fig. 4 (b) and Fig. (d)].The amount is expressed in terms of percentage of area covered by weeds in every area unit-0.25m*0.25m.

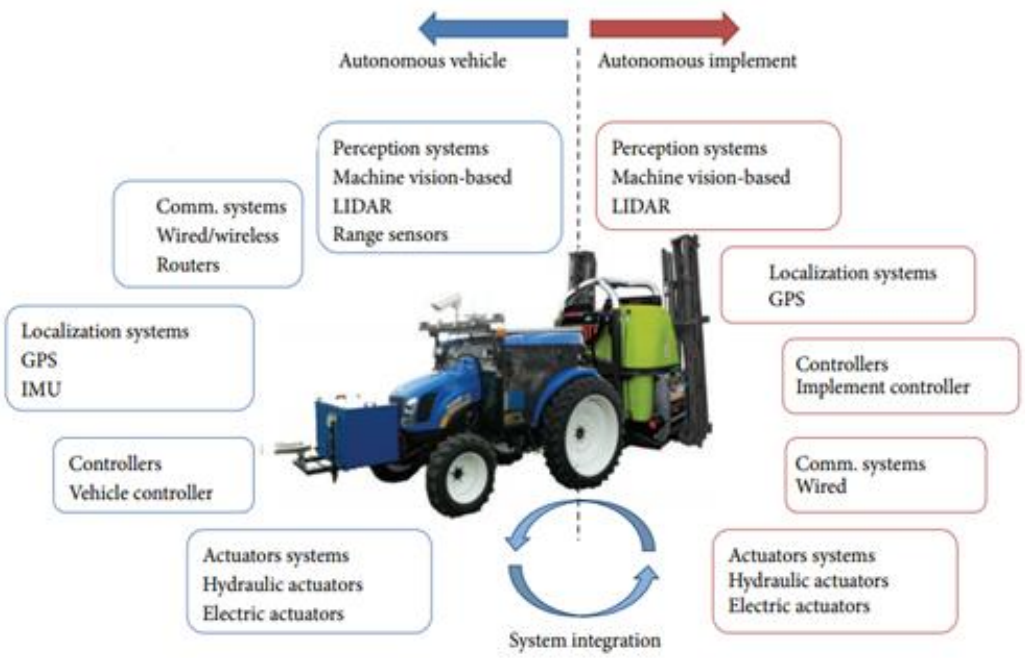

Fig 2. Elements of the autonomous vehicle.

1.6 Airblast Sprayer

Used for pesticide application in olive trees.It has 2 vertical booms with 4 nozzles each. The lower and upper nozzles are aligned by stepper motors based on information provided byultrasound sensors, one per nozzle. The vehicle partially tows this implement which consists of all sensorial systems required application, Fig. 3.

Fig 3.Canopy sprayer

1.7 Main Controller

Main controller is in charge of moving the vehicle accurately and co-coordinating the actions of vehicle but above all maintaining communication with operator. Main controller also brings in participation a large number of subsystems such as the boom sprayer, air-blast sprayer etc. This technology is already implemented in various other countries. In India if this agricultural fleet of robots is implemented it will in turn yield more, efficiency gets increased and development on agriculture will take place and in turn it will lend us better results.The computers are connected by communication network or point to

point communication links exhibiting very well shortcomings derived from its maintenance cost in terms of updates ,security ,the no of different operating systems and programming languages to be handled ,time consuming management needs and network delays in data communication which may impair real time features of the system. Taking into account the limitations and advantages, the appropriate choice depends on the number of sensors, types of peripherals, various computers used etc .This task is comparatively easier when we are aware of the various subsystems and features required .Whereas in agriculture, the various subsystem configurations available, the equipments that are designed for specific application makes the task difficult especially due to different operating systems and other programming languages. The best solution is to use hybrid architecture featuring centralized and distributed characteristics capable of integrating new systems by using distribution features such as ETHERNET networks and CAN bus among others.

Agriculture fleets of robots should rely on following elements-

- Hybrid Computing System: Central, powerful, truly real time, multi tasking computer
- That has fast network communication features to connect various peripherals.
- Central Computer: It should have large no of real plug play hardware modules that includes both wireand wireless communication modules.
- It should support software that are developed for various platforms in different languages.
- Simple and Powerful Connections-external libraries and third-party tools must be included.
- Development Tools: should allow various programming languages for different applications and domain experts in different disciplines.
- Central Computer: should operate in worst conditions and it should solve tougher algorithms and also execute it.
- Architecture should ensure protection to property, human life and should not be a boon to the society.

These features are fulfilled by RIO-9082.(CRIO-9082,1.33GHZ,dual core Intel core i7 processor,32GB non volatile storage,2GB DDR3 800MHZ RAM),high performance integrated system. The system which we have selected will offer powerful execution for real time application. The hardware part also consists of FPGA for the purpose of processing wide array modular I/O for any application requirement .System is designed for I/O flexibility ,reliability and most important of all precision in agriculture applications.The hardware and software features present should satisfy the following requirements/needs-

- Staunch of equipment
- Good and string performance in harsh environment
- Expandability
- Togetherness -state in which two things are able to exist (or) occur without problems.
- In developer community the total number of LAB VIEW users are increased in order to monitor the functioning so as to avoid any malfunction
- Cost effective-should be profitable which can be achieved by reducing the hardware when manufacturing by using products such as single board RIO.

2. FLEET MANAGEMENT TOPLOGY REQUIREMENT

Fleet is nothing but a set of independent mobile units which must co-ordinate and interfaced with a) workspace b) with the operator at required time. In few applications, were two/more vehicles co-operate motion co-ordination between vehicles is more critical to ensure accuracy, end distance, time, fuel where each vehicle will perform a particular task without repetition .Few attempts have been made to solve co-ordinate motion problem. Although workspace is defined, safety plays an important role that will affect fleet composition .The vehicle should be in communication with external computer to give data about current status and operation. A human operator should be in charge of supervision. The operator should be present at necessary instants such as: configurations, start, stop etc .Thus an operator plays a very important role to govern the vehicle. In this setup, a master external computer is connected to group of units through wireless communication system which runs through mission supervisor which will send command to receive data from group of units.

3. THE EVOLUTION OF RHEA COMPUTING SYSTEM

The computing system which is present must be able to communicate with large no of subsystems-which are nothing but computers running with various operating system and software languages(c, C++, python).The basic step is to connect various subsystems through Ethernet network and use a computer as a central controller.The Main Controller is connected to other peripherals through serial line or Ethernet network through Ethernet switch, which in turn requires network manager running on computer connected to Ethernet switch normally the main controller. The first step is integrating the weed detection system into main controller. The vision camera is GigE Vision standard developed using Gigabit Ethernet communication protocol framework for transmitting high speed video and related control data and main controller has 2 Gigabit Ethernet process. This will allow direct connection between camera and main controller. One of the strategies to improve the centralization system is to combine the two vision systems the weed detection system and obstacle detection system. Since both the systems use image capture and image processing algorithms which can be integrated into same computer to save hardware resources.The software which is written in C++ language for Linux operating system is converted to a DLL procedure described for Weed detection system.

But the main problem with this is that the lack of real parallelism in execution of algorithms which will increase the computing time. Increase is compensated by the elimination of delay in information flow from obstacle detection system to the main controller via the Ethernet.The advantages of integrating two systems are as follows-

- On the whole the application will require only one camera, which in turn will reduce the amount of hardware and relevant equipment.
- Two processes can be executed in parallel.
- Main controller will allocate same memory space in order to share information between two vision processes.

Another development and benefits of integration is the performance which has been improved in an obstacle detection task in real-time applications by fusing the camera and laser information. After minimizing the hardware of mobile units, the most crucial step is to reduce the hardware of whole fleet. The process of minimizing the hardware of whole fleet depends on other elements that will constitute fleet of robots-(i.e.) the base station and operator.As said before the operator interface is essential, an operator must be present at required period. The operator interface can be provided in the form of base station (Monitor, keyboard), smart phones which will help the operator close to mobile units.

Fig 4.(a) Boom Sprayer

Fig. 4.(b) Flame hoe

Fig 4.(c)Boom Sprayer

Fig. 4.(d)Flame hoe

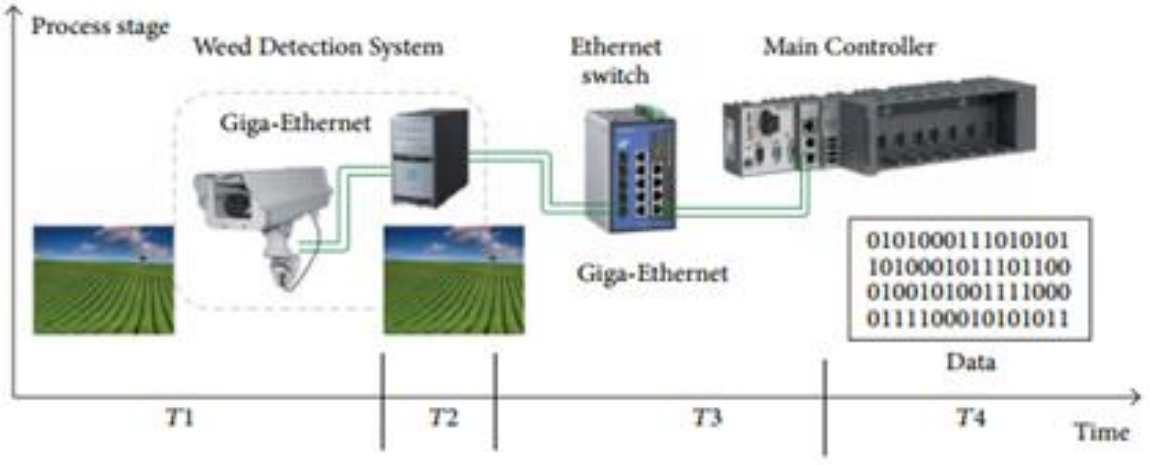

Fig.5.(a) Comparison of distributed approach

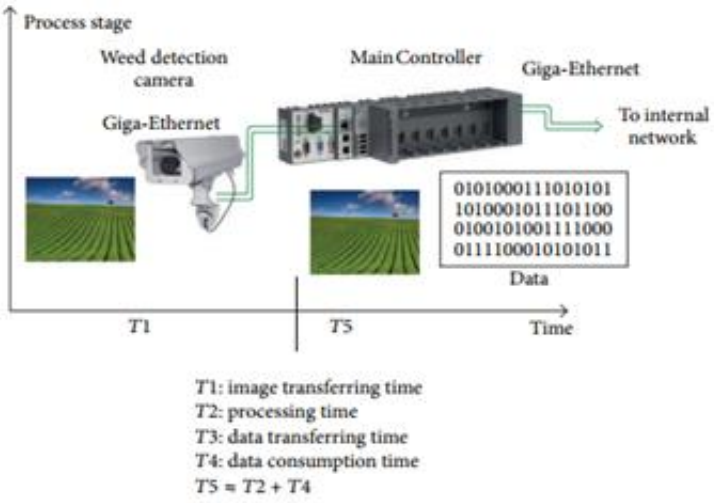

Fig. 5.(b)IN Weed Detection System use of resources information availability, communication time

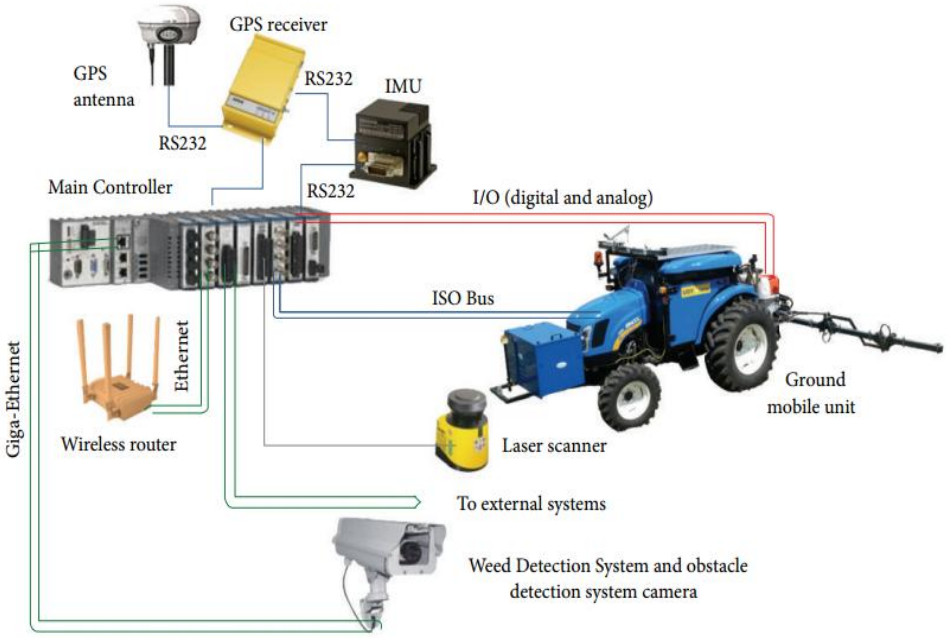

Fig. 6.Hardware Configuration

4. CONCLUSION

The field of robotics has begun to improve lately. The automated agriculture robot can also be used in agricultural techniques such as segregating the crops, checking the livestock, preparing the farm for next plantation of seasonal crop, irrigating from time to time [6].Robotics in agriculture has also started to develop slowly across the globe. In agriculture it will help in increasing yield, less usage of chemicals, identification of weeds etc .Robotics in agriculture will improve the flexibility, modularity and adaptability. This paper presents the general implementation of fleet units in agriculture. This system is operational, the safety precautions are also taken into consideration and if the hardware is reduced, thus the working area, operator can monitor more effectively and efficiently. This technology is already implemented in various other countries. In India if this agricultural fleet of robots is implemented it will in turn yield more, efficiency gets increased and development on agriculture will take place and in turn it will lend us better results.

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