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Robotics Irrigation – A Key to Agricultural Revolution

Mayank Pokharna[1], Purvi Agrawal[1], Charu Kavadia[2]
[1]Department of Electronics & Communication, CTAE, MPUAT, Udaipur (Raj.), India
[2]Department Computer Science Engineering, Arya College of Engineering & I.T.Jaipur (Raj.), India
coolmayank6499@gmail.com

Abstract: Agricultural robots are machine programmed to do agricultural task and farm assignment. Despite the large diffusion of robotic and automated solutions that took place during the last decades in most production processes, the agricultural sector benefited only marginally from automated solutions. Most of the farming is now done with machines but they are not automated, hence there is a need of another revolution in agriculture and that is robotics and automation revolution.

Agricultural robots can be classified into several groups: harvesting or picking, planting, weeding, pest control, maintenance or irrigation. Out of these, irrigation robots have been researched and implemented very less but are of a great importance to increase the production of a crop. Different type of crops has different types of irrigation requirements and should be dealt accordingly. This can be efficiently done if robotics is integrated in irrigation. Hereby, in this paper, we are proposing efficient ways of irrigation by robots, their advantages and future perspectives. Our approach is to utilize available information technologies and the proposed framework in the form of more intelligent machines to reduce and target energy inputs in more effective ways than in the past.

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I. INTRODUCTION

A Robot is a man-made electro-mechanical device that can move by themselves, sense, take decision, etc. for which it is programmed. They are helpful because they can also work in an unfriendly environment which can be very tedious task for humans.

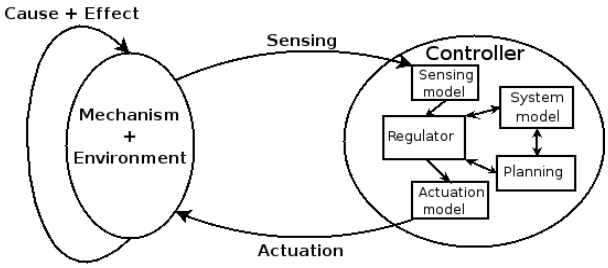


Fig. 1 Showing basic Robot Mechanism
Available online on http://
www.electronicsteacher.com/robotics/ what-is-robotics.php

Agricultural robots or 'Agro-bots' can be very helpful in India's perspective, as it is an agricultural developing nation. Though India is having transition from primary jobs like agriculture, technical advancements in agriculture like implementation of Robots in it in various ways can benefit Indian economy to a large extent. Use of robots for irrigation in agro-sector will not only reduce the time and again attention of the whole irrigation process but will also increase productivity of crops that can be very helpful to feed millions of hunger people like a country in India. Accuracy during all the irrigation process regarding quantity of water and duration for this can be met by using robots. Thus to ameliorate the overall existing irrigation process, implementation of robot can play a key role in increasing the agricultural productivity.

II. OPERATION

The basic fundamental block diagram of a robot working in farm is shown below:

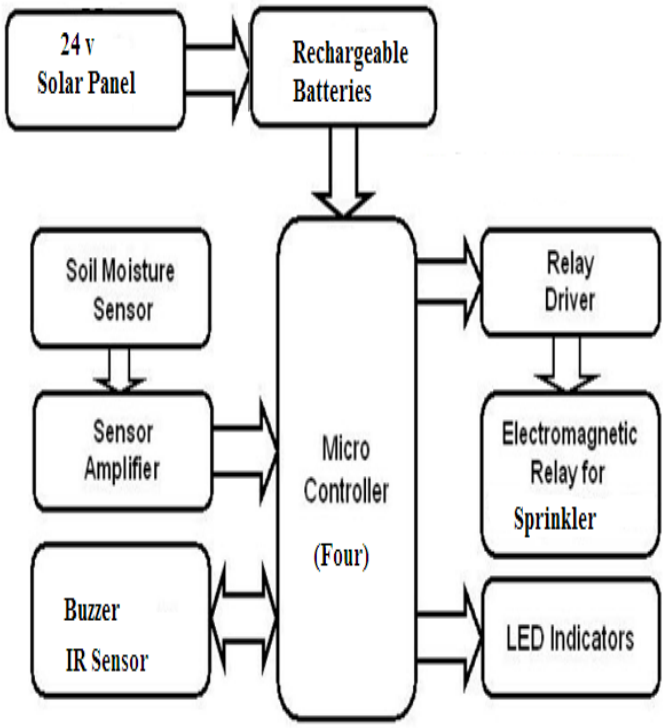


Fig 2 showing basic block diagram

It consists of four microcontrollers. First one is for repeating the task of taking rounds of the field after a fixed interval of time at fixed locations. Second one is programmed for following the path and stopping at specific locations, rather can be called a line follower. Third one is for sending and receiving data serially to computer and lastly Fourth one is for

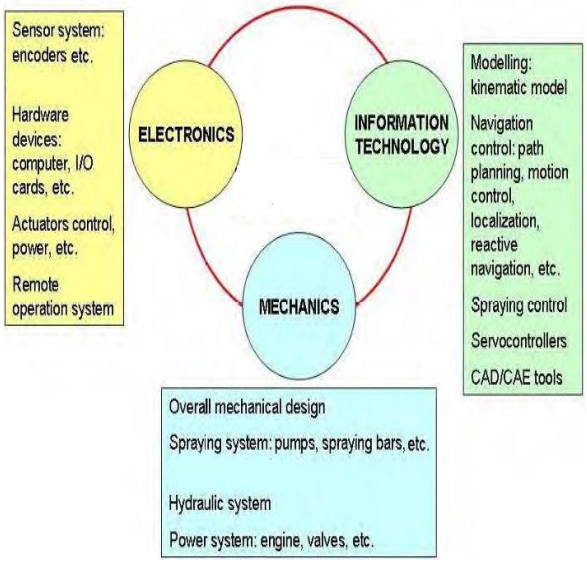
turning the sprinklers of the required area.

Farm consists of a base station where robot is kept which takes rounds of the field at particular locations after fixed interval. We have deduced this interval to be of around 8 hours as after 8 hours the moisture content of the soil decreases considerably and is needed to be checked for irrigation. Hence after every 8 hours robot will take the round of the farm. This is done through the first microcontroller.

The second microcontroller is a line follower programmed controller that directs the robot on a particular path at specific locations. These locations are decided so that the sprinkler at these places covers almost all the cultivated land. This line follower task is done with the aid of IR sensors of considerable range.

The third microcontroller senses the moisture of the soil with the help of a robotic arm at the above mentioned specific locations. The data is being continuously transmitted serially to the computer where it is read and recorded by the software. It is here that the percentage of moisture content is compared with its threshold value and those points where the moisture content is below the threshold level is again retransmitted to the fourth microcontroller which then switch-on the relay of the required sprinklers for the required time as calculated by the computer program to make the moisture content reach above the threshold level and then they are turned off.

III. BASIC REQUIREMENT FOR DESIGNING OF AN IRRIGATION ROBOT



Mechanical System: The basic type of robot has been developed in CAD to take into account requirements like position of various components to have efficient working.

Electronic System: Humidity sensor, 8051 microcontroller, robotic arm, etc. have been used coupled with computers.

Information Technology: Autonomous navigation has been used & control structures were tested & calibrated when the real vehicle was built.

Basic components used in the designing for our robot:

- Four 8051 microcontroller
- Humidity sensor - SMT 01
- SDI - 12/ USB interface
- Resistors, capacitors
- Buzzer
- Switches
- LEDs
- 24V solar panel
- Relays for sprinkler
- 4 Rechargeable batteries
- IR sensor

Humidity Sensor:

It is sensor for monitoring soil moisture levels in precision farming. These are various types of humidity sensor available in the market. For our purpose, we have used SMT 01.

Fig. 3 Humidity Sensor
Available online on http://www.peakmonitoring.com.au

It provides data required for cost efficient irrigation, crop yield optimization and protection of natural resources. The SMT01 has been designed to work in any type of soil. It has a low current consumption and an SDI-12 interface. It is ideally suited for battery or solar powered remote applications. The SMT01 has short measurement time and fast response to any fluctuation in the soil moisture level. It is easy to install and easy to calibrate. The SMT01 is a rugged, hermetically sealed design, equipped with a polyurethane protected cable.

Fig. 4 USB Interface
Available online on http://www.peakmonitoring.com.au

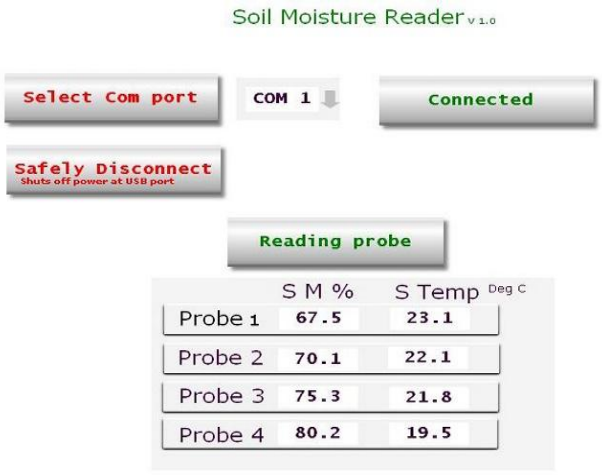


Fig. 5 Software Window for measurement of moisture
Available online on http://www.peakmonitoring.com.au

It has a USB interface which can be connected directly to micro-controller.
Its key features are:

- Accurate soil moisture and temperature measurement
- Fast response
- Not influenced by salinity levels
- Temperature compensated
- SDI-12 Interface
- Rugged design
- Hermetically sealed
- Operating temperature range - 20 o C - 65 o C
- Low power consumption
- Simple installation
- Simple calibration
- Small size (L =150 mm W=25 H= 5mm)

From microcontroller, the data can be serially transmitted to a computer where it can be read with probe reader software & then again it is re-transmitted to micro-controller for further process.
This transfer is done serially with the help of serial transmitting and receiving port. The software also records the information that is being transmitted which can be further used.
The above USB interface provides us an easy way to transmit data directly to the microcontroller which can be easily processed further.

Shown below is graphical representation of humidity v/s time. Here we can see that how humidity of soil changes in different environment conditions & thus the water requirement of the crop.

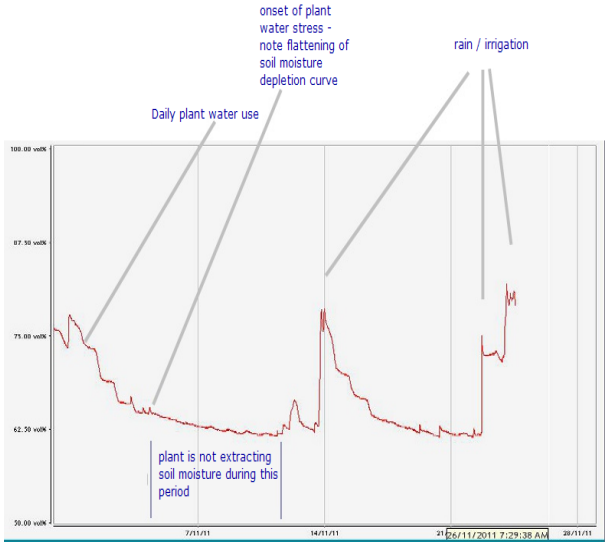


Fig. 6 Graph - humidity v/s time.
Available online on http://www.peakmonitoring.com.au

Solar Panel:
Solar panels make use of renewable energy from the sun, and are a clean and environmentally sound means of collecting solar energy. We are using it so that we can power our robot in an environmental friendly way. Here we are using a 24 V solar panel which is used to recharge the rechargeable batteries of 5 V which acts as power supply for the microcontroller.

Fig. 7 Solar Panel (24V)
Available online on http://www.ledssuperbright.com

IV. FUTURE FARMS

Here is the proposed framework of how farms will look in future. As shown, in the future, robotics will be implemented in agricultural for various purposes like spraying of fertilizers, ploughing, irrigation & harvesting. Implementation of robotics in agriculture will have various advantages like:

- Man-power is reduced
- Farm can operate automatically for 24 hours. Increase in production
- Better quality of crops
- Reduction of crop wastage as proper fertilizing is done.
- Optimization of land usage
- Proper management of crops.

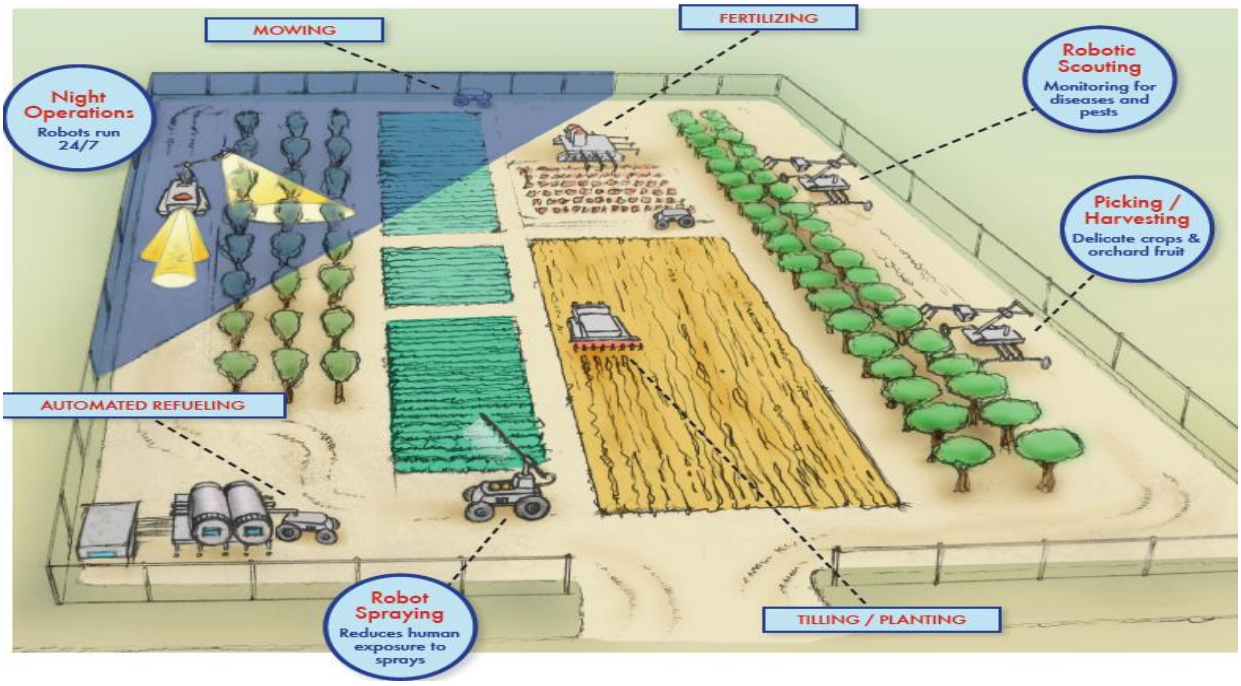


Fig 8 Future Farms

V. CONCLUSION

Through this paper we have proposed a novel method of integrating robotics with irrigation and thus transforming the irrigation system for better crop yield, reduced man power, better quantity and quality of crop, thereby reducing the price of the crop. Here we have tried to use just the basic 8051 microcontroller to perform irrigation task in a different and easy way. We know that this is not an easy task to implement. Many improvements are possible in this design but it will take time. If further research is carried out in this direction it can revolutionize the entire agro-sector in India and can be very helpful for the Indian economy as well.

VI. REFERENCES

1. Figures available at
http://www.peakmonitoring.com.au
http:// www.electronicsteacher.com/robotics/ what-is-robotics.php
2. National Robotics Engineering Center, future farms