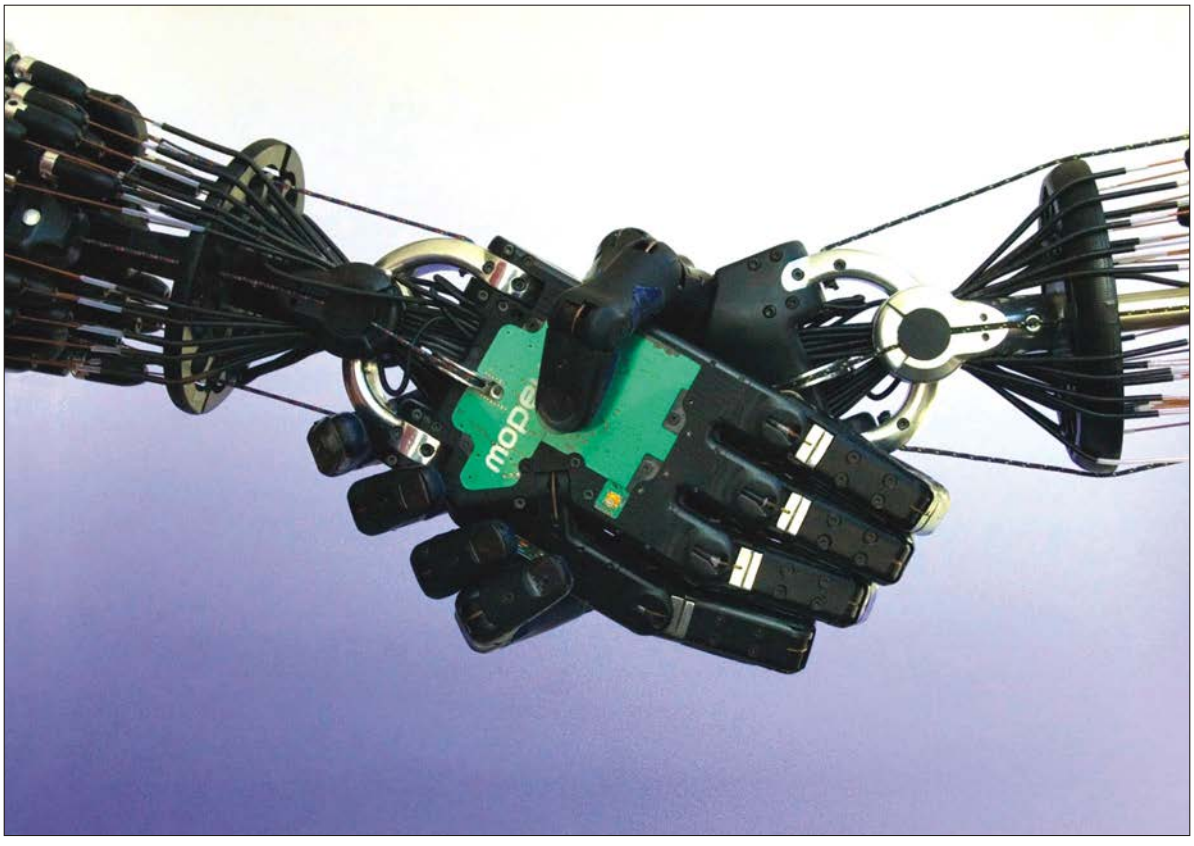

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Automated Agricultural Process Using PLC and ZigBee

A. Dhivya, J. Infanta and K. Chakrapani
School of Computing, SASTRA University, Thanjavur, Tamil Nadu, India

Corresponding Author: A. Dhivya, School of Computing, SASTRA University, Thanjavur, Tamil Nadu, India Tel: 9566714891, 9629799303

ABSTRACT

Agriculture is the backbone of Indian Economy. Because without agriculture living is impossible since agriculture produces the main source of food for us. But in today's situation the availability of labour for carrying out agricultural activities is rare. The automation in all kind of industries leads to industrial growth. Here agricultural process is automated. In this proposed system all the machines to work on its own with the help of inputs received from the sensors which are monitoring the agricultural land round the clock and a single person is enough to monitor whether everything going normal. The entire process is controlled and monitored by programmable logic controller. Above process is transmitted to the user using ZigBee network. Agricultural process involves seeding, ploughing, irrigation, planting, fertilizing, weeding, harvesting. Here three processes can be implemented. The main objective is even a professionals can work in the agricultural field. This idea is implemented in future there is remarkable change in the agricultural field. In general the manual cultivation for one acre of land requires money of around Rs. 15,000-17,000 but due to this technique we reduce the cost and is nearly Rs. 9,000-10,000 only and also the yield is high when compared to normal one.

Key words: Wireless sensor networks, programmable logic controller, ZigBee, graphical user interface, level sensors, photoelectric sensors

INTRODUCTION

Wireless Sensor Networks (WSNs) are the most popular technology used nowadays. WSNs are preferred mainly for low cost, power consumption is less when compare to other networks. It contains multifunctional sensors. Sensors are used for sensing, processing the obtain data and also provide communication between components. Sensor networks provide two improvements when compare to normal sensors which are used traditionally (Akyildiz *et al*., 2002):

- Sensors can be used in far distance
- Sensors that provide only sensing operation may be deployed

Sensor network consist of sensor nodes. There is no need of predetermining the location of the nodes where it should be placed. This is very helpful in relief operation if any disaster occurs. Sensors consist of onboard processor. It is very useful in performing small computation operation locally. Sensor network are used in various applications. Some of the applications like temperature monitoring, soil makeup, humidity, noise level, lightening condition, mechanical stress level and vehicular movement. Sensor networks are employed in various fields (Akyildiz *et al*., 2002). In

military application they are used to analyze assessment of damage, biological attack detection and battlefield surveillance. In environmental application like fire detection in forest, flood detection etc. Health applications like monitoring of human health condition, monitoring drug administration etc. (Akyildiz *et al*., 2002).

There are lots of factors that influence the design of sensor networks. These factors include scalability, production cost, operating environment, power consumption, and transmission media (Akyildiz *et al*., 2002).

The Programmable Controller (PC) is also called as Programmable Logic Controller (PLC). It is a computer technique and this technique is used to control relay. It is used in various industrial applications. PLC provides several advantages. PLC provide high performance, easily connected to the computers, highly reliable, simulating a variable is possible. It is mainly used in agricultural field mainly for controlling the mechanical level (Lixin *et al*., 2010). PLC is low cost, light weight and highly flexible. For programming ladder diagram is used. PLC is used in lot of applications like military, home automation, industrial application etc. (Yilmaz, 2010).

ZigBee protocol is well suited for wireless sensor network. ZigBee network contain sink node, routing node and terminating node. The sink node is made to be initialized first. During initialization the parameter for network and equipment are configured. The sink node after initialization selects the channel and performs connection in the network. It is responsible for managing the network. It is also has the control over join and leaves of the node. Routing node can be join or rejoin the network. It will scan the channel if it adds new network. If it is rejoined it will find the parent node. This routing node acts as a sink node after entering the normal operation. The terminal node can also join or rejoin the network. The terminal node in normal operation just sends or receives data. It takes nearest sink or routing node as a parent node.

ZigBee network has four layers based on ISO OSI model. They are physical layer, media access control layer, network layer and application layer. Basically the ZigBee network involves network creation, transmission of data and performing task treatment (Tao *et al*., 2011). ZigBee module is based on IEEE 802.15.4 standard. It is used in wireless transmission over the range of 100 m (Idris *et al*., 2009). Photoelectric sensors are used for calculating distance, pressure and absence of object with the help of light transmitted and received. Level sensor calculate the level of the substance that flow, for example liquids, granular or powder. Ultrasonic sensor produces high frequency and calculates an echo. It evaluates the time interval for the calculation of distance by sending and receiving the signal.

In this study three modules has been proposed (1) irrigation, (2) seeding and (3) ploughing. In irrigation process the water level is sensed by the sensors and the information are processed by the controller and transmitted over the ZigBee module. At the base station the data is received by the ZigBee module and transferred to PC through RS232 interface. Further controlling commands can be given by the user through PC (Rasin *et al*., 2009).

The automatic irrigation is made possible by using two sensors. These are moisture sensor and temperature sensor. Depending on the need of the soil the water is made to be supplied. The data will be processed by the controller. Depending on this data the motor is operated and required amount of water is supplied (Sudha *et al*., 2011). The content of moisture in soil is measured. Irrigation system plays an important role in the conservation of groundwater resources (Jayapiratha *et al*., 2010).

In seeding, the process is performed by placing the tray over the machine rack. It is made to be controlled by the PLC. After the power is on the PLC checks the entire set up. The motor is made to be on. The tray is moved forward. After reaching the seeding area it is sensed by the sensor and

appropriate action takes place (Lixin *et al*., 2010). Seeding process can be made in controlled manner. Over dosage can be avoided and yield of crop will be increased (Mussavi *et al*., 2009).

In ploughing process, PLC controls the movement of tractor. The appropriate depth of the soil to be ploughed must be determined first. Then the soil penetrometer and shearometer unit must be lowered in order to make the three point linkage perpendicular to the surface. The PLC must be programmed to record the measurement (Boon *et al*., 2005). This method is highly adaptable and easy to manage. Capitalisation cost is less when compare to other methods (Seidi *et al*., 2009). Fertilization process helps in improving quality of soil and helps to yield high crop production (Akhtar *et al*., 2001). The remaining part of this study deals with irrigation system, drain out process, seeding process and ploughing process.

MATERIALS AND METHODS

The PLC unit includes input module, output module and processing unit. The signal from the environmental sensor is given to the sensing unit. The output from the sensing unit is given to the input module of the PLC. The type of PLC which can be used here is Allen-Bradley (AB Type). Then, the output will be given to the processing unit. Processing unit will process the output according to our programming code. The programming language for PLC is ladder logical diagram. To drive the PLC the power unit is given. The output from the processing unit is given to the output unit of the PLC. Then the PC is interfaced with the PLC through RS-232 cable. The output is given to the control unit. From the control unit each module can receive the output signal. The overall block diagram of this study is shown in Fig. 1.

IRRIGATION SYSTEM

The field can be separated into several parts as per the following diagram. PLC technique is used to control the irrigation process with the help of solenoidal valve, capacitor type level sensor, PVC pipes. In the same construction drain out process can be achieved, for that level sensor can be placed in path way. The block diagram of irrigation system is shown in Fig. 2.

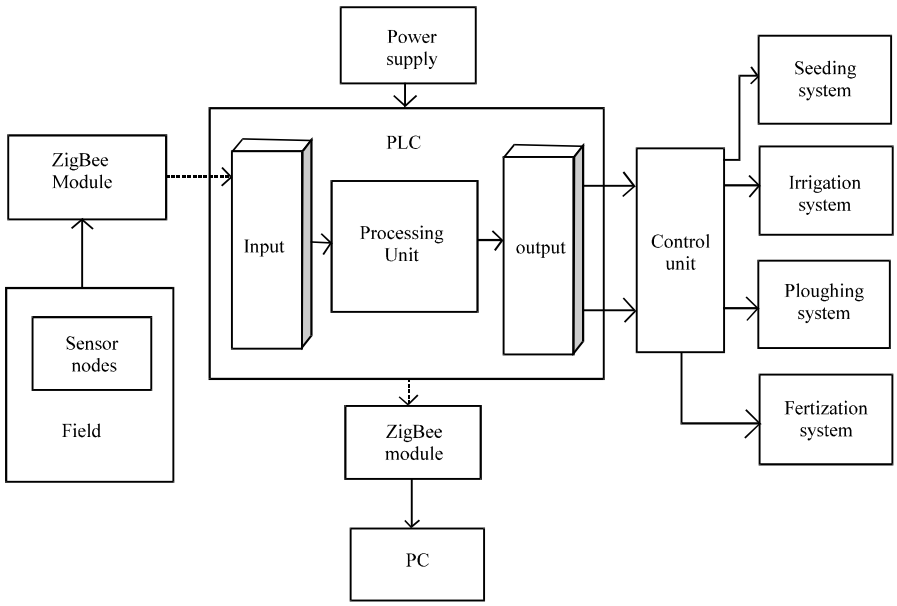

Fig. 1: Block diagram

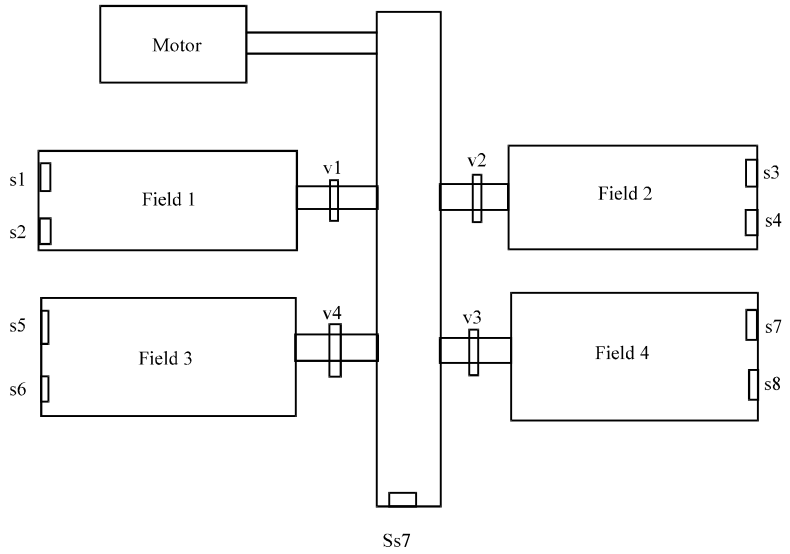

Fig. 2: Block diagram of irrigation system

Motor can be started automatically with the help of PLC to supply the water. At the end of each field the level sensor is placed, likewise in front of each field valve is placed. Initially the valve V4 is in closed position. After sensor S7 sensing the water, the valve V4 is made to be opened by using the PLC controller. After sensor S5, S6 sensing valve V4 can be closed and V3 can be opened. After sensor S7, S8 sensing the valve V3 closed and V1 can be opened. Then, again S1, S2 can be sense the water level. After that V1 is closed and V2 can be opened. Finally sensors S3, S4 can be sense the water level. After sensing, valve V2 can be closed. After finishing all this process the motor can be switch off automatically by the controller.

DRAIN OUT PROCESS

For drain out process, the level sensor can be placed in path way of the field. If the level sensor senses the water level and if the calculated level is above the threshold level, it will open the outlet valve which is placed in the path way of the field. Through, this outlet valve the water can be drained out.

SEEDING PROCESS

For seeding process photoelectric sensor, conveyor motor, PLC technique can be used. Photoelectric sensor is used for sensing the plastic tray. Induction motor can be used to rotate the conveyor. It shows how the seeding arrangement can be done. Plastic tray is kept at initial position of the conveyor. Induction motor rotates the conveyor so the tray can be move and reaches the position of sensor 1. The photo electric sensor sense the object then it stop running motor. Seeding set up is shown in Fig. 3.

At the same time the tray can be filled by soil by opening solenoidal valve. After specific period of time the motor start rotate. This will be achieved through the PLC timer. Initially in our program the timing of PLC timer can be assigned. Then the tray moves and reaches the position of sensor 2. In that water is sprayed above the soil. After some period of time the tray will move and reaches the position of sensor 3 where the seed made to be injected. Then, again the tray can be moved and reached the position of sensor 4 and the tray is filled with the soil. Finally, the tray can be placed

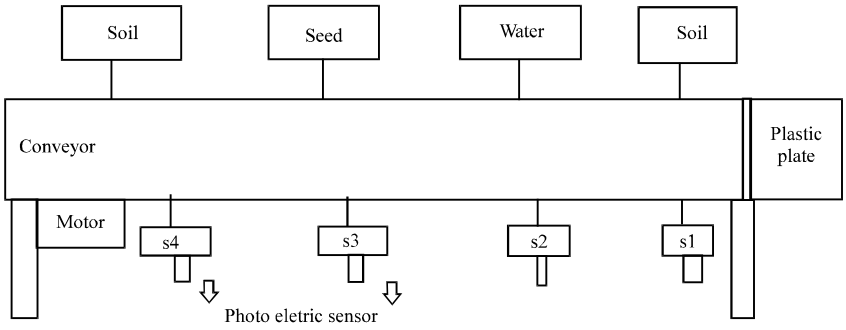

Fig. 3: Seeding process

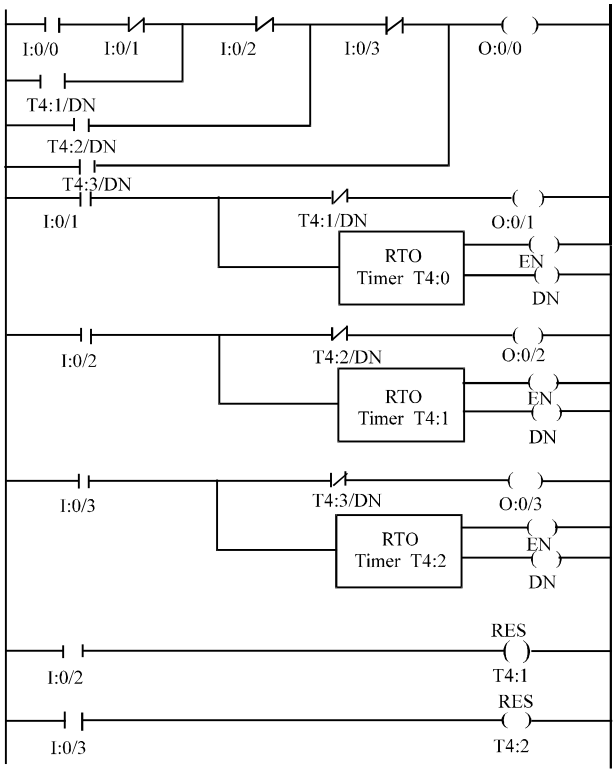

Fig. 4: Ladder diagram for seeding process

in the field by manual. The ladder logic diagram for this process can be shown in Fig. 4. The mechanical arrangement of seeding system is shown in Fig. 5.

PLOUGHING PROCESS

For the ploughing process tractor can be used for both ploughing and leveling. Modern mechanical arrangement can be placed for both plougher and leveller. In the tractor, photo electric sensor and ultrasonic sensor can be used. Photo electric sensor in made to be placed in between the headlamps and also in right and left side of the tractor as shown in Fig. 6.

The concept of robotics can be added here. On the four edge of the field also the photo electric sensor can be placed. If the tractor reached the edge of the field, it will automatically turned to the

Fig. 5: Mechanical arrangement of seeding system

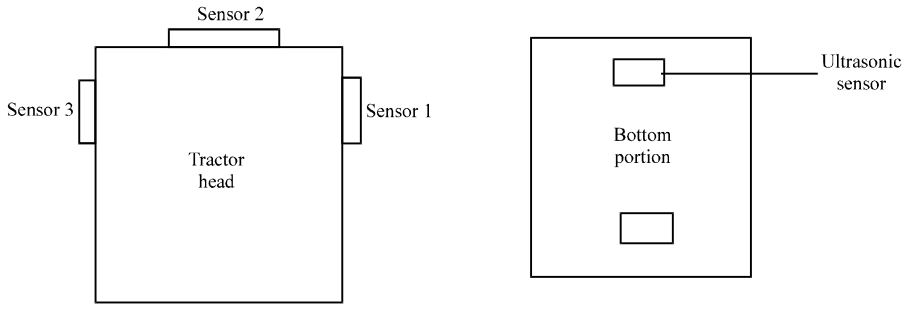

Fig. 6: Ploughing process

desired side either left or right. The photoelectric sensor used only for the control of the motion of the tractor. The ultrasonic sensor is made to be placed at the bottom of the tractor. It can be used for control the level of ploughing. Ultrasonic sensor can be used to calculate the distance to the surface to be ploughed. Sensor generates high frequency sound waves which are received back by the sensor. Sensor calculates the time interval to determine the distance of the floor. To control the steering direction of gear motor can be used. The tractor can be operated at the constant speed. Gear motor is responsible for the movement of motor. The inverter can be mounted directly to the gear motor. There is no need for cable between motor and inverter.

WIRELESS SENSOR NODE

ZigBee module: It can be used for wireless monitoring of all the process. In the base station all the process can be monitored by using Graphical User Interface (GUI). The main features of the ZigBee are low cost, reliable communication, less power consumption. ZigBee node consists of microcontroller, transceiver (cc2430), RF transmitter. The block diagram of ZigBee module is shown in Fig. 7.

Base station: The same programmed ZigBee node can be placed in base station also. It will receive the data from the sensor node. The received data from the sensor can be sent to the PC by using

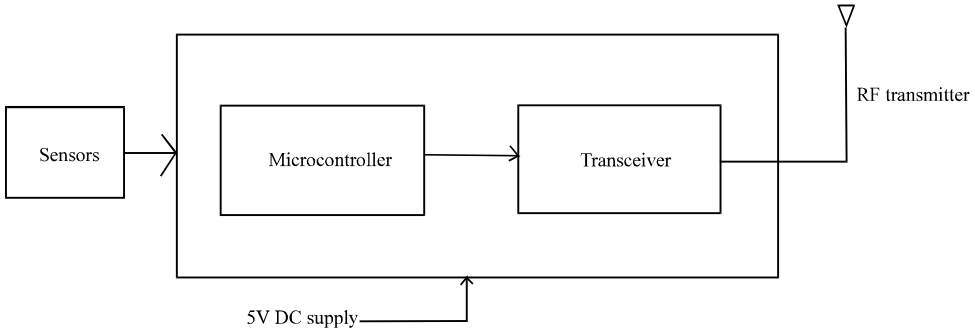

Fig. 7: ZigBee module

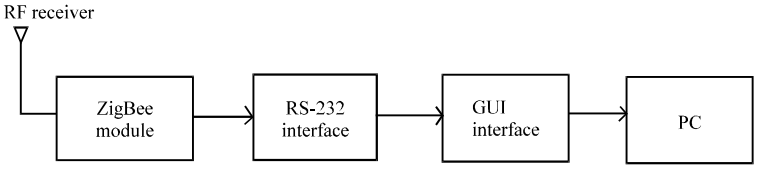

Fig. 8: Block diagram of base station

RS-232 interface. Then the received data can be displayed through the GUI Interface. Here we are using PIC microcontroller family of PIC16F8XX. The block diagram for base station is shown in Fig. 8.

CONCLUSION AND FUTURE WORK

The PLC and ZigBee device with RF functionality could control all the above said agricultural process like seeding, irrigation, ploughing and fertilizing. Irrigation system could be achieved automatically with the help of PLC and level sensor. For this, field could be separated into several parts. For seeding process photoelectric sensor and conveyor should be used. The movement of plastic tray was controlled by the conveyor motor. For ploughing process the robotics principle could added. For the control of tractor gear motor could be used. Then ultrasonic sensor and photoelectric sensor also used for ploughing process. Due to this automation of agricultural process the cost for maintaining the field also reduced. Mixing of fertilization in a correct ratio will be done using PLC. Then, it is converted into liquid form by supplying water. Then, it will be stirred and send through the pipe or sprayer. For this process single phase induction motor and level sensor will be used.

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