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A Low Cost Smart Irrigation Control System

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***Abstract*—This paper focus on a smart irrigation system which is cost effective and a middle class farmer use it in farm field. Today we are living in 21st century where automation is playing important role in human life. Automation allows us to control appliances automatic control. It not only provide comfort but also reduce energy, efficiency and time saving. Today industries are use automation and control machine which is high in cost and not suitable for using in a farm field. So here we also design a smart irrigation technology in low cost which is usable by Indian farmers. The objectives of this paper were to control the water motor automatically and select the direction of the flow of water in pipe with the help of soil moisture sensor. Finally send the information(operation of the motor and direction of water) of the farm field to the mobile message and g-mail account of the user.**

***Keywords*—Soil moisture sensor, Electro magnetic valve, Arduino, Raspberry-Pi, Modem, Display,Wireless Sensor Network (WSN)**

I. INTRODUCTION

In our country Agriculture is major source of food production to the growing demand of human population. In agriculture, irrigation is an essential process that influences crop production. Generally farmers visit their agriculture fields periodically to check soil moisture level and based on requirement water is pumped by motors to irrigate respective fields. Farmer need to wait for certain period before switching off motor so that water is allowed to flow in sufficient quantity in respective fields. This irrigation method takes lot of time and effort particularly when a farmer need to irrigate multiple agriculture fields distributed in different geographical areas. Traditionally farmers will present in their fields to do irrigation process. But nowadays farmers need to manage their agricultural activity along with other occupations. Automation in irrigation system makes farmer work much easier. Sensor based automated irrigation system provides promising solution to farmers where presence of farmer in field is not compulsory. A small processor programmed for control a electromagnetic valve and also compare to electromagnetic valve operate motor to start watering. Really INDIAN farmers need cheap and simple user interface for controlling sensor based automated irrigation system. Now a day's internet is widely used. Using internet farmer know about the agriculture field irrigation status. This helps farmers to know the status of farm field watering direction through a message whether the farmer is far away from field know the status of water motor is ON or OFF and direction of watering.

In this paper we present a prototype for fully automation accessing of irrigation motor where Prototype includes number of sensor node placed in different directions of farm field. Each Sensors are integrated with a wireless networking device and the data received by the "ATMEGA-328" microcontroller which is on a "ARDUINO-UNO" development board. The RASPBERRY-Pi is use for send messages through internet correspondence to the microcontroller process. For experimentation we have abstracted number of soil moisture sensor used in different direction of the farm fields. The soil moisture in each direction of field is sensed by sensor node and the sensed data is sent to microcontroller node through wireless networking device. On receiving sensor value the controller node checks it with required soil moisture value. When soil moisture in a particular field is not up to required level then controller node switch on the motor to irrigate associated field and the RASPBERRY-Pi process all data and notification SMS is send to registered mobile phone which is registered in RASPBERRY-Pi. The RASPBERRY-Pi is monitoring with a screen to see the current status of the irrigation and use for change the setting of user required.

II. IMPORTANCE OF IRRIGATION

The rainfall of in our country depends on monsoons. Rainfall controls agriculture, but the agriculture is said to be "the gambling of the monsoon" as the monsoon rainfall are uncertain, irregular and uneven or unequal. So irrigation is essential for agriculture.
In INDIA there are 80% of the total annual rainfall occurs in four months, i.e. from mid June to mid October. So it is very necessary to irrigation for farm field during the rest of the eight months [1].

III. METHODS OF IRRIGATION

There are different types of method for irrigating farm field for different types crop field. Basically Indian farmer use these three methods channel system, sprinkler system, drip system. Channel system is a traditional method of irrigation. But a

smart irrigation system is a new technology to irrigating farm field automatically.

A. Channel System

This system is widely used in farming irrigation system. As this system is a very low cost system for irrigating a large area farming field. In this system pipes are connected with a water pump and while pump started water flow through pipe a from lake, river, bore well to farming field. And the farmer fully engaged for irrigating the crop field with number of workers. Huge amount of water waste and large number of workers are engaged during watering.

Figure 1
CHANNEL SYSTEM IRRIGATION

B. Sprinkler System

This system is more useful whether the water is available in smaller quantity. When pump started then water flow through main pipe and also flow through the perpendicular pipes. A nozzle on the top of perpendicular pipe is joined and rotating automatically at regular intervals. This system is very useful on the sandy soil. Less number of worker required water waste is less [1].

Figure 2
SPRINKLER SYSTEM IRRIGATION

C. Drip System

In this system waterfall drop by drop at the position of the roots. It is the best technology for watering fruit plants, gardens and trees. Water flow through a main pipe and divided into sub pipes. Special prepared nozzles are attached to these sub pipes . In this system waste of water is very less and No worker need for irrigating. When the farmer knows the status of the farm field then start the motor and chose the direction from nozzles. Then automatically watering the plants and after some time the farmer check the status of the field and while the whole crop are irrigating then OFF the motor [1].

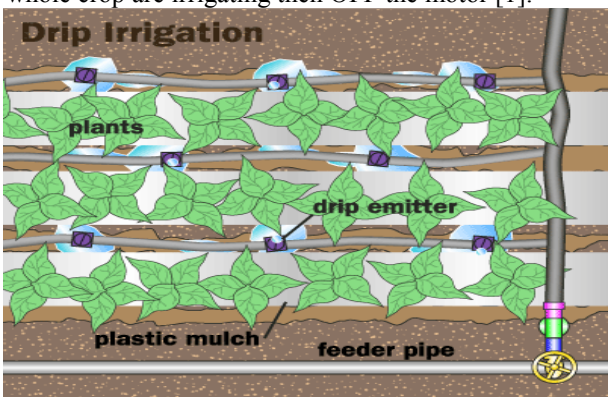

Figure 3
DRIP SYSTEM IRRIGATION

D. Smart Irrigation System

Above three systems are generally operate by a user but a smart irrigation tells that the total system is controlled by autonomous mean automatically control the total irrigation system whether the farmer is not present his farm field and send messages to the farmer about the information of farm field and change in operation of the farm field. Which require no worker for operating, and also less waste of water with compared to previous three methods.

Figure 4
SMART IRRIGATION SYSTEM

IV. SYSTEM COMPONENTS

A. Soil moisture Sensor

Soil moisture sensor includes comparator (LM393) which converts analog data to discrete. Two soil probes consist of two thin copper wires each of 5 cm length which can be immersed into the soil under test. The circuit gives a voltage output corresponding to the conductivity of soil. The soil between the probes acts as a variable resistance whose value depends upon moisture content in soil. The resistance across soil probes can vary from infinity (for completely dry soil) to a very little resistance (for 100% moisture in soil) his variation in resistance across the probes (R_S) leads to variation in forward-bias voltage which leads to corresponding variation

in input base current (I_b). For common emitter configurations $I_c = \beta.I_b$, where β is current amplification factor. Hence a small variation in base current leads to a large variation in emitter current and hence the emitter voltage is taken as the voltage output of sensor [4].

B. Arduino

The Arduino-Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started [8].

SUMMARY OF ARDUINO-UNO BOARD

ATMEGA328	MICROCONTROLLER
5V	OPERATING VOLTAGE
7-12V	INPUT VOLTAGE (RECOMMENDED)
6-20V	INPUT VOLTAGE (LIMITS)
14 (OF WHICH 6 PROVIDE PWM OUTPUT)	DIGITAL I/O PINS
6	ANALOG INPUT PINS
40 MA	DC CURRENT PER I/O PIN
50 MA	DC CURRENT FOR 3.3V PIN
32 KB (ATMEGA328) OF WHICH 0.5 KB USED BY BOOTLOADER	FLASH MEMORY
2 KB (ATMEGA328)	SRAM
1 KB (ATMEGA328)	EEPROM
16 MHZ	CLOCK SPEED

C. Raspberry-pi

The Raspberry Pi is a small, powerful and lightweight ARM based computer which can do many of the things a desktop PC can do. The powerful graphics capabilities and HDMi video output make it ideal for multimedia applications such as media centres and narrowcasting solutions. The Raspberry Pi is based on a Broadcom BCM2835 chip. It does not feature a built-in hard disk or solid-state drive, instead relying on an SD card for booting and long-term storage [9].

Specifications:

Chip Broadcom BCM2835 SoC
Core architecture ARM11
CPU 700 MHz Low Power ARM1176JZFS Applications Processor
GPU Dual Core Video Core IV® Multimedia Co-Processor
Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode
Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
Memory 512MB SDRAM
Operating System Boots from SD card, running a version of the Debian Linux operating system
Dimensions 85.6 x 53.98 x 17mm
Power Micro USB socket 5V, 1.2A

Connectors:

Ethernet 10/100 BaseT Ethernet socket
Video Output HDMI (rev 1.3 & 1.4)
Composite RCA (PAL and NTSC)
Audio Output 3.5mm jack, HDMI
USB 2.0 Dual USB Connector
GPIO Connector 26-pin 2.54 mm (100 mil) expansion header: 2x13 strip. Providing 8 GPIO pins plus access to I²C, SPI and UART as Well as +3.3 V, +5 V and GND Supply lines.
Camera Connector 15-pin MIPI Camera Serial Interface (CSI-2)
JTAG Not populated
Display Connector Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane
Memory Card Slot SDIO

D. Electro magnetic valve

The solenoid is an electromagnetic part of a valve, comprised of a coil, core tube, core and enclosure. The selection of 2-way, 3-way and 4-waysolenoid valves, designed to handle the most demanding fluid control applications.

Figure 5
3-way Electro Magnetic Valve

3-Way Electromagnetic Valves have three pipe connections and two orifices. When one orifice is open, the other is closed and vice versa.Which is automatically controlled by the water requirement of sensor node.

V. CONTROL SYSTEM

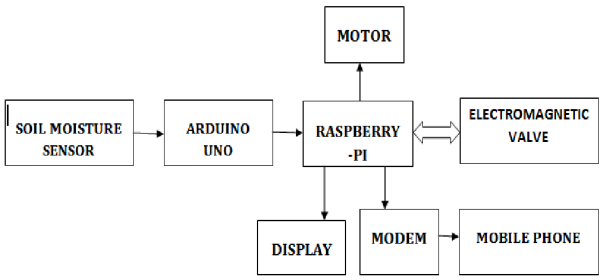

Figure6
FUNCTIONAL BLOCK DIAGRAM

Soil moisture sensors are used to sense the moisture level in soil and send the data to wireless network device and the data from network device send to ARDUINO-UNO where an ATMEGA-328 Microcontroller process the data and calculate the percentage of dryness. The sensor data are voltage values so calculating percentage of dryness from voltage values using an algorithm

Voltage= sensor value*(5/1023)
Percent= (voltage/5)*100

The ARDUINO board has 10-bit analog to digital converter.This means that it will map input voltages between 0 and 5 volts into integer values between 0 and 1023.This yields a resolution between readings of: 5 volts / 1024 units or, .0049 volts (4.9 mV) per unit.It takes about 100 microseconds (0.0001 s) to read an analog input, so the maximum reading rate is about 10,000 times a second [8]. Which generate a large number of data so we take a delay of 5minute. In each 5 minutes ARDUINO give one output value of percentage in dryness. The value of dryness fed to the Raspberry-Pi to control the electromagnetic valve and operate motor. User knows the status of the farm field through a message to the registered mobile number.

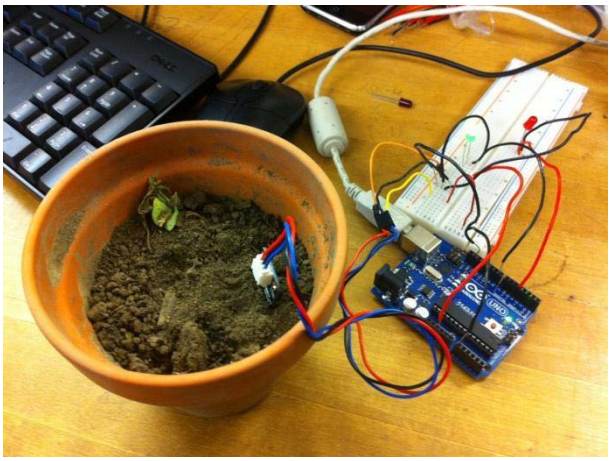

Figure7
ARDUINO UNO and SOIL MOISTURE SENSOR

The RASPBERRY-Pi is used for control the irrigation system and connects with internet to send data to the registered mobile number. Automatic message sending is developed using python programming in raspberry-pi. If the farmer is far away from his field he always update with his field status through mobile message or Gmail. The raspberry-pi check the condition in which direction of the farm field is dry then it open the electromagnetic valve at the correspondence direction and then ON the pump.

VI. PROPOSED SYSTEM

In a large area of farm field there is use a large number of pipes for watering plants in different directions from the socket of motor. Which is changed by the farmer to irrigate a particular direction of the field. But use of electromagnetic valve the pipe system are always connected and electromagnetic valve automatically change the direction of the water required area of the field and the valve is controlled by the Raspberry-Pi. While the valve is open then the water motor ON automatically. And send a message to the registered mobile number and registered g-mail account. By which farmer know the status of the farm field while farmer far away from field.

In a irregular surface of the field there are use a large number of sensors and wireless networking devices which is increase the cost of the smart system. So in this we focus to decrease the number of sensors and wireless network devices. The farm field covered by the set of *n* sensors distributed randomly over a 2-D plane. Normally farm fields are irregular in surface area. So change inside of an irregular surface area to square. which is shown in Figure 8.

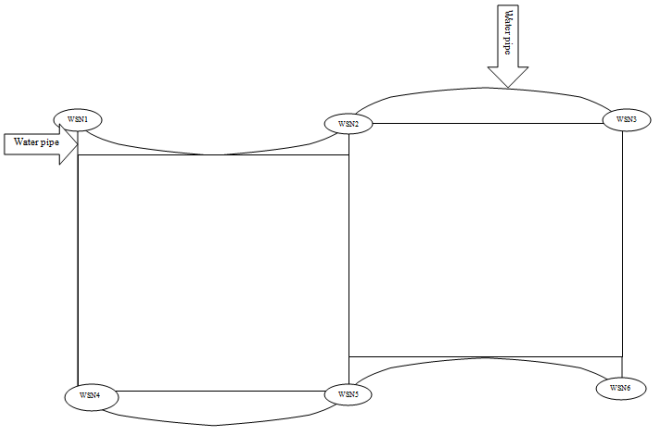

Figure 8

Irregular area and less number of sensors use

Sensors are deployed in each corner of the irregular area and then design the inside of an irregular surface like square and then sensors are deployed in each corner of the square. Which required less number of sensors. Each sensor node connect with a wireless network devices.

A. Network Model

An algorithm called Local Shortest Path(LSP) use for control in wireless multiple networks. In this algorithm each WSN device computes the shortest paths connecting itself to the nearby WSN devices based on some link weight function[17].

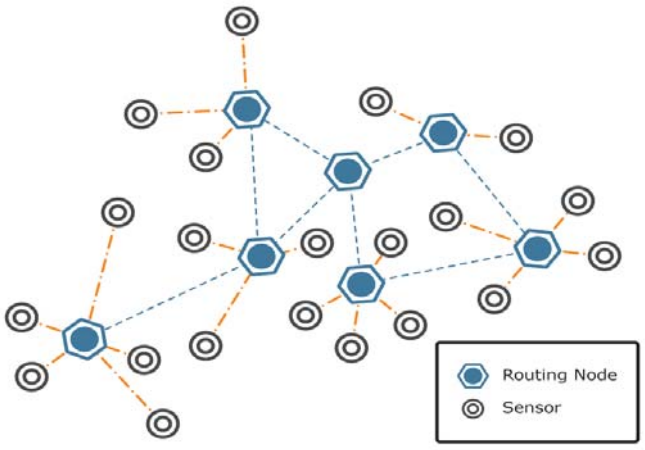

Figure 9

The sensor nodes and wireless network devices are powered by battery with limited power source. Therefore, the energy consumption of the sensor nodes is treated as the most serious issue for the long operation of the WSN. Clustering WSN devices is an efficient technique which is known for energy saving of the sensor nodes[13].

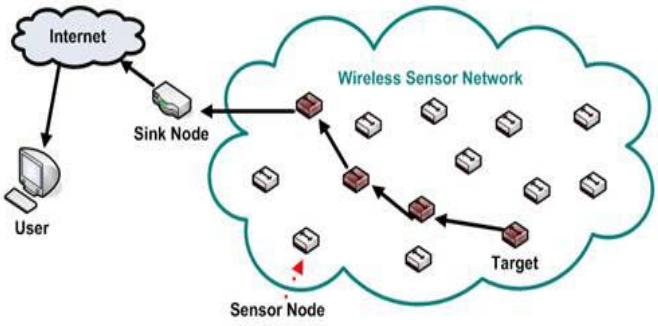

Figure10

A two-tire WSN is formed by grouping sensor nodes into clusters in the lower tire. In each cluster there is a cluster head(CH) and remaining nodes are cluster members(CMs). CMs collect the data and send to the CH. The CH then send the aggregated data to the sink directly or via other CH. There are two types of communication between CH and sink i.e., single-hop communication and multi-hop communication. In single-hop the CH directly connect to sink and the multi-hop the CH connect via other CH to sink. Each CH distributes and transmits the data packet to the sink so that the load of the forwarding nodes is balanced and the energy consumed by the CH is minimized in the process of data routing[13].

B. Energy Model

The energy model of the sensor node is adopted from [16]. The energy consumed to transmit β-bit data packet over the distance $D_{(i,j)}$ where $D_{(i,j)}$ is the distance between the node i and j is given as

$$E_{tx}(i,j)=\begin{cases}(\alpha_{tx}+\varepsilon_{fs}D_{(i,j)}^{2})\beta & D_{(i,j)}<d_0\\(\alpha_{rx}+\varepsilon_{mp}D_{(i,j)}^{4})\beta & D_{(i,j)}\geq d_0\end{cases} \quad (1)$$

Where α_{tx} and α_{rx} are the energy dissipated in transmitting and receiving the data bit respectively. If the distance between the sensor and receiver is less than d_0 then free space ε_{fs} channel model is used. Otherwise multi path fading ε_{mp} channel model is used. the energy consumed in receiving the β-bit data is given by

$$E_{rx}(j)= \alpha_{rx}\beta \quad (2)$$

VII. COST ANALYSIS

In a smart irrigation system there are used a very high cost instruments to control the system. But here we use a very low cost hardwires which are easily a INDIAN farmer buy and implement in farm field. Decreasing the number of sensors are also for a cost effective of the smart irrigation system.

TOTAL COST	QUANTITY	UNIT COST	COMPONENT
Rs.200.00	1	Rs.200.00	SOIL MOISTURE SENSOR
Rs.1000.00	1	Rs.1000.00	ARDUINO
Rs.3000.00	1	Rs.3000.00	RASPBERRY-PI
Rs.700.00	1	Rs.700.00	MODEM
Rs.1300.00	1	Rs.1300.00	MONITOR
Rs 5000.00	1	Rs 5000.00	3-Way Solenoid Valve
Rs 1300.00	1	Rs 1300.00	Wireless NetworkDevice

These are the approximation value of the used hardware in a smart irrigation system which total is approximately Rs.15,000.00-20,000.00. This is very low in cost and easily implement in a farm field.

VIII. CONCLUSION

In this paper we present a prototype for automatic controlling a irrigation system. Here prototypes includes sensor node and control node. The sensor node is deployed in irrigation field for sensing soil moisture value and the sensed data is sent to controller node.On receiving sensor value the controller node checks it with required soil moisture value. When soil moisture in irrigation field is not up to the required level then the motor is switched on to irrigate associated agriculture field and alert message is send to registered mobile phone. The experimental results show that the prototype is capable for automatic controlling the experimental results show that the prototype is capable for automatic controlling of irrigation motor based on the feedback of soil moisture sensor. This system is used in a remote area and there are various benefits for the farmers. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduce the human intervention for farmers. It saves energy also as it automatic controlling the system. So there are the system is OFF when the field is wet and automatically start when the field id dry. It is implemented in all type of irrigation system (channel, sprinkler, drip). And we present also less number of sensor nodes to use in a large area of field so the cost of the system also decrease. And power consumption of the wireless network devices are also less and the system perform a long time function.

REFERENCES

[1] International journal of engineering sciences & research technology(IJESRT) survey of smart irrigation system h.n.kamalaskar* dr. p.h.zope** issn: 2277-9655

[2] water conservation potential of landscape irrigation smart controllers (m. d. dukes)

[3] Advance in Electronic and Electric Engineering.ISSN 2231-1297, Volume 4, Number 4 (2014), pp. 341-346Solar Powered Smart Irrigation System S. Harishankar[1], R. Sathish Kumar[2], Sudharsan K.P, U. Vignesh and T.Viveknath

[4] International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE) Prototype for Automatic Controlling and Remote Accessing of Irrigation MotorR.Jaichandran[1], Dr. A. Anthony Irudhayaraj[2], Surabhi[3], Rajkumar Kuila[4], Trisha Sinha[5]

[5] Hydrol. Earth Syst. Sci., 14, 141–156, 2010 Soil moisture active and passive microwave products: intercomparison and evaluation over a Sahelian site C. Gruhier[1], P. de Rosnay[2], S. Hasenauer[3], T. Holmes[4], R. de Jeu[5], Y. Kerr[1], E. Mougin[1], E. Njoku[6], F.Timouk[1],W. Wagner[3], and M. Zribi[1]

[6] soil moisture estimation using remote sensing (Jeffrey Walker[1]and Paul Houser[2])

[7] International Journal of Environmental Research and Development. ISSN 2249-3131 Volume 4, Number 4 (2014), pp. 371-374 Smart Irrigation Control System Mr. Deepak Kumar Roy and Mr.Murtaza Hassan Ansari.

[8] The Arduino Playground (http://playground.arduino.cc/)

[9] RASPBERRY-Pi (http://www.raspberrypi.org/)

[10] Practical Programming Second Edition An introduction to Computer Science Using Python 3, Paul Gries, Jennifer Campbell, Jason Montojo, Edited by Lynn Beighley

[11] An introduction to the Linux Command Shell for Beginners, Presented by: (Victor Gedris)

[12] Linux Fundamentals (Paul Cobbaut)

[13] ©Springer International Publishing Switzerland 2014, Energy-Aware Multi-level Routing Algorithm for Two-tire wireless Sensor Networks Tarachand Amgoth[1],Nabin Ghosh[2],Prasant K. Jana[1]

[14] ©Springer International Publishing Switzerland 2014, Minimum Range Assignment Problem for Two Connectivity in Wireless Sensor Networks Bhawani Sankar Panda and D. Pushparaj Sethy Computer science and Application Group,Department of Mathematics,IIT Delhi

[15] A Shortest-Path-Based Topology Control Algorithm in Wireless Multihop Networks Yao Shen,Yunze Cai,Xiaoming Xu Dept. of Automation,Shanghai Jiaotong Univ. Shanghai 200240, China

[16] Heinzelman, W.B., Chandrakasan, A.,Balakrishnan,H.: Energy-efficient communication protocols for wireless micro sensor networks. In: Proceeding of Hawaii International conference on System Science(2000)

[17] ©Springer International Publishing Switzerland 2014, A Digital-Geometric Approach for Computing Area Coverage in Wireless Sensor Networks Dibakar Saha[1],Nabanita Das[2],Shyamosree