GREEN FARMING USING PHOTOVOLTAIC ENERGY SYSTEM AND LORA TECHNOLOGY

Senthilkumar A[1], Vijayan.K[2], Malathi G[3], Senthamarai Kannan A[4], Kannan D[5], Ravichandran S[6]

[1]Faculty of Electrical And Electronics Engineering, [2]Faculty of Mechanical Engineering, [3]Faculty of Electronics and communication Engineering, [4]Faculty of Electrical And Electronics Engineering, [5,6]Faculty of Mechanical Engineering,
M.A.M. School of Engineering, Trichy-621105, (Tamil Nadu), India.

Abstract:
The pressing need for efficient water management in agriculture has led to the development of advanced irrigation systems. This abstract explores the integration of solar energy and LoRa (Long Range) technology in a smart irrigation system, aiming to enhance water conservation, crop yield, and energy efficiency.
The proposed system leverages solar energy to power sensors, actuators, and communication modules, reducing reliance on grid electricity and mitigating environmental impact. LoRa technology enables long-range, low-power communication between various components of the system, facilitating seamless data transmission across vast agricultural landscapes.
Key features of the smart irrigation system include real-time monitoring of soil moisture levels, weather conditions, and crop health, enabling precise and automated irrigation scheduling. Through data analytics and machine learning algorithms, the system optimizes water usage, ensuring that crops receive adequate hydration while minimizing wastage.
Furthermore, remote accessibility via mobile applications or web interfaces empowers farmers to monitor and control irrigation operations from anywhere, enhancing operational flexibility and decision-making capabilities.
By combining solar energy and LoRa technology, this smart irrigation system offers a sustainable and scalable solution to address the challenges of water scarcity and agricultural productivity, thereby contributing to the advancement of precision agriculture practices.

Keywords: LoRa, Soil Moisture Sensor, Arduino Micro Controller, Agriculture, Irrigation.

I. INTRODUCTION

In the face of escalating water scarcity and the imperative to enhance agricultural productivity sustainably, the integration of innovative technologies has emerged as a pivotal strategy. Among these, the convergence of solar energy and LoRa (Long Range) technology stands out as a promising approach for revolutionizing traditional irrigation practices. This introduction delineates the paradigm shift towards smart irrigation systems, elucidating the significance of harnessing solar energy and LoRa technology to optimize water management in agriculture [1].
Agriculture, as the primary consumer of freshwater resources, confronts mounting challenges exacerbated by climate change- induced water scarcity and population growth. Traditional irrigation methods, often reliant on manual intervention or outdated systems, exhibit inefficiencies leading to overuse or underutilization of water resources, compromising crop yield and environmental sustainability. In response, the concept of smart irrigation systems has gained traction, leveraging advancements in renewable energy and wireless communication technologies to reimagine irrigation practices.[2.3]
Solar energy presents an abundant and sustainable power source ideally suited for powering remote agricultural systems. Its utilization in smart irrigation systems not only reduces dependence on grid electricity but also aligns with the imperative for eco-friendly solutions. Concurrently, LoRa technology offers a robust communication infrastructure capable of transmitting data over long distances with minimal

power consumption, addressing the connectivity challenges inherent in expansive agricultural landscapes.
This paper delves into the conceptualization and implementation of a smart irrigation system integrating solar energy and LoRa technology. By elucidating the underlying principles and functionalities of such a system, it seeks to underscore its potential to revolutionize water management in agriculture. Through real-time monitoring, data analytics, and remote control capabilities, this integrated approach promises to enhance water conservation, optimize crop yield, and foster sustainable agricultural practices.[4]
In the subsequent sections, the paper will delve deeper into the components, operation, and benefits of a smart irrigation system powered by solar energy and facilitated by LoRa technology. It will explore the technical intricacies, operational efficiencies, and environmental impacts of such a system, offering insights into its potential as a transformative solution for addressing the pressing challenges facing modern agriculture.

II. METHODOLOGY

The soil moisture sensor is of variable resistance. The conductivity of the rod changes as per the soil's moisture content. If the soil get dry, the conductivity is less (and the resistance is high). So, the sensor's resistance changes from high to low, or "max" to "min", as per the soil's moisture. This change in resistance is converted into an Analog voltage output. The sensor's output voltage is given to Arduino as an Analog input.[5] It will convert it into a digital value and measure the soil's moisture level (from 0 to 100%).If the moisture level is less than the set threshold level (say, 10 or 20%), it will switch ON the relay through the transistor, by turning ON the pump the soil begins to moisture. When a set moisture level is reached (say, 90 or 95%) in both of the sensor rods, Arduino will switch OFF the relay, which turns OFF the pump. This cycle is continuous so the plant is watered when its soil becomes dry. In rainy days this system was working for reverse process. In this time we use ultrasonic sensor, its measure the water level.[6] If the water level is more than reached, the motor was working on reverse process.

Design and Selection of Components

A. Arduino Uno R3

Arduino is the main part of the project; hence it should be selected properly. In our project we have selected Arduino Uno R3 which only operates using G-codes. The Uno is a microcontroller board which is based on ATmega328P. It has a 14 digital input or output pins (of which 6 can be for PWM output), 6 analog inputs, a 16 MHz quartz crystal, an USB connection, a power jack, a ICSP header and a reset button. It has everything needed to help the microcontroller; connect it with a computer using a USB cable or give it power using adapter or battery to start.
The board consists of an **ATMEL** ATmega328 microcontroller operating at 5 V with 2Kb of RAM, 32 Kb of flash memory for remembering programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which executed about 300,000 lines of C source code per sec. The board has 14 digital I/O pins plus 6 analog input pins. There is also an USB connector for interacting with the host computer and a DC power jack for connecting an outer 6-20 V power source.

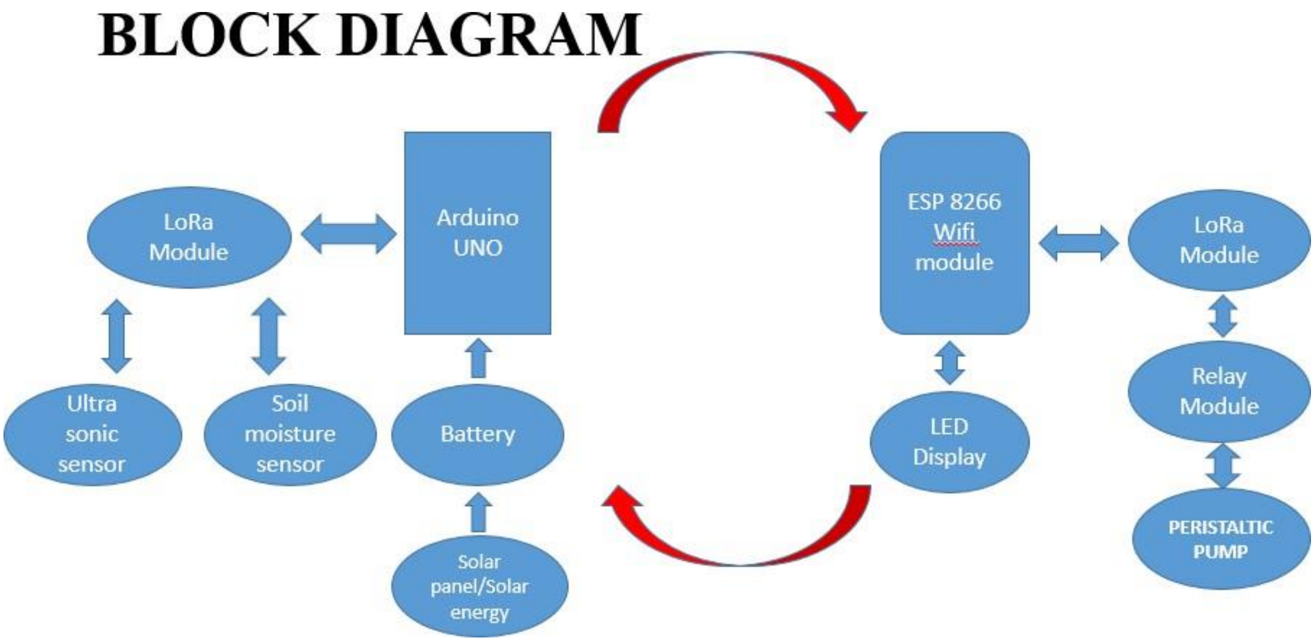
B. Soil Moisture Sensor:

Soil moisture sensors are devices used to measure the moisture content in the soil. They are commonly used in agricultural and gardening applications to help monitor and manage irrigation and watering systems. Here are some short notes about soil moisture sensors:
1. Purpose: Soil moisture sensors are designed to measure the amount of water present in the soil. This information is crucial for efficient irrigation management, as it helps determine when and how much water to supply to plants.
2. Types: There are different types of soil moisture sensors available, including tension meters, gypsum blocks, capacitance sensors, and resistance-based sensors. Each type operates based on different principles and has its own advantages and limitations.
3. Operation: Soil moisture sensors work by measuring either the electrical conductivity or the dielectric constant of the soil, both of which are influenced by moisture content. The sensors are inserted into the ground at a desired depth, and the readings are used to determine the soil's moisture level.

C. PERISTALTIC PUMP

Peristaltic pumps, or tube pumps are a type of positive displacement pump. The pumps use the principle of peristalsis as the basis for their design. Peristalsis, in a biological sense, is a series of muscle contractions that moves food to different parts along the digestive system.

III. MODELING



CNC plotting machine has control circuit diagram is shown on above fig. In the control circuit shows as all the connections and components that are required to run the plotting machine we used Arduino as controlling unit and to attach all necessary components for controlling the motion. To interface stepper motor and servo motor. To arduino controller interface we required motor driver A4988 stepper motor driver to control the stepper motor. All stepper motor and motor drivers are attached and interfaced to arduino with the help of CNC shield. Basically CNC shield has some features to control component of CNC machine like actuators, sensors and spindle and trigging signal for coolant ON & OFF. And also this CNC shield is used to power supply the stepper motor.[7]

In the CNC plotting machine firstly we have one design or part model on the designing software called inkscape and this design & drawing is converted to a 'G' code file. This file is send to arduino with the help of universal 'G' code sender software this software sends all the 'G' code & 'M' code to arduino after all that arduino has processing on the 'G' codes & 'M' codes .According to 'G' code commands. Arduino will send the particular signal to the motor driver and motor driver control the stepper motor axis with particular signals.[8]

According to particular motor running the axis of that motor start to draw. Similarly to pointer should start to draw. Similarly the pointer should get up & down this operation of pointer up & down is controlled by commands of m3 & m5. The m3 has upward and m5 for downward the pointer. With the use of all the operation particular drawing is made by the machine and we can give the command through the 'G' code sender for manual operation.[9]

IV. SOFTWARE INSTALLATION

The following software description is explained in details about that Arduino IDE and embedded c program in the bellow section.

A. ARDUINO IDE

A program for Arduino hardware may be written in any programming language with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their 8-bit AVR and 32-bit ARM Cortex-M based microcontrollers: Audio Video Receiver (AVR) Studio (older) and Atmel Studio (newer). The binary code of Arduino is shown in fig A

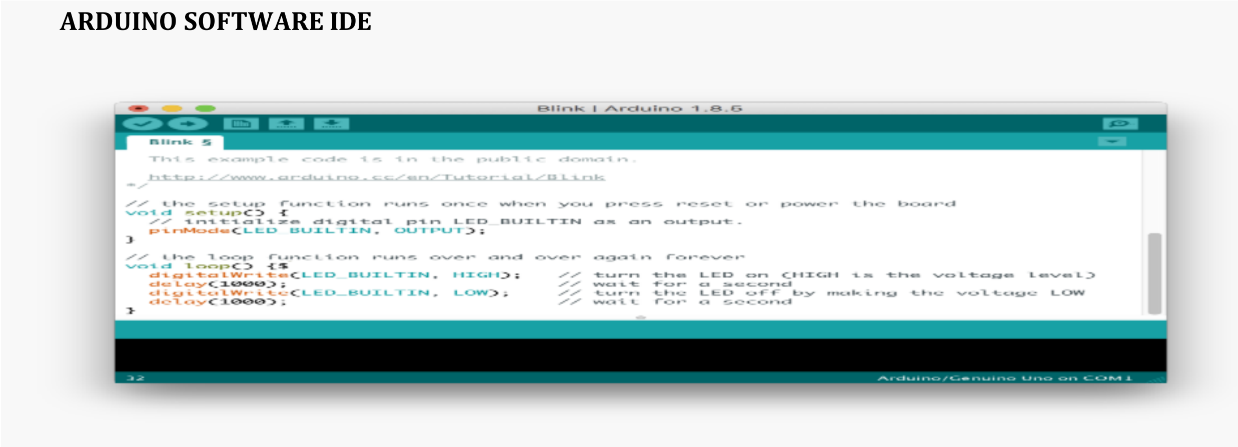


Fig A. Binary code of Arduino

Integrated Development Environment (IDE)

The Arduino (IDE) is across-platform application (for Windows, mac OS, and Linux) that is written in the Java programming language .It originated from the IDE for the languages processing and wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The source code for the IDE is released under the General Public License GNU.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop ,that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

B. Embedded C

Embedded C is a set of language extensions for the C programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems.

Embedded C programming typically requires nonstandard extensions to the C language in order to support enhanced microprocessor features such as fixed-point arithmetic, multiple distinct memory banks and basic I/O operations. In 2008, the C Standards committee extended the C language to address such capabilities by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces and basic I/O hardware addressing.

Embedded C uses most of the syntax and semantics of standard C, e.g., main () function, variable definition, data type declaration, conditional statements (if, switch case), loops (while, for), functions, arrays and strings, structures and union, bit operations , macros ,etc.

Embedded software is computer software, written to control machines or devices that are not typically thought of as computers, commonly known as embedded systems. It is typically specialized for the particular hardware that it runs on and has time and memory constraints. This term is sometimes used interchangeably with firmware.

A precise and stable characteristic feature is that no or not all functions of embedded software are initiated/controlled via a human interface, but through machine-interfaces instead.

Manufacturers build embedded software into the electronics of cars ,telephones ,modems, robots ,appliances

,toys, security systems, pacemakers, televisions and set top boxes ,and digital watches ,for example. This software can be very simple, such as lighting controls running on an 8-bitmicrocontrollerwitha few kilobytes of memory with the suitable level of processing complexity determined with a probably approximately correct computation framework (a methodology based on randomized algorithms), or can become very sophisticated in applications

V. RESULT AND ANALYSIS

This Green Farming System operates on automated mode. The main purpose of this project is to do all the functions by using Arduino UNO. Moisture level of the soil can be tested by soil moisture sensor and the pump gets ON automatically when the soil is detected dry. Our work has advantage of being extremely easy to monitor the farm in anytime. Also cost and time saving.

VI. CONCLUSION AND FUTURE SCOPE

The primary applications for this project is for farmers and gardeners who do not have enough time to water their crops/plants. It also covers that farmers who were waste the water during irrigation. As water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensing make the commercial use of this technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types perform under all conditions with no negative impact on crop yields with reductions in water use range as high as 70% compared to traditional practices.

REFERENCES:

1. "Automated Irrigation System using a Wireless Sensor Network and GPRS Module"- Joaquin Gutierrez, Etal, Volume 63 January 2019
2. "Design of Remote Monitoring and Control System with Automatic Irrigation System using GSM-Bluetooth"- Purnima,
3. Etal Volume 42, June 2020
4. Devi Kala Rathinam. D ,Surendran. D ,Shilpa. A, Santhiya Grace. A Sherin. J, "Modern Agriculture Using Wireless Sensor Network (WSN)", IEEE, 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 15-16 March 2019
5. Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides Artif. Intell. Agric., 4 (2020), pp. 58-73
6. Irrigation of world agricultural lands: evolution through the Millennia Water, 12 (5) (2020), p. 1285
7. Solar-powered automated IoT-based drip irrigation system IoT and Analytics for Agriculture, Springer (2020), pp. 27-49
8. "Micro Controller Based Automatic Plant Irrigation System"- Venkata Naga Rohit Gunturi, Volume 2, Issue 4 April l2021
9. Prathyusha.K1, G. Sowmya Bala2, Dr. K. Sreenivasa Ravi, "A real time irrigation control system for precision agriculture using WSN in Indian agricultural sectors" International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol.3, No.4, August 2020.
10. "Smart Drip Irrigation System using Raspberry pi and Arduino"- Nikhil Agrawal, Etal, 2020 J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 2020, pp.68-73.