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Original Article

Advanced method of Water Management in Paddy Cultivation using IoT

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Abstract: *The effective use of irrigation systems is critical since the major reason is a lack of land-reserved water owing to a lack of rain, as well as spontaneous water consumption, which wastes enormous volumes of water. The first stage of water irrigation in paddy agriculture is water irrigation monitoring. We have numerous steps in this monitoring to manage the water in paddy farming area using an Arduino controller. The harvesting process takes 90 days in total. This 90-day span was split into six equal sections (15*6). We must modify the water irrigation every 15 days based on the crops and the agricultural field. This controller is mostly used to keep the water irrigation running according to the crops that have been scheduled in the programme. It is used to preserve and grow the paddy by preventing it from being irrigated too much or too little. If the land's water level is low, the water pump is turned on, and it turns off automatically once it reaches the appropriate level. Another major use of this project is when the field is over-irrigated as a result of heavy or persistent rain, causing damage to the paddy. In this scenario, a shutter is set to open automatically to drain the excess water out of the farmland. While spraying pesticides and applying fertilisers, we have the flexibility to increase or reduce the water level.*

Keywords: *Automatic Watering System, Arduino Board, Sensors, Relay, Motor, Internet of Things.*

INTRODUCTION

Rice is a wonderful semi-aquatic plant that has been farmed in a variety of agro-climatic zones across the world for at least 8,000 years. Rice is the staple diet of more than half of the world's population; more than 3.5 billion individuals get more than 20% of their daily calories from rice. Asia consumes 90% of the world's rice, and total rice demand continues to climb in the region. Rice is one of India's most important crops. Furthermore, because rice is one of the main food crops, this country has the biggest area under rice production. It is, in fact, the country's most important crop. One of the main producers of this crop is India. Indian rice is well-liked over the world due to its flavour and adaptability. Rice is a good source of carbohydrate, protein, vitamins, minerals, and fibre, among other things. It grows well in humid tropical and sub-tropical climates with high temperatures and high relative humidity. Rice is the most water-intensive crop. Water is the most valuable resource and a significant driver of agricultural productivity. Water is the single most critical component for long-term rice production, especially in the Region's traditional rice-growing areas, therefore irrigation water must be handled wisely and properly. Irrigated lowland rice uses more than half of the freshwater available, while irrigated floodedrice uses two to three times as much as other cereal crops like wheat and maize. In terms of freshwater resources, rice cultivation is now experiencing growing competition from fast urban and industrial expansion. Food securitynecessitates "more rice with less water," and irrigation will play a larger role in addressing future food demands than it has in the past. Under anaerobic circumstances, continuous flooding offers a favourable water and nutrient supply. The traditional technique, on the other hand, uses a lot of water.

A few water-saving irrigation methods have been developed for rice-based systems to minimise water usage, boost water use efficiency, and maintain or increase productivity. Alternate wetting and drying (AWD) irrigation is one of the most often used methods. Water is used to irrigate the field in AWD, and it is administered according on the weather or until small cracks emerge on the soil surface. Water ponding in rice fields is one technique to fulfil these moisture demands while simultaneously lowering the risk of plant stress and yield loss. Ponding also serves to limit weed development, enhance the efficiency of nitrogen and phosphorus utilisation, and protect the crop from temperature variations in particular conditions. When cultivated on flooded soils, mostrice types sustain superior growth and yields than when grown in dry soils. Water is required to moisten the rootzone prior to seeding or transplanting. The amount of water required is determined by the soil type and depth of roots.

This proposed method for automated plant watering and soil moisture monitoring is extremely beneficial in all climates. India is a predominantly agricultural country. The majority of our people are fully reliant on agricultural harvests. Agriculture employs the majority of Indians and has a significant influence on the country's economy. Irrigation becomes difficult in arid locations or when rainfall is scarce. As a result, it must be automated for optimal plant watering and managed remotely by the farmer. When the soil becomes dry, the pump will beginto irrigate it. The goal of the implementation is to minimise water use, and automated irrigation may be employed to save time and energy. The goal of implementing this project was to show how automated plant watering can beutilised to save water while also saving time.

Dry Paddy field

Flooded Paddy field

TNAU's Coimbatore Recommendations

- Water usage is reduced by puddling and levelling. Plough with a tractor-drawn cage wheel to decrease percolation losses and save up to 20% on water usage.
- In terms of crop establishment, water usage efficiency, and yield, ploughing once with a mould-board ploughand puddling twice with a disc harrow produced the best results.
- Maintain a shallow layer of 2cm of water over the puddle and let the green manure to degrade for a minimum of 7 days for less fibrous plants like sun hemp and 15 days for more fibrous plants like Kolinchi (Tephrosia purpurea).
- When transplanting, a modest depth of 2cm of water is sufficient, since a deeper depth of water would resultin deep planting, which will reduce tillering.
- Maintain a 2 cm water level for the first seven days after transplanting. The ideal method for rice productionafter the establishment stage is periodic submergence of water. This 5cm cyclic submergence must be maintained throughout the crop cycle.
- During the summer and winter, one and three days following the disappearance of ponded water, respectively, irrigation should be applied to loamy soils.
- Irrigation should be applied soon before/immediately after the disappearance of ponded water in clay soilsduring the summer or 1-2 days after the disappearance of ponded water in the winter.
- Inadequate water during the roots and tillering stages produces poor root development, which results in lesstillering, a poor stand, and decreased yield.
- Provide adequate drainage facilities to drain excess water or strictly follow irrigation schedule of one day after disappearance of ponded water during the booting and maturity stages to advance root decay and leaf senescence, delay in heading and reduction in the number of filled grains per panicle, and poor harvest index.It's possible that the last irrigation will be 15 days before harvest.

Scheduling of irrigation to rice								
Short duration variety			**Medium duration variety**			**Long duration variety**		
Days	**No. of irrigation**	**Water level (cm)**	**Days**	**No. of irrigation**	**Waterlevel (cm)**	**Days**	**No. of irrigation**	**Water level (cm)**
Jan-25	05-Jul	02-Mar	Jan-30	05-Jul	02-Mar	Jan-35	06-Aug	02-Mar
25	-	Thin film of water	30	-	Thin film of water	35	-	Thin film of water
28	-	Life irrigation	33	-	Life irrigation	38	-	Life irrigation

29-50	6	02-May	34-65	06-Aug	02-May	39-90 or 95	Dec-15	02-May
51-70	05-Jun	02-May	66-95	08-Oct	02-May	96-125	07-Sep	02-May
71-105	05-Jun	02-May	96-125	06-Aug	02-May	126-150	05-Jun	02-May

Precautions for irrigation

- Withhold water for few days till the seedlings have established.
- Field to field irrigation should be avoided.
- Drain-off water for about 2 days prior to the application of fertilizers.
- Small bund may be formed parallel to the main bund of the field at 30 to 45cm within the field to avoid leakages of water through main bund crevices.To minimize percolation loss, the depth of stagnated water should be 5cm or less.
- In waterlogged conditions provide open drains about 60cm in depth and 45cm width across the field.Care should be taken not to allow development of cracks.
- In canal command area, conjunctive use of surface and ground water may be resorted to for judicioususe of water.
- Where irrigation facilities are not available, store all the rainwater in paddy fields by making 25 to 30cm raised bunds.
- Maintain about 8-10 cm of water level in the fields at puddling time and subsequently depth of pondedwater may be maintained throughout the growing period
- Drain-off water completely for 5 to 7 days following tillering and flowering stages. This helps toremove the toxic substances like sulphides and regulates oxygen supply to roots

Note: Stop irrigation 10 days before harvest Number of irrigation may be decided depending upon the receipt ofrain and available moisture content.

Irrigation schedule for rice under limited water resources

For summer rice under limited resources of water, phasic stress irrigation can be practised to the advantage of saving substantial quantity of irrigation water without any significant reduction in yield. About 20-30% more area can be irrigated with the same water resources by adopting any of the following phasic stress irrigation schedulesas given in the following table. Depending up on the schedule, water saving ranges from 24-36% of the requirement for 5 cm continuous submergence throughout the crop growth. Grain yield reduction in the above practice is only 0.1% to 1.6%.

Critical Stages of Irrigation and Stage-wise Water Requirement: The stage at which the water stress causes severe yield reduction is known as critical stage of water requirement. It is also known as moisture sensitive period. Critical stages of water requirement in rice are follows (a) Active tillering (b) Panicle initiation (c) Booting (d) Heading and (f) Flowering. During these stages, the irrigation interval should not exceed the stipulated time so as to cause the depletion of moisture below the saturation level. Water requirement of flooded rice varies from one stage to the other as indicated in Table 1. After transplanting, water levels should be maintained around 3 cm which gradually increased to 5−10 cm with increasing plant height and maintained at the same level until the fieldis drained 7−10 days before harvest. always Maintaining 5 cm water from heading to end of flowering stage is thebest option.

Working

An automatic plant watering system using Arduino microcontroller UNO R3 is programmed such that it gives theinterrupt signals to the motor via the motor driver module. Soil sensor is connected to the A0 pin to the Arduino board which senses the moisture content present in the soil. Whenever the soil moisture content values goes down, the sensor senses the humidity change, giving signal to the microcontroller so that the pump (motor) can be activated. This concept can be used for automatic plant watering system. The circuit comprises an Arduino UNO board, a soil moisture sensor, a 5V motor pump, a Motor driver L293D (IC1), motor driver IC to run the water pump. You can power the Arduino board using a 5V to 9V wall wart or plug-in adaptor or solar panel. You needa separate 5V to 9v battery for the pump motor.

Block Diagram

There are two functional components in this project. They are the moisture sensors module and the motor driver for motor pump. Thus the Arduino Board is programmed using the Arduino IDE software. The function of the moisture sensor is to sense the temperature content present in the soil, and also it measure moisture level in the soil. The motor driver interrupts the signal to, water pump supplies water tothe plants. This project uses microcontroller Arduino Uno board to controls the motor and monitor soil moisture. Follow the schematic to connect the Arduino to the motor driver, and the driver to the water pump. The motor can be driven by a 5 volt battery, we can also supplies power from external source or from Arduino board. The Arduino Board is programmed using the Arduino IDE software.

In figure 2 it is showing an Arduino board is an open source platform used for building electronics projects. Arduino is a programmable circuit's board which wecan write a program based on your projects. Arduino program will be uploading with IDE (Integrated Development Environment) software that runs on your computer, it is usedto write and upload computer code to the Arduino physical board. Arduino language is merely a set of C/C++ functions that can be called from your code.

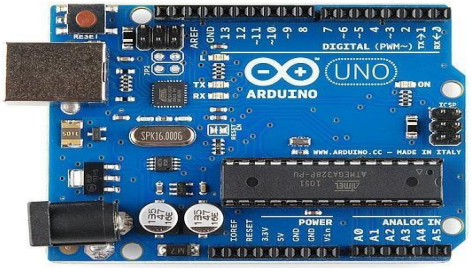
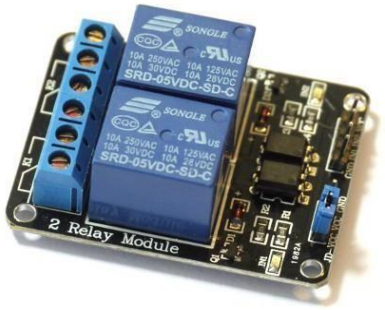


Figure 2: Arduino Uno R3 board

In figure 4, Soil moisture sensors measure the humidity of water content in soil. Since the direct hydrometric measuring of free soil wetness needs removing, drying, and coefficient of a sample, soil wetness sensors livethe meter water content indirectly by victimization another property of the soil, like electrical phenomenon, nonconductor constant, or interaction with neutrons, as a proxy for the wetness content[6].

Relay



In figure 3, shows are a relay is an electrically operated switch. Several relays use a magnet to automatically operate a switch, however alternative in operation principles are used, like solid state relays. Relays are used wherever it's necessary to regulate a circuit by a separate low-power signal, or wherever many circuits should be controlled by one signal. The essential relays were handling in long distance communicate circuits as amplifiers, they unbroken the signal coming back in from one circuit and re-transmitted it on another circuit.

Soil Sensor

In figure 4, Soil moisture sensors measure the humidity of water content in soil. Since the direct hydrometric measuring of free soil wetness needs removing, drying, and coefficient of a sample, soil wetness sensors livethe meter water content indirectly by victimization another property of the soil, like electrical

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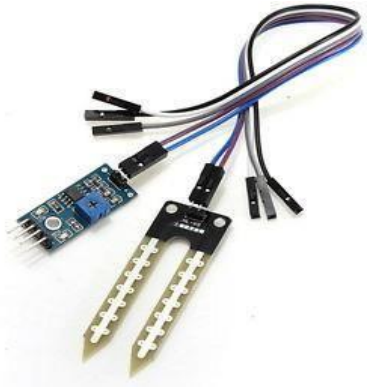

In figure: 4, L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that we can control more than two DC motor with a single L293D IC at same time.

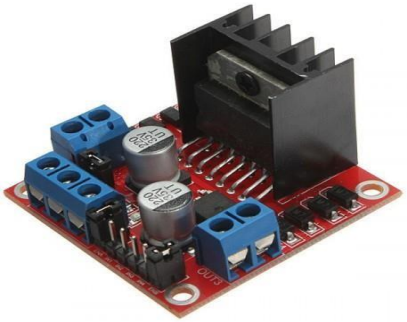

Table 1: Stage wise water requirement of paddy crop

Stages of crop growth	Water requirement (mm)	Percentage of total water Requirement
Nursery	40	3.22
Main field preparation	200	16.12
Planting to panicle initiation	458	37
Panicle initiation to flowering	417	33.66
Flowering to maturity	125	10
Total	1240	100

Source: *Kumar and Barik (2015) and ICRISAT (2019)*

Experimental setup of smart irrigation system (10)

S. No.	Component	Specification
1	Solar Panel	5W
2	Water Pump	12V DC
3	Size of plants land	0.4
4	Arduino	5 V
5	GSM SIM900 shield for Arduino	9V, Require SIM CARD,
6	Soil Moisture Sensors	4 sensors
7	LCD	I2C

CONCLUSION

Thus the "Automated Irrigation system based on soil moisture using Arduino" has been designed and tested successfully. It has been developed by integrated features of all the hardware components used. In this figure 9 is showing pin diagram of project. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Thus, the Arduino Based Automatic Plant Watering System has been designed and tested successfully [5]. The system has been tested to function automatically. The moisture sensors measure the moisture level (water content) of the different plants. If the

moisture level is goes to be below the desired and limited level, the moisture sensor sends the signal to theArduino board which triggers the Water Pumpto turn ON and supply the water to respective plant using the Rotating Platform/Sprinkler. When the desired moisture level is reached, the system halts on it's own and the water Pump is turned OFF. Thus, the functionalityof the entire system has been tested thoroughly and it is said to function successfully.

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