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Smart Irrigation System

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Abstract*: With the water requirements in irrigation being large, there is a need for a smart irrigation system that can save about 80 of the water. This prototype aims at saving time and avoiding problems like constant vigilance. It also helps in water conservation by automatically providing water to the plants/gardens depending on their water requirements. It can also prove to be efficient in Agricultural fields, Lawns Parks. As As technology advances, so does the possibility of risk reduction and easy work. Embedded and micro controller systems provide solutions to many problems. This application precisely controls the water system for gardens by using a sensor micro controller system. It is achieved by installing sensors in the field to monitor the soil temperature and soil moisture which transmit the data to the microcontroller for estimation of water demands of plants.*

Keywords: smart irrigation

I. INTRODUCTION

Watering system refers to the artificial application of water for the progress of harvest creation in the field. This field has been a central medium for food purposes over decades and decades. The main subject of this project is to make the water system easier and smart. It will make the need of the pattern in changing irrigation from a manual method to smart irrigation through the assistance of smart sensors and electrical equipment. Especially we have taken the help of soil moisture sensor detects the moisture value of the soil which leads the farmer to turn on/off of the pumping motor and in the controlled outcome, results in water and time saving of the farmer. We know that Agriculture makes a huge industrial and financial growth in our country. In that case, we have the responsibility on us to keep the growth constant and sustainable. But the only problem is water because plants need water regularly. In some areas, there is a huge water demand. In all the fields we know, technology has improved and had a great impact on them. In some agricultural cases, the farmer even doesn't know when water will come. In this case, we have to implement a smart irrigation idea to keep the morale going high and positive. To overcome this kind of crisis we have done a project, which will detect the soil moisture level and makes the delay pumping the field accordingly. It makes the system more efficient and convenient. Assume if there is rain then the rain sensor detects the reading if the reading is more than the threshold value then the pump will remain shut which results in a huge saving of water and farmers' time. Outside water investment funds can be accomplished utilizing shrewd water system innovations. Clever water system regulators and sensors have been developed to reduce open-air water usage by flooding given plant water needs compared to traditional programmed framework clocks, which flood on a client-decided fixed plan. Why brilliant water system is developed because it helps in insignificant wastage of water. It allows reinvesting in better than ever innovations that guarantee economical and dependable water systems over the long term.

II. LITERATURE SURVEY

Rafael Munoz-Carpena and Michael D. Dukes[1], smart˜ Irrigation Based on Soil Moisture for Vegetable Crops, IFAS Extension, 2005 Several key studies that may be considered for developing and applying soil moisture-based irrigation systems have been shown and supported by the literature in "Smart Irrigation Based on Soil Moisture for Vegetable Crops" by Rafael Munoz-Carpena and Michael D. Dukes in the year 2005. The˜ growing demand for irrigation techniques, particularly those requiring less water, especially with vegetable crops having higher demands is emphasized by the literature. Initial basic irrigation control was introduced with studies such as those made by Keller and Karmeli (1974) for soil moisture but laid out for later development for automated irrigation technology. Along the line of time, far more complicated systems have since been offered, which integrated advanced sensors and real-time data for dynamic adjustments on irrigation schedule dynamics seen in Allen et al. (1998) and Irmak et al. (2003). These systems ensure irrigation only when the soil moisture level is below a certain threshold. This will ensure that the water is saved without sacrificing the crop yield. Further, research by Bastiaanssen (2000) and Mulla (2004) emphasizes the integration of soil moisture measurements with environmental data, such as weather conditions, to refine irrigation practices. Such approaches enhance the efficiency of irrigation and support sustainable agriculture by minimizing water waste. Despite these advances, the challenges still facing installation cost, calibration of sensors, and the integration of multiple sources into the system remain, as outlined in various studies by Fipps (2003). Generally, the literature survey calls for smart irrigation systems based on precise soil moisture data to improve water management in vegetable crop production with benefits to sustainability and crop yield Alberto Pardossi, Luca Incrocci, Dipartimento di Biologiadelle Piante Agrarie[2], University of Pisa, Vialedelle Piagge 23, 56124-I Pisa, Italy; E-Mails: incrocci@agr.unipi.it(L.I.); g.incrocci@inwind.it (G.I.);fmalorgio@agr.unipi.it (F.M.). In the literature survey of the work by Alberto Pardossi, Luca Incrocci, and colleagues from the Department of Agricultural Plant Biology, University of Pisa, a number of key advances in soil moisture-based irrigation are examined. Studies focus on the critical role of soil moisture management in improving irrigation efficiency and promoting sustainable agricultural practices. Key works include those from Pardossi et al. (2005), who describe the importance of optimal levels of soil moisture, primarily in controlled environments like that of a greenhouse, where high-precision irrigation is considered necessary for increasing crop yields while conserving water. Moreover, the literature has extensively debated the integration of modern soil moisture sensors into automated irrigation systems. More research has been done regarding studies by Pardossi and Incrocci (2001), focusing on the optimization of irrigation schedules in preventing over-irrigation and waste through the use of real-time data from these sensors. In fact, research by Bastiaanssen (2000) and Allen et al. (1998) underscores the environmental merits of such systems, most notably in water-scarce regions. The literature also covers innovation in substrate-based irrigation systems, which are essential in controlled agricultural environment, as discussed by Incrocci et al. (2006). Such systems have been effective, although challenges such as the expensive initial costs, calibration, and maintenance, as presented by Fipps (2003) and Hanson et al. (2004), still limit their spread. In summary, climatic data with associated soil moisture readings as suggested recently in such works as Mulla 2004 and Irmak et al. (2003) present promising paths through which irrigation systems are rendered more responsive and sensitive to change in the surroundings. On the whole, therefore, the literature reveals an increasing emphasis on wateruse efficiency with smart irrigation technology leading towards sustainable crop productions. V. A. Deshpande and J. P. Prasad,[3] “Automated Irrigation System Using a Wireless Sensor Network and GPRS Module,” 2015, doi:10.3850/978-981-096200-5-d-51.In the literature survey of ”Smart Irrigation System Using a Wireless Sensor Network and GPRS Module” by V. A. Deshpande and J. P. Prasad (2015), several key studies and advancements in smart irrigation systems are discussed. There have been many studies done on the integration of WSNs in agriculture, including by Gupta et al. (2012) and Boulos et al. (2010), which point out the fact that WSNs are highly effective in providing realtime soil moisture data that helps in controlling the irrigation schedules precisely and thus avoids water wastage. Moreover, the use of GPRS technology for remote communication, as discussed by Kumar and Saini (2013) and Ahmed et al. (2014), allows farmers to monitor and control irrigation systems from a distance, thus enhancing the responsiveness of irrigation to changing soil conditions. As quoted from the literatures mentioned earlier, the advantages of automation, especially in irrigation, utilizing data from sensors are seen; benefits include water applied when really required, optimizing the amount used and increasing crop yield by Jain et al. (2010) and Sivakumar et al. (2012). The sustainability aspects of these studies by Mishra et al. (2013) and Pawar et al. (2012) point out the role of solar-powered sensors in making these systems more energy-efficient and suitable for regions without reliable electricity access. However, challenges related to sensor calibration, network reliability, and data security, as mentioned by Rao et al. (2011) and Sethi et al. (2015), continue to pose hurdles to widespread implementation. The initial high setup cost of WSN-based systems is another barrier, though IoT integration, as discussed by Kumar et al. (2015), offers a promising direction for further enhancing the efficiency of these systems by incorporating a broader range of environmental data. Overall, the literature supports the idea that smart irrigation systems using WSNs and GPRS can significantly improve water efficiency, crop productivity, and sustainability in agriculture. R. Koech and P. Langat,[4]“Improving irrigation water use efficiency: A review of advances, challenges and opportunities in the australian context,” Water, vol. 10, no. 12, p. 1771, 2018.on this liturature survey

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In the literature survey of ”Improving Irrigation Water Use Efficiency: A Review of Advances, Challenges and Opportunities in the Australian Context” by R. Koech and P. Langat (2018), the authors explore various advancements in irrigation technologies aimed at improving water use efficiency (WUE) in Australian agriculture, while also addressing the challenges posed by the country's climate. According to the research conducted by Allen et al. (1998) and Bastiaanssen (2000), the development of smart irrigation systems with soil moisture sensors, climate data, and automated control systems delivers water precisely when it is needed, as identified in the review. Moreover, the adoption of drip irrigation and microirrigation systems in which water is directly supplied to the root zone, as a critical innovation towards the reduction of wasteful water usage, has been widely adopted, as argued by Rohith et al. (2016) and Sadler et al. (2005). Stresses the importance to irrigation scheduling and water management practices, wherein researches in Keller and Karmeli (1974) and Steduto et al. (2009) optimize the irrigation timing and volume as depending directly on real-time data availability. However, Koech and Langat mention several issues in this regard, which include the high cost of implementation of advanced irrigation systems especially for small-scale farmers, and uncertainty in the availability of water due to the Australian variable rainfall and drought conditions. Moreover, they talk about climate change impacts on water resources. According to Hughes (2003) and Howden et al. (2003), warmer temperatures and changed rainfall will make water-efficient technologies crucial for sustaining agricultural productivity in the future. K. S. Harmanny and Z. Malek,[5] “Adaptations in irrigated agricultureˇ in the mediterranean region: an overview and spatial analysis of implemented strategies,” Regional environmental change, vol. 19, no. 5, pp. 1401–1416,2019.In the literature survey of ”Adaptations in Irrigated Agriculture in the Mediterranean Region: An Overview and Spatial Analysis of Implemented Strategies” by K. S. Harmanny and Z. Malek (2019), theˇ authors review the strategies aimed at improving irrigation water use efficiency in response to the unique challenges of the Mediterranean region. The paper highlights key issues such as water scarcity and climate change, which are exacerbated by the region's climate characterized by irregular rainfall and prolonged dry periods. Advancements in irrigation technologies like drip and micro-irrigation systems are emphasized, with studies like those by Pereira et al. (2012) and Lichtenberg et al. (2013) showcasing their role in reducing water wastage. The authors also discuss water conservation techniques such as rainwater harvesting and the use of treated wastewater, supported by research from Alcamo et al. (2007) and Garcia et al. (2015), which help mitigate the pressure on freshwater resources. In terms of climate adaptation, strategies like the adoption of drought-tolerant crops and improved irrigation scheduling are highlighted, as discussed by Zaroug et al. (2017) and Daccache et al. (2014). A spatial analysis included in the paper shows significant regional variability in the adoption of these strategies, with countries like Spain and Italy leading in modern irrigation practices, while others face infrastructure challenges. Moreover, policy frameworks and institutional support play an essential role in promoting efficient irrigation, as discussed by Wichelns (2015) and Ribaudo et al. (2012). The review concludes by emphasizing the need for integrated water resource management (IWRM) and a more holistic approach combining technological innovation, policy support, and local engagement to ensure the sustainability and resilience of irrigated agriculture in the Mediterranean.

III. METHODOLOGY

Assemble a smart irrigation system using the following components. First, prepare 2×3.7V 18650 LiPo batteries for use in series to achieve a sum of 7.4V. This will power the NodeMCU-ESP8266 and the 3V to 12V mini DC submersible pump. Since the NodeMCU operates on 3.3V, a DC-DC stepdown converter should be used to regulate the 7.4V from the batteries to the required 3.3V for the NodeMCU. Direct connection from the output of the 7.4V battery to power the pump; afterwards, display with the LCD with I2C and NodeMCU. VCC and GND on the LCD to NodeMCU will connect 3.3V and GND, respectively; while connecting the SDA and SCL to the D2 (GPIO4) and D1 (GPIO5), it makes possible communication of display of data, among others: moisture level, pump status, and all that needs to be read in the application.To measure the soil moisture, the Soil Moisture Sensor has to be connected: connect the VCC of NodeMCU to 3.3V and the GND of NodeMCU to GND. The sensor's analog output will be connected to the A0 pin of NodeMCU. The pump will activate through the 1-channel relay module connected to the 5V pin on NodeMCU once it is at or below that threshold. The relay will control the pump by connecting the COM terminal to the positive terminal of the pump and the NO (Normally Open) terminal to the positive terminal of the battery pack. The other terminal of the pump connects to the GND of the battery pack. Once everything is wired, program the NodeMCU to continuously

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monitor the soil moisture level. In case the soil is too dry, the NodeMCU will activate the relay, and it will water the plants through the pump. Additionally, the LCD will display real-time information regarding the moisture level and whether the pump is on or off. This smart irrigation system only activates the pump when it is really necessary for the plant watering activity, basing it on real-time soil conditions. This is further powered fully by LiPo batteries; therefore, it is a sustainable water solution to plants.

IV. CONCLUSION

Smart irrigation systems use transformational water management through technologically advanced methods with sustainable operations aimed at maximizing water in the agricultural and landscaping settings. With sensors and analytics capabilities, the systems would know exactly how much the plant needs to minimize as much waste as possible of its water, which should eventually save 50 percent water. Although the initial installment costs are higher, there are savings in water bills as well as energy cost paid back within the shortest possible period. In addition to that, smart irrigation further contributes to environmental sustainability and minimizes the carbon footprint linked to water pumping alongside preventing harmful runoff in ecosystems at local levels. Systems enhance the health of plants as there is optimal watering, thereby obtaining better crop yields and very lively landscapes. Its features include remote monitoring and integrating a mobile app, by which users can conveniently handle irrigation systems from anywhere; there is efficient water management without having to constantly monitor manually. Modern agriculture and landscaping require smart irrigation systems that provide economic, environmental, and operational advantages in support of sustainable practices.

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