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AUTOMATIC SMART IRRIGATION SYSTEM

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Abstract - This paper presents an autonomous smart irrigation system driven by a microcontroller unit. By employing sensors to measure soil moisture, temperature, and humidity levels, the system intelligently manages irrigation through control of a water pump and solenoid valves. The setup supports remote access, scheduling, and real-time notifications via integration with communication platforms. Its core objective is water conservation while maintaining ideal soil moisture, ultimately enhancing crop yield, reducing operational costs, and promoting sustainable agricultural practices. Powered by a 9–12V DC supply, the system uses soil probes to assess moisture. When dry soil conditions are detected, the micro controller activates a relay to start irrigation. This smart setup reduces human intervention, increases efficiency in water use, and is economically beneficial for modern farming.

1. INTRODUCTION

Agriculture remains a cornerstone of the global economy. With the surge in population, the demand for food has significantly increased, putting immense pressure on the agricultural sector to evolve and adopt innovative techniques. Automation in agriculture is becoming increasingly important to meet these growing demands and ensure food security. The integration of technology in agriculture can greatly enhance productivity and resource management.

Smart irrigation stands out as a vital advancement, utilizing real-time data to optimize water usage and improve crop yields while minimizing environmental impact. Data-driven agricultural methods, powered by sensors and analytics, provide deep insights into environmental conditions, enabling precise and timely interventions.

This approach also aligns with the Sustainable Development Goals (SDGs) set by the United Nations, particularly SDG 6, which emphasizes access to clean water and sanitation. Target 6.4, focusing on water use efficiency and reducing water stress, is directly addressed by implementing smart irrigation techniques. Such systems are crucial for promoting sustainable agriculture and combating water scarcity, a pressing issue due to excessive groundwater extraction and limited water reservoirs.

Despite the growing need for smart solutions, many agricultural areas still depend on outdated irrigation methods that lack adaptability to environmental changes. This highlights the urgency for adopting smart irrigation technologies that ensure efficient water use and improved agricultural outcomes.

1.1 EXISTING SYSTEM:

Traditional irrigation systems largely depend on manual operation or fixed timers. These methods are often inefficient, leading to water wastage as they do not account for variations in soil moisture or weather conditions.

1.2 PROPOSED SYSTEM:

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2.PROJECT DESCRIPTION

An embedded system is a specialized computing unit designed to perform a dedicated function. Common household electronics like air conditioners, DVD players, and printers are examples of such systems. Each of these devices includes a processor, tailored hardware, and embedded software—often referred to as firmware—designed for specific tasks.

Unlike general-purpose computers, embedded systems are resource-constrained and operate with minimal memory, often lacking secondary storage devices. They are typically required to function under strict time constraints, and in many cases, such as real-time systems, missing a deadline could lead to serious consequences. Power efficiency is crucial, especially for battery-powered devices, and these systems are frequently deployed in harsh environments.

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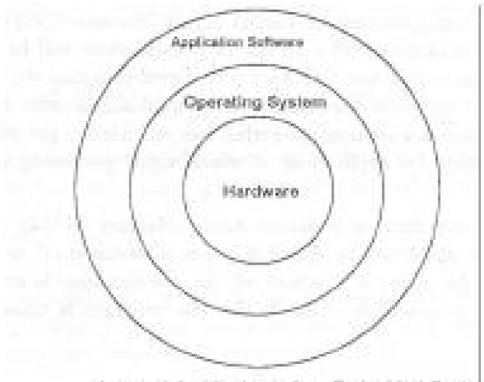
Architecture of an Embedded System

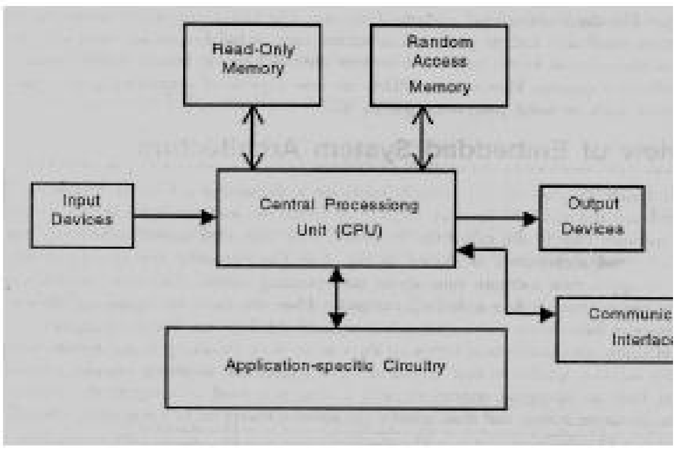
An embedded system's hardware is centered around a CPU and includes memory, input/output devices, and communication interfaces, all configured to fulfill specific application needs. Firmware, stored in memory chips, directs system behavior. The software stack typically involves an operating system layered directly on the hardware, with application-level programs running on top of it.



Layered Architecture of an Embedded System

Overview of Embedded System Architecture

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Fig. The operating system runs above the hardware, and the application software runs above the operating system.



Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are;

- Central Processing Unit (CPU)
- Memory (Read-only Memory and Random Access Memory)
- Input Devices
- Output devices
- Communication interfaces
- Application-specific circuitry

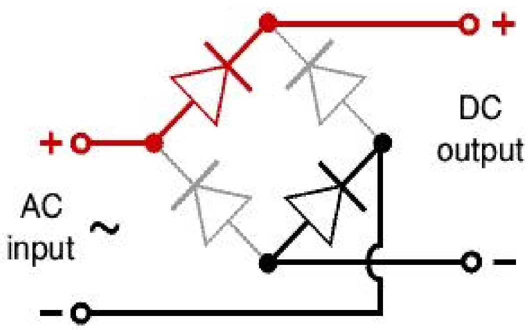
TRANSFORMER

Transformers play a key role in electrical systems by adjusting voltage levels with minimal power loss. They only work with alternating current (AC). Most irrigation systems use a step-down transformer to lower the high-voltage (230V AC in India) supply to a safer, usable voltage.

A transformer consists of two coils: a primary (input) and a secondary (output), coupled magnetically via a core. As voltage decreases, current increases proportionally, maintaining power equilibrium.

BRIDGE RECTIFIER

A bridge rectifier uses four diodes arranged in a specific configuration to convert AC to DC. When voltage is applied, two diodes conduct during each half-cycle of the input signal, allowing continuous current flow in one direction. This DC output is then used to power the irrigation system's electronic components.



3. CONCLUSIONS

In today's rapidly evolving technological landscape, automation and innovation have become crucial across all sectors, including agriculture. The introduction of smart irrigation systems offers a highly efficient, cost-effective, and environmentally conscious method of managing water resources. By automating the irrigation process with sensor-based decision-making, the system ensures timely and precise watering, reducing human effort and conserving vital resources. This approach significantly contributes to sustainable agriculture, addressing both productivity and environmental concerns..

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