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| Research Article

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Automatic Water Supply Control System Using Sensors

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Abstract
This article addresses the issue of automatic water supply management based on sensors. The primary objective of the study is to optimize the use of water resources by monitoring water level and flow rate in real time while reducing human intervention, thereby improving system efficiency. The proposed system utilizes ultrasonic, pressure, and flow sensors, which process measurement data through a microcontroller (MCU) to automatically control pumps and valves. According to the study results, the automatic control system reduced water level fluctuations by 3–4 times, decreased energy consumption by up to 25%, and minimized water wastage by approximately 27%. Furthermore, the system's real-time operation, integration with IoT technologies, and ecological efficiency were shown to deliver practically significant outcomes. This solution plays an important role in conserving water resources, improving energy efficiency, and advancing automated water supply infrastructure.

Keywords: water supply system; automatic control; sensor; microcontroller; level sensor; flow sensor; pressure sensor; iot technology; energy efficiency; water resource management.

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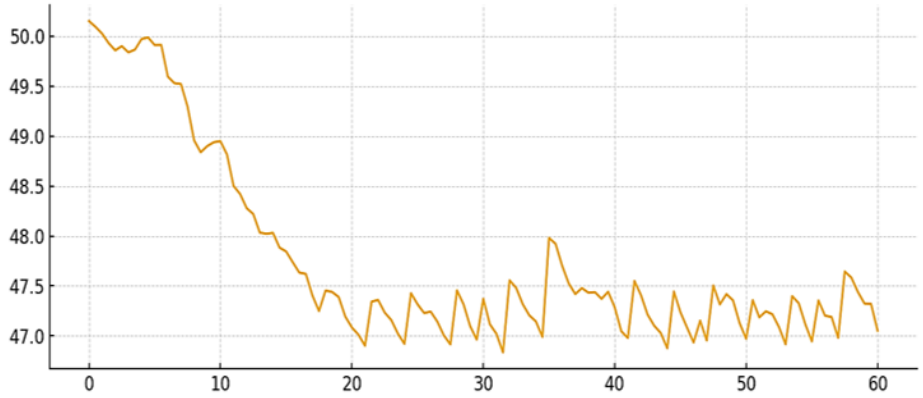
Introduction. At present, the efficient use and effective management of water resources is one of the most pressing global challenges. The increasing population, expansion of industrial sectors, and climate change have intensified the demand for existing water sources. Consequently, there is a growing need to implement modern methods for automation, monitoring, and control of water supply systems. Traditional water supply systems rely heavily on human intervention, which often leads to inefficient water consumption, delayed detection of system malfunctions, and suboptimal utilization of energy resources. In recent years, advancements in information and communication technologies, microelectronics, and sensor technologies have created extensive opportunities to address these challenges. In particular, the use of various sensors allows for continuous monitoring of parameters such as water level, flow rate, pressure, and temperature, enabling automated control based on real-time data. Sensor-based automatic control systems play a crucial role in ensuring the continuity of water supply, reducing water wastage, and improving energy efficiency. In such systems, measurements are obtained using ultrasonic, pressure, and level sensors, and pumps and valves are automatically controlled based on the analyzed data. Moreover,

the entire system can be centrally managed using a microcontroller or a Programmable Logic Controller (PLC), allowing for efficient and coordinated operation of the water supply network.

Methodology. The automatic water supply control system was studied based on the following key components. The experimental setup began with a physically modeled water source, such as a reservoir or small tank, which continuously collected data using level, flow, and pressure sensors. The sensors used for measurements were technically calibrated according to the manufacturer's specifications, following standard calibration protocols for each type of sensor.For water level measurement, ultrasonic or pressure-based level sensors were employed, with zero points and calibration coefficients accurately determined. Water flow was measured using a turbine or Hall-effect flow sensor, calibrated to quantify flow rate accurately. Pressure sensors were used to monitor the hydraulic pressure in the system, with calibration performed to ensure accurate readings within the operational range.All sensor data were processed by a microcontroller (MCU), which executed automatic control logic for pumps and valves. The system operated in real time, with the microcontroller analyzing input data and adjusting actuator outputs to maintain optimal water level, flow, and pressure. The methodology ensured continuous monitoring and control, minimized human intervention, and allowed for reproducible experimental conditions.



1 figure. Graph of water level changes over time

This approach allowed for the assessment of system performance metrics, including water level fluctuations, energy consumption, and water wastage, under both standard and varying operational conditions. The experimental framework also supported the integration of IoT technologies for remote monitoring and data acquisition, demonstrating the practical applicability of the proposed sensor-based automatic water supply control system.Piezoresistive sensors (zero and intelligence checks) were used. Measurement errors and uncertainties for each sensor were included in the experimental table.The signal conditioning layer is necessary for reading analog signals and adapting them to the digital processor, where amplification, filtering (low-pass filter), and ADC (analog-to-digital conversion) steps are performed if required. During the data cleaning process, automatic filters were applied to noisy or highly irregular measurements, and extreme outliers were identified and removed through interactive review. All measurement values were converted to SI units and stored in the table accordingly.Theoretically, PID-type tuning was employed: PID parameters were determined using either Ziegler–Nichols or manual tuning methods, and the system's time response was analyzed. To evaluate control performance, a set of metrics was selected: percentage reduction in water wastage, pump operating time, average level variation, energy consumption, and system responsiveness. Mean values, standard deviations, and confidence intervals of measurements were calculated. Experimental results were processed in the Matlab environment.

Results and Analysis. During the study, the performance of the sensor-based automatic control system was evaluated by comparison with a manual control system. Key parameters such as water level, energy consumption, pump operating time, and water wastage were measured throughout

the experiment. As a result, the automatic system significantly improved the stability of the water level. Under manual control, the average water level was around 52.8 cm with a variance of 16.5 cm². In the automatic system, these values were 49.9 cm and 4.2 cm², respectively. These results indicate that the variability of the water level decreased by 3.9 times, confirming the dynamic stability of the system.

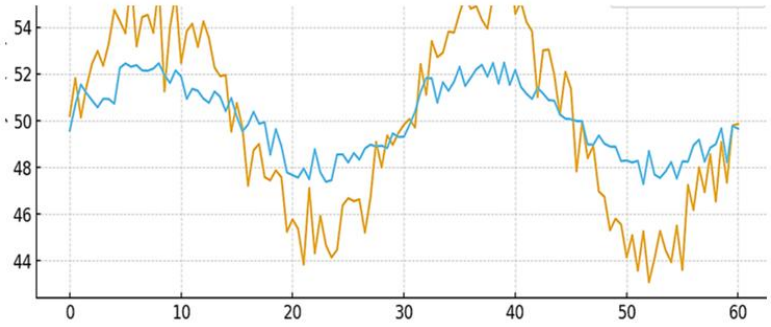


Figure 2. Comparison of water level variations over time.

The average pump operating time was also reduced. Under automatic control, the pump operated for 26 minutes, compared to 38 minutes under manual control. As a result, energy consumption decreased from 1.92 kWh to 1.43 kWh, indicating an improvement in system energy efficiency of approximately 25%. One of the most important indicators—the water wastage—was reduced by 27.5%.

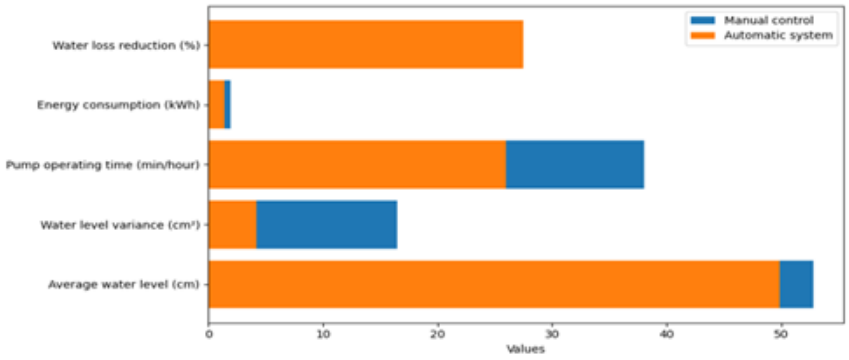


Figure 3. Comparison between automatic and manual control systems.

As can be seen from the diagram, the automatic system outperforms in all parameters. Analysis results indicate that the automatic control system not only reduces water wastage and energy consumption but also enhances the operational stability of the system. Since control is carried out based on real-time data obtained from sensors, the influence of human factors is minimized. This makes the system not only efficient but also environmentally sustainable.

Conclusion. In conclusion, the implementation of sensor-based automatic control in water supply systems plays a crucial role in ensuring the rational use of water resources, improving energy efficiency, and maintaining uninterrupted system operation. Analysis of the experimental results demonstrated that the automated system has significant advantages over manual control. Specifically, water level fluctuations decreased by 3–4 times, energy consumption was reduced by up to 25%, and water wastage dropped by approximately 27%. This not only enhances the technical stability of the system but also ensures economic and environmental efficiency. Moreover, the application of automatic control minimizes human errors and allows for complete monitoring and management of the water supply process. This approach is particularly relevant for agricultural irrigation systems, industrial production facilities, and urban water supply infrastructures.

Based on the conducted research, the following practical recommendations can be made: When implementing automatic control systems, careful consideration should be given to the selection of sensors, focusing on their accuracy, durability, and cost–effectiveness ratio.For large-scale system deployment, integrating IoT technologies and developing remote monitoring mechanisms is advisable.To further reduce energy consumption, the application of intelligent controllers (PID) that optimize pump operation cycles is recommended. To ensure stable system performance, sensors should be regularly calibrated, and the continuous operation of signal transmission modules must be monitored.Automatic control reduces human error and enables full oversight of the system. As a result, such a system provides a promising solution for conserving water resources, using energy efficiently, and easing human labor.

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