

# Intelligent Water Tap Management System Using Android Application and Microcontroller

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**Abstract.** Access to clean drinking water is a precious resource in today's world. We've designed an innovative Android-based automated tap control system to address this. This system uses the Atmega 328p microcontroller to remotely control a tap, allowing users to quickly turn it on and off via a wireless connection and a dedicated Android app. The Atmega 328p acts as the brain of the operation, regulating the tap's functionality and receiving commands from the Android app through Bluetooth technology.

Additionally, the system includes a sensor to detect user inputs, streamlining the process. We aim to create a user-friendly, remote-controlled tap control system that enables individuals to manage their water supply effortlessly using their Android devices. This promotes convenience, efficiency, and responsible water management.

**Keywords:** Android; Microcontroller; Management.

## INTRODUCTION

Water has been essential to life since the beginning of time. Water automation is a method of automating the use of water. The basic concept behind water automation is to ensure the proper use of water and reduce human effort. It is employed for various purposes such as irrigation in agricultural land, water pump control, water usage monitoring, billing of water usage, and so on, in multiple locations such as households, agricultural land, industry, hotels, and so on [1]. Every day, a massive amount of water is wasted due to the use of manual processes worldwide. The constant waste of water for manual use is lowering the earth's water level, slowly causing a lot of land to migrate into un-irrigated zones. The manual system is still used to control the tap water. In a manual water tank system, the user must be at the tap to turn it on and off. Researchers have implemented several water automation projects based on water pump controllers, water level detection, and water billing with the detection and control of water leakage. This project implemented an automatic tap control system using an Android application.

An Android application is used to control the tap on and off by connecting the Android application and the tap water through a Bluetooth connection. This is achieved with the use of an Arduino Atmega 328 p microcontroller. The microcontroller uses Bluetooth to take input from the Android application, and the input is then used to control the water taps on and off.

This project aims to build an automatic tap control system using an Android application:

- 1) Design an autonomous system that allows an Android phone to turn tap water on and off to avoid water waste.
- 2) Implement Arduino programs to establish a connection between Android applications and tap.
- 3) Test Arduino Atmega 328p microcontroller accuracy and speed with other electronics.

*Water Reservoir.* Water is the most essential natural resource for living creatures. Water scarcity is becoming the leading offender facing most cities worldwide, and wastage during transmission is a global risk. More than half of the earth's surface is covered with water, 96.5 % is salt water, and only 2.65 % is freshwater [2]. Hence, controlling and conserving the water for our future is necessary.

Because of a growing population and for daily needs, overhead tanks/ containers are installed in many areas for water storage. Traditional water tanks neither control nor save the water level in the tanks. So, human interference is required [3]. Hence, there is a need to automate the water-controlling system using technologies like the Internet of Things (IoT).

*Bluetooth Technology.* Bluetooth is a high-speed, low-powered wireless technology link to connect phones or other portable equipment. It is a specification (IEEE 802.15.1) for using low-power radio communications to link phones, computers, and other network devices over short distances without wires. Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters).

Embedded low-cost transceivers achieve it into the devices. It supports a frequency band of 2.45 GHz and can support up to 721 Kbps along with three voice channels. International agreements have set aside this frequency band for using industrial, scientific, and medical devices (ISM).rd-compatible with 1.0 devices.

It can connect up to "eight devices" simultaneously, and each device offers a unique 48-bit address from the IEEE 802 standard, with the connections being made point-to-point or multipoint. It can connect up to "eight devices" simultaneously, and each device offers a unique 48-bit address from the IEEE 802 standard, with the connections being made point-to-point or multipoint. Generally, the devices connected through Bluetooth are very secure from hacking. They work with different frequencies & the devices which jump between these frequencies are 100s of times for every second, called the "frequency-hopping spread spectrum". This device is frequently used to connect mobile devices or otherwise fixed devices. But it also works to link a printer or mouse to a computer. As Bluetooth & Wi-Fi are often complementary, they work at the same time & provide the same connectivity, so you cannot find out which hardware is connected. Most tablets, computers, and smartphones permit connecting with one device that is Bluetooth enabled at a time.

Bluetooth Network consists of a Personal Area Network or a Piconet, which contains a minimum of 2 to a maximum of 8 Bluetooth peer devices- Usually a single master and up to 7 enslaved people. A master is a device that initiates communication with other devices. The controller device

governs the communications link and traffic between itself and the associated agent devices. An agent device is a device that responds to the controller device. Agent devices are required to synchronise their transmit/receive timing with the masters.

In addition, transmissions by agent devices are governed by the controller device (i.e., the controller device dictates when an agent device may transmit). Specifically, an enslaved person may only begin its transmissions in a time slot immediately following the time slot in which it was addressed by the master or in a time slot explicitly reserved for use by the agent device.

The primary device's Bluetooth device address (BD\_ADDR) defines the frequency hopping sequence. The primary device first sends a radio signal asking for a response from the agent devices within the range of addresses. The enslaved people responded and synchronised their hop frequency and clock with the primary device.

*Water Pump.* A water pump is a machine that moves, compresses, or transfers water. Several different types of pumps are available: jet pumps, centrifugal pumps, gear pumps, peristaltic pumps, gravity pumps, and impulse pumps. All are useful across various industries. The most commonly used pump category in daily life is the centrifugal variety.

Water Pumps are vital tools for various residential, light commercial, or agricultural jobs, and especially in rural areas, they can play a critical role. A water pump can drain water from a basement or shallow flooded areas, drain and fill a swimming pool or dam, or be used in agricultural irrigation. The primary function of Water pumps is to get rid of excess water or transfer water between two points.

*Android Mobile Application.* A mobile application is a program designed to run on a mobile device such as a phone, tablet, or watch. Mobile applications often contradict desktop applications that run on desktop computers and web applications that run on mobile web browsers. The Android software development platform is among the most popular mobile application development platforms. Android software development is the process that creates new applications for devices based on the Android operating system. Applications are commonly developed using the Android Software Development Kit in the Java programming language. The Android software

development kit (SDK) includes extensive development tools [4].

Mobile applications are used for various purposes, such as medicine, blogging, newspapers, games, security, etc. Social networking companies also have their applications. Different types of automation systems are controlled using mobile applications, and they are also being used in water pump controller systems.

## Literature Review

More recently, various studies about the subject (water automation for water pump controllers) have been carried out globally. However, a review of research papers has been conducted to study how those embedded the Internet of Things into their applications. As a result, a few research papers have been reviewed.

The first review is an automated solar-powered irrigation system [4]. A model of a variable rate microcontroller-based automated irrigation system has been proposed, and solar power was used as the only source of power to control the entire process. Only by visiting the agricultural land can farmers find information about the moisture level. Farmers can control the water pump based on the moisture level by sending a message from his/her cellular phone. Even when the farmers are away, the automated irrigation system always confirms the exact water level in the agricultural lands.

The second review is an automated water tank overflow control unit integrated with a mobile application [5]. This proposes a water monitoring system with an automatic overflow control circuit unit. The proposal is based on automatically monitoring water flow into the tanks and setting it per the user's demands using a mobile application. The system's advantages are the conservation of water resources, reduction of manual attempts, and time-to-time changes in the water storage situation with the help of sensors.

Next, an automated system is described as one where a farmer can control the motor and irrigation process with the help of an Android application. The computerised control system uses microcontrollers and Bluetooth Devices. Commands are sent to the receiver to control the movement of the seeding device, either forward or backward, using the Android application and the irrigation pump, either on or off - however, no Android application interface [6].

Then, the based system is fully automated for the following article, saving human energy and time. So, there is no need to check the water level manually. In real-time monitoring, an intelligent water tank consists of a sensor that senses the water level. A microcontroller reads the sensor data and sends it to the Thing Speak cloud using its on-chip Wi-Fi to operate the system anywhere from remote areas. The motor will act automatically at the water level in the tank. GSM module is used for mobile communication to alert the user if there is any failure.

Last, the water level detection technique of smartphone water pump controllers is described [7]. A basic Android-based application model is proposed by which water pumps can be turned ON and OFF with the help of wireless radio transmitters and Wi-Fi routers. The Android app can run on Android OS versions up to 6.0.1, i.e., Android Marshmallow. The paper briefly shows the connections between the required equipment.

## METHOD

There are numerous approaches for constructing an automatic tap control system utilising an Android application and a switching device, but they all require human intervention. In this project, an automatic water tap controller using an Android app for both overhead and underground tanks with a switching device is designed using electronic control to switch on/off the tap water Android Device human. The system was meticulously designed to switch on the tap using an Android device, Bluetooth, and to turn off the tap after 30 minutes if it is not turned off. The approach used in this work is the modular design approach, and the overall design was broken into functional block diagrams where each block in the diagram represents a section of the circuit that carries out a specific function. The system in Figure 3.1 was designed using functional blocks, as shown in the block diagram below. In this method, the circuit displays the connection between the power supply, sensors, Bluetooth, Android app and Arduino to monitor and tap water.

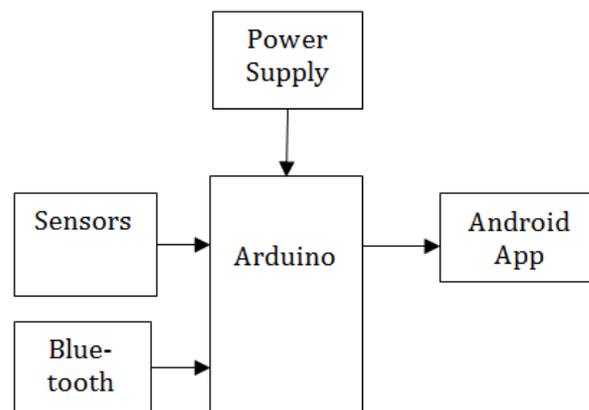


Figure 1 – Block diagram of the overall system

**Power Supply.** Figure 2 explains the power supply circuit used to power the system. This works by taking in 220 v alternating current from the wall outlet, and then it will be stepped down to 12v alternating current with the help of a transformer. Then, the 12 v alternating current will be rectified into a 12 v direct current with the help of a full bridge rectifier. A capacitor 1000 of 25 v filters the noise, and a 12 v regulator regulates the voltage to produce a constant 12 v to power the sensor. Finally, LM 7805, a five-volt regulator, regulates the voltage to 5 volts to power the microcontroller.

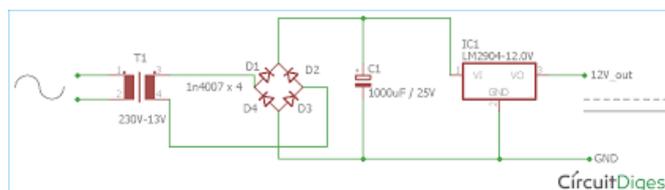


Figure 2 – Power Supply Circuit

Figure 3 Hc-06 is a Bluetooth module that establishes short-range wireless data communication between two microcontrollers or systems.

The module works on the Bluetooth 2.0 communication protocol and can only act as an agent device. This module is an intermediary between the Android application and the system. The signal is sent from the Android application via Bluetooth to the Hc-06 module, and then the signal is delivered to the Arduino microcontroller to carry out operations.

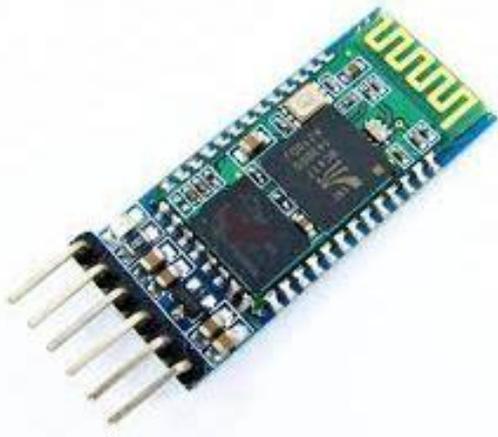


Figure 3 – HC-06 Bluetooth Module

**Arduino Controller.** An Arduino microcontroller is an open-source electronic prototyping platform based on easy-to-use hardware and software. It is intended for hobbyists, artists, designers, makers, students, and anyone interested in creating interactive objects or environments. Figure 4 shows an Arduino Atmega 328p.



Figure 4 – Atmega 328p

A water pump sensor senses the fluid flow rate through a pipeline and controls the tap. The sensor in Figure 5 controls the taps on and off.



Figure 5 – Sensor

It responds to signals sent to it from the Arduino microcontroller.

**Arduino IDE.** The Arduino IDE is a free and open-source integrated development environment (IDE) for developing Arduino programs. It is available for Windows, macOS, and Linux. The Arduino IDE provides a graphical user interface (GUI) for writing and uploading Arduino programs. It also provides a text editor for writing code, a message area, a text console, a toolbar with buttons for standard functions, and a series of menus. It is used in this project to develop, test and upload codes running on the automatic tap control system.

**Android Application.** An Android application is software designed to run on Android devices. It is written in the Java programming language and uses the Android SDK to access the features of the Android operating system. Figure 3.6 shows a picture of an Android application developed to control the on and off of the tap.



Figure 6 – Android Application

**Working.** Figure 7 shows the project workflow.

An Arduino microcontroller controls the system. The sensor reads the surrounding value and stores it in a controller. If the sensor reading exceeds the threshold value, we can start the drip using an Android app through Bluetooth.

## RESULTS AND DISCUSSION

This project aimed to develop an automatic tap control system that allows users to remotely control water flow from a tap using a mobile application via Bluetooth protocol. The system aimed to provide convenience, water conservation, and enhanced user experience. This report presents detailed results and discusses implementing and

testing the automatic tap control system using Bluetooth protocol.

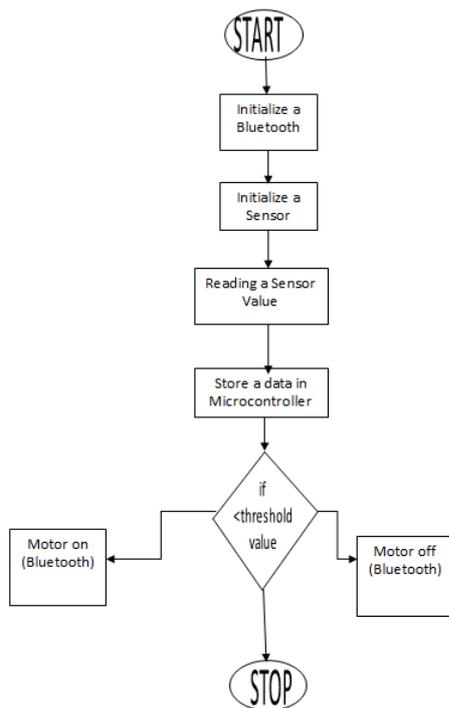


Figure 7 – Project Flowchart

Extensive testing was conducted to evaluate the performance of the automatic tap control system using Bluetooth protocol. The following results were observed.

**Remote Control Functionality.** The mobile application successfully established a Bluetooth connection with the tap control system, enabling users to control the tap remotely. The microcontroller accurately received and executed Commands from the mobile application, resulting in seamless remote control functionality (Figure 8).



Figure 8 – Complete Set Up for the Tap control System

**Flow Control.** The motorised valve integrated into the system facilitated precise control over the water flow. Users could adjust the flow rate using the mobile application, allowing customised water usage and conservation. The system demonstrated responsiveness and accuracy in implementing flow control commands.

**Connectivity and Range.** The Bluetooth protocol provided reliable connectivity between the mobile application and the tap control system. The Bluetooth connectivity range was typically up to 100 meters, allowing users to control the tap from a reasonable distance. However, to maintain a stable connection within this range, the positioning of the mobile device and the tap control system must be considered.

**User Experience.** The mobile application's user interface was designed to be intuitive and user-friendly. Through iterative testing and user feedback, improvements were made to enhance the user experience. The application provided clear options for tap control, flow adjustment, and status monitoring, resulting in a positive user experience.

During the implementation and testing phase, several aspects were discussed and addressed. These include:

1) **Security.** Secure pairing and encryption protocols were implemented to ensure the security of the tap control system. This prevented unauthorised access and ensured the integrity of the communication between the mobile application and the tap control system.

2) **Range Limitations.** Bluetooth connectivity has a limited range, typically up to 100 meters. While this range suits most residential and small-scale applications, larger-scale implementations may require alternative connectivity options, such as Wi-Fi or Internet of Things (IoT) protocols, to overcome range limitations.

3) **Power Consumption.** Efficient power management was considered to optimise the system's energy consumption during the implementation. The tap control system was designed to operate using low-power components, ensuring prolonged battery life for mobile devices and minimising overall power consumption.

The automatic tap control system using a mobile application and Bluetooth protocol proved to be a successful implementation for remote tap control.

The system demonstrated practical remote control functionality, precise flow control, and an intuitive user interface. Integrating hardware components, mobile applications, and Bluetooth connectivity facilitated seamless communication and enhanced user experience.

The automatic tap control system offers significant potential for various applications, including homes, offices, and public spaces. It eliminates the need for manual operation, promoting convenience, water conservation, and improved water usage management.

Future work can focus on expanding the mobile application's capabilities, incorporating additional features such as scheduling, water usage monitoring, and integration with smart home systems. Exploring alternative connectivity options like Wi-Fi or IoT protocols can extend the system's capabilities and adaptability to different environments.

In conclusion, the automatic tap control system using a mobile application and Bluetooth protocol presents a reliable and efficient solution for remote tap control. With continuous improvement and refinement, the system can contribute to efficient water management and enhance user convenience in various settings.

## CONCLUSIONS

In this work, we have successfully implemented "The Automatic Tap Control System" to efficiently control the on and off of tap water using an Android phone with Bluetooth with less human intervention and efficiently use water resources. The project mainly focuses on the automatic control of tap water using Android Bluetooth.

Based on the implementation and evaluation of the automatic tap control system using a mobile application and Bluetooth protocol, several recommendations can be made to improve further the system's functionality, user experience, and potential applications.

*Expand Connectivity Options.* While Bluetooth connectivity offers convenience and reliability within a limited range, exploring alternative connectivity options can enhance the system's adaptability to different environments. Consider integrating Wi-Fi or Internet of Things (IoT) protocols to enable broader range coverage and seamless integration with other smart devices or home automation systems.

*Implement Water Usage Monitoring.* Incorporate a feature in the mobile application that allows users to monitor their water usage. Providing real-time information on water consumption can raise awareness and promote responsible water usage habits. Additionally, usage data can be used to analyse and optimise water management practices.

*Integrate Smart Home Integration.* Integrating the system with existing smart home systems or platforms can enhance its capabilities. This integration can enable users to incorporate tap control into their broader home automation routines, such as scheduling tap operations based on occupancy or specific periods.

*Enhance Security Measures.* While secure pairing and encryption protocols were implemented in the current system, continuous improvement in security measures is necessary to protect the system from potential cyber threats. Regular security updates and vulnerability assessments should be conducted to ensure the system's integrity and prevent unauthorised access.

*Consider Voice Control Functionality.* Incorporating voice control functionality in the mobile application can further enhance the user experience. Users can control the tap using voice commands, providing a hands-free and convenient option for tap operations.

*Introduce Energy Efficiency Features.* Explore integrating energy-efficient features into the system. This can include incorporating sensors to detect water flow and automatically adjust the flow rate based on user-defined preferences or optimising the energy consumption of the tap control system itself.

*Conduct Field Testing in Various Settings.* Conduct field testing in various environments, such as residential, commercial, and public spaces, to validate the system's performance and suitability in different settings. Gathering user feedback in these contexts will provide valuable insights for further system refinement.

*Collaborate with Water Conservation Organizations.* Partnering with water conservation organizations can promote adopting the automatic tap control system and raise awareness about the importance of responsible water usage. Such collaborations can also facilitate access to data and resources to improve the system's water management capabilities.

*Seek Integration with Water Supply Infrastructure.* Explore possibilities for integration with the existing water supply infrastructure, such as water meters and utility systems. This integration can provide real-time data on water usage, enable efficient billing, and contribute to overall water resource management.

*Continuous User Feedback and Iterative Improvement.* Encourage users to provide feedback on their experience with the automatic tap control

system. This feedback should be collected to drive iterative improvements and ensure the system effectively addresses user needs and preferences.

Considering these recommendations, the automatic tap control system can enhance functionality, usability, and adaptability. Continued development and refinement will contribute to the widespread adoption of the system, promoting sustainable water usage practices and offering convenience to users in various settings.

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