



IOT BASED WATER CONSERVATION SYSTEM

CONTACTLESS WATER FLOW DETECTION AND WATER CONSERVATION SYSTEM

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Abstract: — In this project, a unique method for detecting and controlling water flow using a piezoelectric vibration sensor module is presented. This system's primary goal is to address the problem of water waste brought on by accidentally left open water tap. To measure water flow, the device uses a piezoelectric vibration sensor module mounted to a flat's output pipe. If the user is at home and the water flow continues for a predetermined amount of time, the system notifies them. In order to reduce water waste when the user is not present, the system operates the solenoid valve to control the main water supply. The system utilizes a microcontroller that processes the detected signal and analyzes it to determine the water flow status. The experimental results demonstrate the effectiveness of the proposed system in detecting water flow accurately and controlling it by the solenoid valve. This system can be used in various applications, including domestic, industrial, and agricultural sectors, where water wastage needs to be minimized. Overall, this project aims to reduce water wastage caused by unintentional water taps being left open.

Index Terms - Internet of Things (IOT), Flow induced vibrations, sensors, contactless water flow detection

I. INTRODUCTION

The design and development of a PROPOSED SYSTEM contain a sensor module, a home module, solenoid valve and a buzzer and involves several steps. In this system, the piezoelectric vibration sensor senses the water flow by flow-induced vibration. The sensor module is installed on the outlet pipe and is powered by solar energy. The sensor module is connected to the home module, which checks whether a person is at home or not. If the water flow time exceeds the maximum allowable time, the status will show on the display. The home device will turn off the water inlet if there is no one at home, and if someone is at home, the buzzer will notify them. This includes understanding the water consumption patterns in the household and determining the maximum allowable time for water flow. Once the requirements have been gathered, the system can be designed. The piezoelectric vibration sensor must be selected based on the water flow rate and the vibration caused by the flow. The sensor module must be designed to be compatible with the sensor and to communicate with the home device. The home module must be designed to check whether someone is at home or not and to control the water inlet.

II. DESIGN AND DEVELOPMENT OF THE PROPOSED SYSTEM

The design and development of a proposed system contains a sensor module, a home module, solenoid valve and a buzzer and involves several steps. In this system, the piezoelectric vibration sensor senses the water flow by flow-induced vibration. The sensor module is installed on the outlet pipe and is powered by solar energy. The sensor module is connected to the home module, which checks whether a person is at home or not. If the water flow time exceeds the maximum allowable time, the status will show on the display. The home device will turn off the water inlet if there is no one at home, and if someone is at home, the buzzer will notify them. This includes understanding the water consumption patterns in the household and determining the maximum allowable time for water flow. Once the requirements have been gathered, the system can be designed. The piezoelectric vibration sensor must be selected based on the water flow rate and the vibration caused by the flow. The sensor module must be designed to be compatible with the sensor and to communicate with the home device. The home device must be designed to check whether someone is at home or not and to control the water inlet. Figure 1 represents the sensor module. sensor module that harnesses solar energy, stores it in a battery, and utilizes an ESP controller to process data from a vibration sensor.

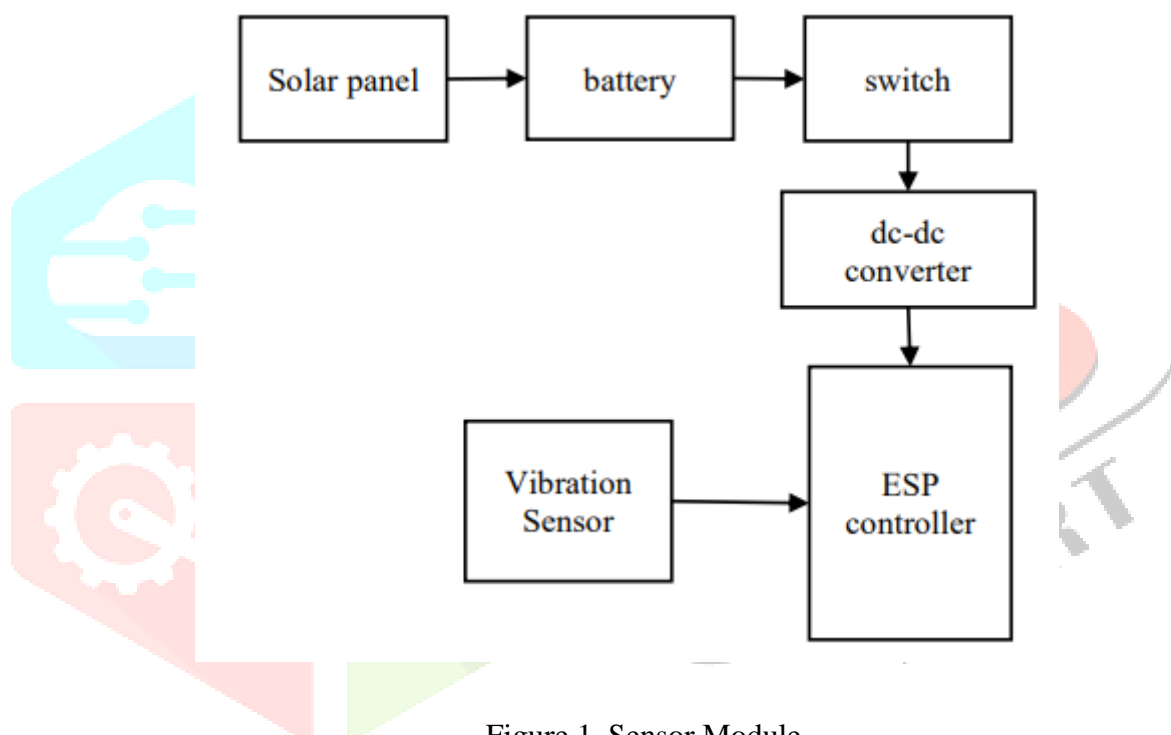


Figure 1. Sensor Module.

Figure 2. represents the home module .In this Module, the status switch detects the presence or absence of a person in the home. The ESP controller processes this information and controls the LCD display to show the person's status (in or out) and the status of the solenoid valve (open or closed). The ESP controller can control the solenoid valve by activating the relay, allowing or blocking the flow of water from the main supply according to data from sensor module.

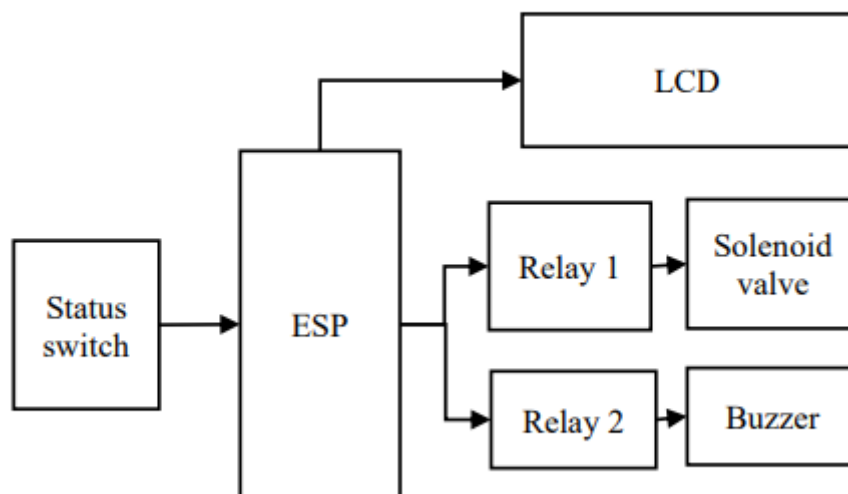


Figure 2. Home Module

III. FLOW CHART

Figure 3. represents the working flow diagram of the system. This system with occupancy detection is a comprehensive solution designed to monitor water flow, detect anomalies, and take appropriate actions based on the presence of individuals at home. This system incorporates a vibration sensor to measure the water flow, analyzes the data to detect continuous flow, and combines it with occupancy information to trigger specific actions.

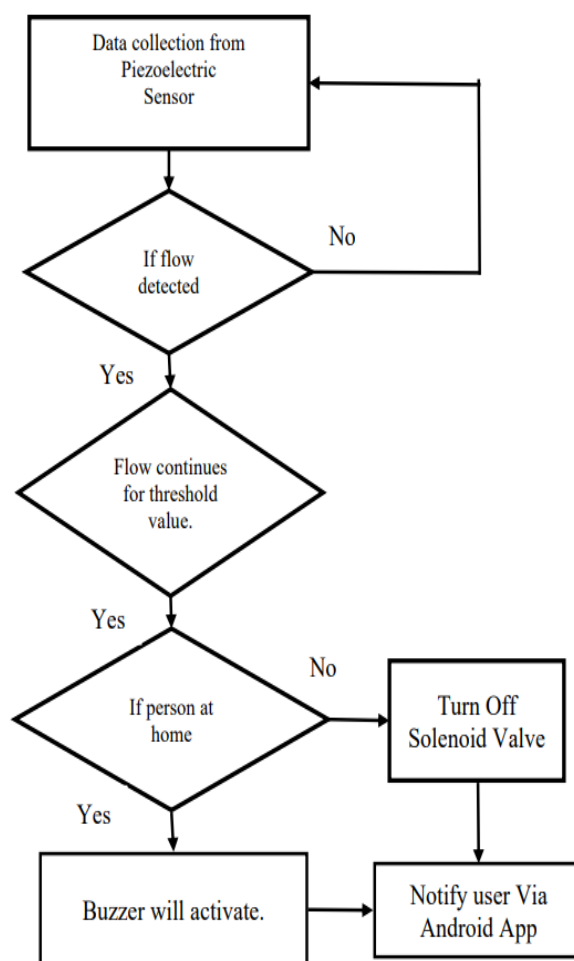


Figure 3 Working flow diagram

- **Vibration Sensor Data:** The vibration sensor continuously monitors the water flow in a specific area, such as a pipe or a water line. It measures the vibrations caused by the flowing water.
- **Flow Detection:** The sensor data is analyzed to detect if there is a continuous flow of water. This can be achieved by setting a threshold duration, which specifies the minimum amount of time the flow needs to be detected to trigger further actions.
- **Check Home Occupancy:** Simultaneously, the system checks whether a person is at home or not.
- **Flow and Occupancy Logic:** The system combines flow detection and home occupancy information to determine the appropriate action.
- **Buzzer Activation and App Notification:** If the flow is detected for the threshold time and a person is detected at home, the system activates a buzzer to alert the individual about the continuous flow of water. Additionally, the system sends a notification to the user's mobile app to provide real-time information about the detected flow.
- **Solenoid Valve Control:** If the flow is detected for the threshold time, but no person is detected at home, the system initiates control over a solenoid valve. The solenoid valve is responsible for controlling the main supply of water. By activating the solenoid valve, the system shuts off the water supply, preventing any further flow. This action helps prevent potential water damage and wastage
- **App Notification:** In the event that the solenoid valve is activated to shut off the water supply, the system sends a notification to the user's mobile app to inform them about the water supply being turned off as a precautionary measure.
- **Monitoring and Reset:** The system continues to monitor the flow and occupancy status to ensure accuracy and provide timely responses. Once the flow stops or the person returns home, the system resets and prepares for the next detection cycle. It also sends a notification to the user's app to indicate that the flow has ceased or that the person has returned home, along with any relevant details.

IV. RESOURCES REQUIRES:-

A) **Microcontroller** This is the main brain of our project. When we want implement embedded system with Wireless communication we need one embedded controller/processor and one wireless module. But this is combination of embedded controller and wireless communication. NodeMCU is a development board and open-source firmware specifically designed for IoT applications, utilizing the ESP8266 Wi-Fi SoC from Espressif Systems. It features Luabased firmware and is built on the reliable ESP-12 module, combining hardware and software to enable seamless IoT development.

Microcontroller	NodeMCU ESP8266
Operating Voltage	3.3V
Input Voltage	7-12 V
Digital I/O pins	16 pins
Analog Input Pins	1
SRAM	64 KB
Flash Memory	4 MB
Clock speed	80 MHz

Table 1 :AT mega 328 specification.

B) Piezoelectric sensor Acceleration and pressure are the two main physical variables that a piezoelectric sensor typically measures. Piezoelectricity underlies both pressure and acceleration sensors, however the method force is applied to each sensor's sensing element differs significantly. To transfer the applied force to the piezoelectric element in the pressure sensor, a thin membrane is positioned on a substantial base. This thin membrane generates electrical voltages when pressure is applied, loading the piezoelectric material. The relationship between produced voltage and applied pressure is linear. Seismic mass is affixed to the crystal element in accelerometers in order to transmit applied forces to piezoelectric materials. Newton's second law of motion states that seismic mass loads the piezoelectric substance when motion is applied. Charge is produced by the piezoelectric material and is utilized to calibrate motion. Because pressure sensors are susceptible to picking up unintended vibrations and providing inaccurate readings, they are utilized in conjunction with acceleration adjustment elements such as spring.

Specifications for Piezoelectric Sensors

The following are some of the fundamental qualities of piezoelectric sensors:

- The measuring range: There are measurement restrictions on this range.
- Sensitivity S is the ratio of the change in the output signal (y) to the change causing signal (x). $S = \Delta y / \Delta x$.
- Reliability: This refers to the sensor's capacity to maintain characteristics within predetermined bounds while operating under predetermined settings

C) DC-to-DC Converter: The DC-to-DC converters change the DC voltage from one level to another. It is required to specify a voltage for each device since the working voltage of various electronic components, including ICs and MOSFETs, can range over a large range. The circuit's efficiency, ripple, and load-transient response can all be modified by using DC-to-DC converters. The most effective external parts and components are typically reliant on operational circumstances like input and output requirements. As a result, when creating the products, the standard circuits must be modified or updated to meet each product's unique specification needs.

D) Solenoid Valve: A solenoid valve is an electromechanical device that is commonly used to control the flow of fluids, such as liquids or gases, in a system. It consists of a coil of wire and a movable plunger or piston inside a hollow tube. When an electric current is applied to the coil, it generates a magnetic field, which causes the plunger or piston to move. The solenoid valve operates based on the principle of electromagnetic attraction. When the coil is energized, the magnetic field attracts the plunger, pulling it towards the coil. This movement creates an opening or passage for the fluid to flow through. Conversely, when the coil is de-energized, the plunger returns to its original position, closing the passage and preventing the fluid from flowing. Solenoid valves are available in various configurations, such as normally closed (NC) or normally open (NO). In a normally closed solenoid valve, the flow passage is closed in its default state when the coil is not energized. When the coil receives an electric current, it opens the valve, allowing the fluid to pass through. In a normally open solenoid valve, the flow passage is open in its default state, and the valve closes when the coil is energized.

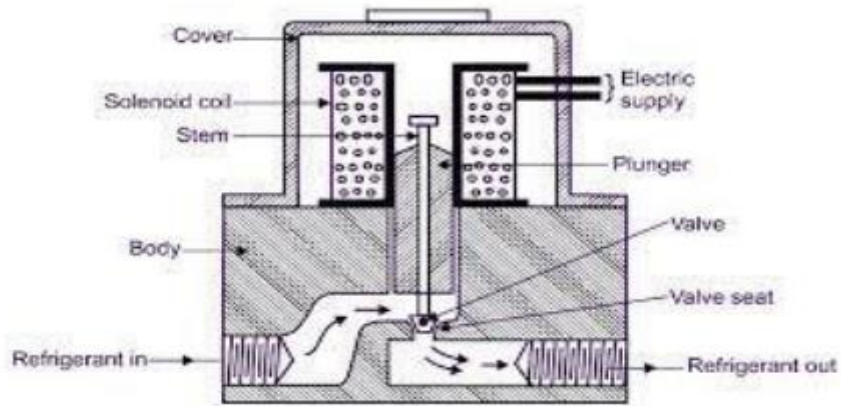


Figure 4 Solenoid Valve.

Software Description

A) Arduino IDE Arduino IDE is an integrated development environment specifically designed for programming Arduino boards. It provides a user-friendly interface, a simplified coding language, and a range of libraries. The microcontroller plays a crucial role in this project by reading the output signals from the piezoelectric vibration sensor. It acts as the central processing unit, responsible for data monitoring and analysis. The acquired data is then communicated between two ESP (Wi-Fi modules) for further processing or transmission to external systems. The Arduino software platform is utilized to program and control the microcontroller, enabling seamless integration and efficient data handling. Through this implementation, the microcontroller facilitates real-time monitoring and communication, leveraging the capabilities of the Arduino software to effectively manage and process the collected data from the piezoelectric vibration sensor.

B) ESP-NOW Protocol:

It is Another protocol created by Espressif that enables many devices to connect with one another without the use of Wi-Fi is called ESP-NOW. The protocol is comparable to the 2.4GHz low-power wireless communication that is frequently used in wireless mice. Prior to their communication, devices must first pair with one another. Once the pairing is complete, there is no need for a handshake because the connection is secure and peer-to-peer. This indicates that the connection is persistent once a device has been paired with another. To put it another way, if one of your boards suddenly loses power or resets, it will immediately establish a connection with its peer when it resumes to carry on the conversation. The following features are supported by ESP-NOW: • unicast communication that is both encrypted and unencrypted; • Peer devices that are both encrypted and not encrypted; • Calling back function that can be configured to notify the application layer of successful or unsuccessful transmissions. Additionally, ESP-NOW technology has the following drawbacks: • Fewer peers that use encryption. Station mode supports a maximum of 10 encrypted peers; SoftAP or SoftAP plus Station mode supports a maximum of 6 encrypted peers. • Multiple unencrypted peers are supported, but their combined number, including encrypted peers, should not exceed 20; • Maximum payload size is 250 bytes. To put it simply, ESP-NOW is a quick communication protocol that ESP32 boards can utilize to send and receive brief messages (up to 250 bytes).

C) Firebase: Firebase is a comprehensive cloud platform provided by Google that offers a range of services for creating mobile and web applications. It provides various cloud services, including authentication, storage, cloud functions, and hosting. With Firebase, you can easily build and deploy your applications without the need to manage your own web server or deal with complex deployment and networking setups. One of its notable services is Realtime Database, which allows real-time data synchronization across multiple devices. Additionally, Firebase's hosting service provides a hassle-free solution for hosting your applications, and the best part is that it's free (although with some limitations) and userfriendly. In essence, Firebase simplifies the development and deployment process, enabling developers to focus more on building their applications rather than managing infrastructure.

C) MIT App Inventor: MIT App Inventor is an innovative web-based integrated development environment (IDE) specifically designed for creating Android applications. It offers a user-friendly graphical interface that resembles popular programming languages like Scratch and Star Logo. With App Inventor, users can effortlessly drag and drop visual objects to construct their applications without the need for traditional coding. These applications can then be deployed and run on Android devices. While a version of the App-Inventor Companion is in development for iOS devices, currently it is only available for Android, allowing users to test and debug their apps directly on Android devices. The team behind App Inventor is working towards expanding its compatibility to iOS in the future.

4.1 Results:-

Figure 5 represents Implemented sensor module The components used in the home module, such as the piezoelectric vibration sensor, solar panel, battery, switch, DC-to-DC converter, and ESP microcontroller.

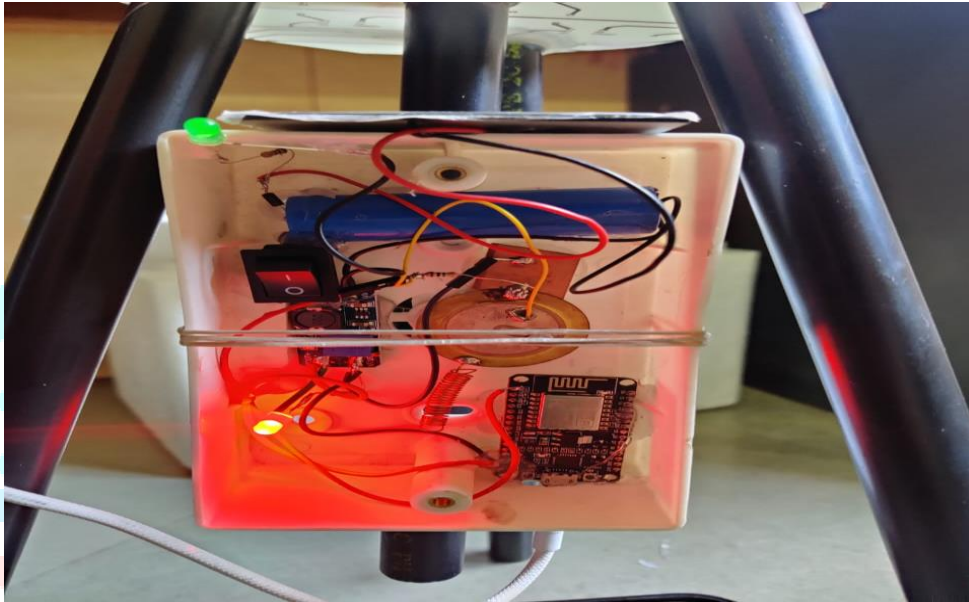


Figure 5. Implemented Sensor Module.

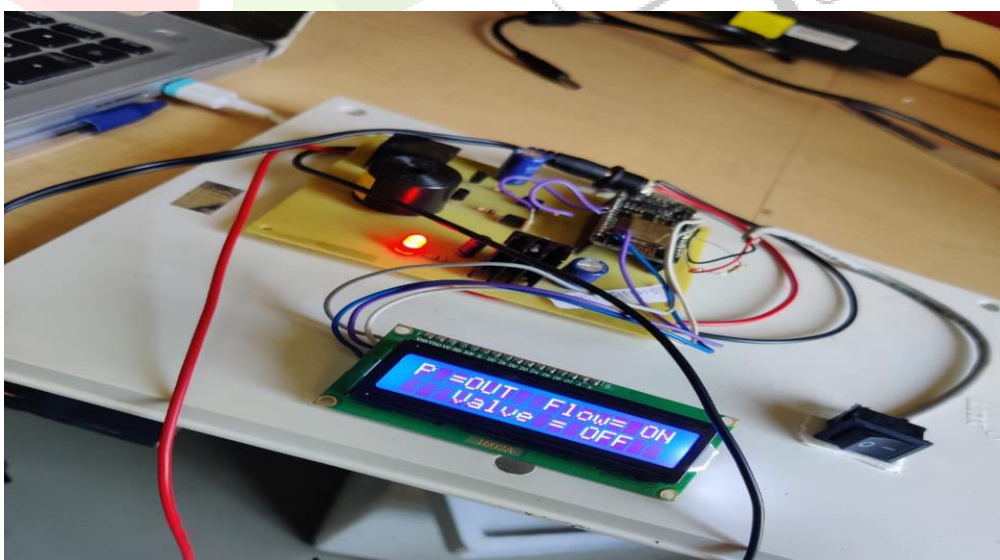


Figure 6. Implemented Home Module.

Figure 6 represents the Implemented home Module. In the depicted figure 4.5 the Home module has detected that there is no person present at home. Simultaneously, the flow of water is detected, triggering the monitoring system. As a result, the ESP module receives this information and determines that the solenoid valve should be turned off based on predefined conditions.

The solenoid valve, controlled by the ESP module, receives the command to shut off the water flow. This action is taken to conserve water or prevent any unwanted water usage or leakage when no one is present at home.

4.2 Conclusion: -

An effective and convenient method of managing water is offered by the Internet of Things-based contactless water flow detection system. It combines a home automation system with an outlet pipe monitoring system for a specific house as well as an inlet pipe with a solenoid valve for that same house. The system provides real-time water flow monitoring and control, valve status monitoring, and occupancy detection.

We developed a low cost contactless running water flow detection system with the aid of calibration and analysis, which is helpful for both home and industrial applications. The measurement of flow-induced vibration signals in water using a piezoelectric plate as a vibration sensor has been accomplished.

The device correctly detects and measures water flow in the outlet pipe using IoT technology, providing efficient water consumption monitoring. It also helps users in understanding their patterns of water use, water resource conservation, and water bill reduction. The inlet pipe's inbuilt solenoid valve automates the process of turning off the water flow when it is essential, reducing waste and assuring effective use.

Users are simply able to access and adjust water flow and valve status remotely thanks to the system's connection to a home automation system. Users can track the water flow and valve status in real-time through a single site, learning important details about their water usage. The technology can also determine whether individuals are in the house or not, which increases security and makes possible to take energy-saving measures.

The device comes with an Android app that offers notifications and control options on users' smartphones to improve accessibility. Users are informed of abnormalities in water flow, valve problems, or changes in the occupancy status, enabling them to take prompt action. Users can actively contribute to water conservation efforts because to this feature's simplicity.

V. ACKNOWLEDGMENT

The application of knowledge gained our years is when practical skills are nourished, during the execution of this project, we have implemented various theories and implemented principles studied in theory over the course of our education. We are filled with gratitude for the opportunity to implement the same for this project. We would like to express our heartfelt gratitude towards Dr. Dr. S. T. Gandhe, Principal PICT and Dr. M.V. Munot Head of Department (Electronics and Telecommunication), for providing us with all the necessary resources for the successful completion of our project. It would have been an impossible task

without the guidance of our guide Dr.S.V. Gaikwad and his constant motivation for the same for which we are filled with gratitude. We would also like to express our gratitude for all the lab asst and dept staff for their continuous guidance. At last, we are acknowledging all the authors of the references and other literatures referred in this project.

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