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Drainage and Seepage Monitoring System in Appartment Building Using Iot – Performance

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***Abstract*—The Drainage and Seepage Monitoring System- in Apartment Building Using IOT Performance is designed to integrity and sustainability of modern apartment buildings are increasingly reliant on advanced infrastructure monitoring systems. Drainage and seepage issues, if left undetected , can lead to structural degradation, increased maintenance costs, and health hazards due to mold and dampness. This system offers a comprehensive by integration 'smart sensors , wireless communication, and real-time data analysis' to detect early signs of water leakage and blockages within the building's drainage network. These system continuously track moisture levels , water flows rates , and pressure variations in critical locations such as bathroom , kitchen , basements and service ducts. In the event of abnormal readings, alerts are generated and communicated to building management for prompt intervention.. As urban living becomes denser, such system are essential components of resilient, smart, and future-ready residential infrastructure. Monitoring water usage in each apartment unit enables efficient resource management and conservation. A smart water metering system tracks consumption patterns, providing accurate data for billing and leak detection.**

***Index Terms*—Drainage monitoring, seepage monitoring, water infiltration, groundwater movement, subsurface flow.**

I. INTRODUCTION

Modern urbanization has led to a rapid increase in the construction of multi-storey apartment buildings, where the efficient management of utilities such as water supply, drainage, and sewage disposal plays a vital role in ensuring sustainable living conditions. Among these, the issue of drainage and seepage has become a critical challenge in residential complexes. Drainage systems in apartments must handle large volumes of wastewater on a daily basis, and any inefficiency in monitoring or maintenance may result in severe problems such as waterlogging, structural damage, foul odor, mold growth, and even health hazards. Similarly, seepage caused by leaking pipes, faulty waterproofing, or underground water infiltration not only weakens the structure but also reduces the lifespan of the building and affects the comfort of residents.

IoT allows the integration of sensors, wireless communication, data analytics, and cloud storage to create a smart monitoring ecosystem. In the context of drainage and seepage systems, IoT can be used to detect early signs of leakage, water accumulation, and pipeline blockages in real time. Smart sensors embedded in critical points of the drainage and plumbing network can continuously transmit data on water flow, pressure, and moisture levels. This data can be analyzed to detect anomalies and notify maintenance teams instantly .

Therefore, the drainage and seepage monitoring system using IoT is not merely a technological upgrade but a necessity for modern apartment buildings. It enhances safety, ensures sustainability, reduces maintenance costs, and improves the overall quality of life for residents. This paper presents a detailed overview of the concept, scope, and objectives of such a system, along with its expected performance and benefits in apartment building management.

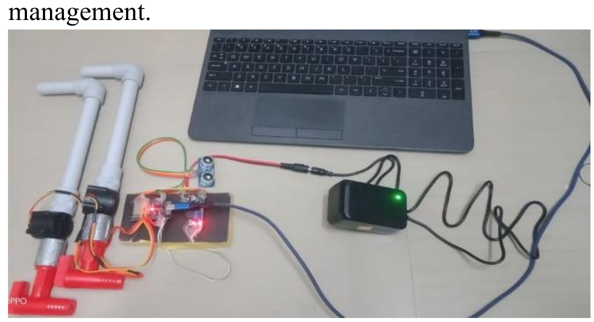

FIG: 1.1 Model of the Project

II. LITERATURE REVIEW

Recent studies highlight that drainage blockage and seepage problems in apartment buildings are major contributors to structural damage, unhygienic conditions, and increased maintenance costs. Traditional inspection-based monitoring methods are reactive and inefficient, leading researchers to explore IoT-based drainage and seepage monitoring systems for real-time, automated supervision. Internet of Things technology enables continuous data collection using distributed sensors, early detection of abnormal conditions, and timely alerts to building management, thereby reducing damage and improving operational efficiency.

Several researchers have proposed IoT architectures that integrate water level, flow, pressure, moisture, and gas sensors to monitor drainage pipelines and seepage-prone areas such as basements, walls, and underground parking zones. Ultrasonic and float sensors are commonly used to detect rising water levels caused by blockages, while moisture and pressure sensors help identify seepage through cracks or pipe leakages. Gas sensors detecting methane or carbon monoxide are also employed to indicate stagnant sewage conditions. These sensors are typically interfaced with microcontrollers such as ESP32 or NodeMCU, which transmit data to cloud platforms through Wi-Fi, cellular networks, or low-power wide-area networks like LoRaWAN.

Performance evaluation in the literature focuses on accuracy, reliability, latency, power consumption, and scalability. Many studies report high detection accuracy for blockage and seepage events under controlled conditions, with IoT systems outperforming manual inspections in response time. Communication performance analyses show that LPWAN technologies provide better coverage and lower energy consumption for large apartment complexes, while Wi-Fi is effective for smaller buildings with existing network infrastructure. Cloud-based dashboards and mobile alerts improve usability by enabling real-time visualization and maintenance decision-making.

Recent advancements also integrate data analytics and machine learning techniques to enhance system performance. Predictive models trained on historical sensor data are used to identify abnormal drainage patterns and forecast potential seepage issues before visible damage occurs. These intelligent systems support preventive maintenance strategies rather than corrective repairs, significantly reducing long-term costs. However, existing studies are largely prototype-based and lack long-term real-world deployment data in apartment buildings.

Overall, the literature demonstrates that IoT-based drainage and seepage monitoring systems are effective in improving detection speed, monitoring accuracy, and maintenance efficiency. Nevertheless, gaps remain in standardized performance benchmarking, long-term reliability evaluation, and building-specific implementation studies. Future research is recommended to focus on large-scale apartment deployments, energy-efficient sensor networks, and advanced predictive analytics to enhance system robustness and sustainability.

III. PLANNING AND SETUP

The primary goals of this experimental setup are:

- To develop a functional prototype for monitoring drainage and seepage in residential apartments.
- To integrate multiple IoT sensors (flow, moisture, pressure, ultrasonic) for real-time data acquisition.
- To transmit sensor data to the cloud using wireless communication (Wi-Fi).
- To design an alert mechanism through a mobile or web application.
- To evaluate system accuracy, response time, and reliability under different test conditions.

IV. HARDWARE INSTALLATION

Hardware Material Used:

ESP – 32 Module:

Fig: 4.1 ESP – 32 Module

The ESP32 is a low-cost, low-power system-on-chip (SoC) microcontroller from Espressif Systems. It integrates both Wi-Fi and Bluetooth connectivity — making it very popular for IoT, embedded systems, smart devices and more.

Flow sensor:

Fig: 4.2 Flow Sensor

A flow sensor (sometimes called a flow meter) is a device that measures the rate of flow of a liquid or gas within a pipe or channel (for example, how many litres per minute are flowing).

Ultrasonic Sensor:

Fig: 4.3 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures distance or detects objects by using high-frequency sound waves (typically above 20 kHz, which humans cannot hear) It's commonly used for non-contact measurement in robotics, automation, tank level sensing, obstacle avoidance, etc.

LM 2596 DC – DC Socket:

Fig: 4.4 LM 2596 DC – DC Socket

At its heart is the IC LM2596 (a step-down switching regulator, aka buck converter) which takes a higher DC input voltage and produces a lower DC output voltage.

The module version you buy typically includes the LM2596 IC plus surrounding components (inductor, diode, capacitors, adjustment potentiometer) mounted on a small PCB so you can easily use it in projects.

V. SOFTWARE INSTALLATION

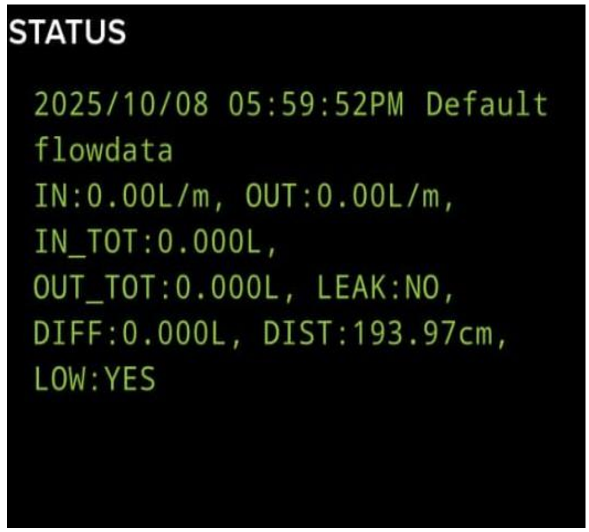

Fig: 5.1 Result Diagram

The software implementation procedure involves the development of embedded code, configuration of cloud services, and integration of a mobile application for real-time monitoring and alerts. The entire process ensures smooth data acquisition from sensors, reliable data transmission to the cloud, and effective visualization for end users.

The Arduino IDE programming phase begins with installing the required libraries such as WiFi, Firebase, and Ultrasonic to enable communication, cloud connectivity, and sensor interfacing. The sensors are initialized, and appropriate threshold limits are defined based on acceptable flow rate, pressure, and water level values. Logical conditions are implemented to calculate flow rate, detect pressure variations, and identify abnormal drainage or seepage conditions. The ThingSpeak API key and channel number are configured within the code to allow data transmission to the cloud platform. Additionally, logic is written to automatically trigger alerts whenever sensor values exceed predefined thresholds. Once the code is verified, it is compiled and uploaded to the ESP32 microcontroller.

In the Firebase cloud setup, a Firebase account is created to enable real-time data storage and synchronization. A new database channel is generated with multiple fields to store parameters such as flow rate, pressure, and water level. The Firebase configuration details are copied and integrated into the Arduino program to establish secure communication between the ESP32 and the cloud. This setup allows continuous uploading of sensor data, which can be visualized in real time using the io.adafruit interface for effective monitoring.

The IO Adafruit mobile application setup involves installing the Adafruit IoT application on an Android or iOS device. A new project is created by selecting ESP32 as the device type, and necessary widgets such as notification components are added for alert generation. The project token is linked with the Arduino code to enable seamless data exchange between the hardware and the mobile application. Live sensor readings and alert notifications are verified in real time to ensure proper system functionality. Additionally, the application allows users to view and export previously collected data records in Excel format for further analysis and documentation.

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