Engineering Clinics

Synopsis

IoT Based Weather Monitoring System

BACHELOR OF TECHNOLOGY

(Artificial Intelligence and Data Science.)

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Chapter 1 : Introduction

1.1 The Importance of Real-Time Weather Data

Weather monitoring is a critical field that impacts numerous sectors, from agriculture and aviation to disaster management and daily public life. The timeliness of this data can be the deciding factor in crop yields, flight safety, and effective emergency response. Traditional meteorological systems have long been the standard, but they often provide data with significant delays and for broad geographical regions. This project introduces an Internet of Things (IoT) based approach to overcome these limitations, focusing on providing hyperlocal, real-time atmospheric data. The proposed system aims to create a low-cost, scalable network of sensors that can stream live weather updates directly to end-users.

1.2 Proposed System Overview

The core of this project is the development of a standalone IoT node equipped with sensors to measure key environmental parameters such as temperature, humidity, and barometric pressure. This data is processed by an onboard microcontroller and transmitted wirelessly to a cloud server. The server aggregates the data, which is then made accessible through a custom-built mobile application. This approach democratizes weather data, making it immediately available and highly localized, which is a significant improvement over existing infrastructure.

Chapter 2 : Brief Literature Survey

2.1 Conventional Weather Monitoring Techniques

Traditional weather monitoring relies on a network of sophisticated and expensive weather stations established by governmental meteorological departments. These stations provide highly accurate data but are sparsely distributed due to high deployment and maintenance costs. The data from these stations is typically processed centrally and disseminated through official channels with a notable time lag. While reliable for large-scale forecasting, these methods are insufficient for applications requiring immediate, localized weather intelligence.

2.2 Advancements with IoT and Embedded Systems

The emergence of low-cost microcontrollers and sensors has catalysed a shift towards decentralized weather monitoring. Numerous studies have explored the use of platforms like Arduino and Raspberry Pi for this purpose. For instance, research by Patel and Jain demonstrated a functional prototype using a DHT11 sensor for temperature and humidity. These works establish the feasibility of using embedded systems for data collection but often stop at local data logging or basic web displays. This project extends these concepts by focusing on a robust cloud backend and a polished mobile application for a complete end-to-end, real-time solution.

Chapter 3 : Problem Formulation

The fundamental problem addressed by this research is the **lack of accessible, real-time, and hyperlocal weather data**. End-users, ranging from farmers to urban commuters, currently rely on generalized forecasts that are updated infrequently. This information gap leads to inefficient decision-making and potential losses.

Beyond this primary user-facing problem, the successful deployment of a robust IoT system presents several technical challenges that this project must also address:

- **Database Management:** The constant, high-frequency stream of data from multiple sensors requires an efficient database solution. The project must solve the problem of storing, processing, and querying large volumes of time-series data without performance degradation.
- **Network Issue:** The IoT nodes will be reliant on Wi-Fi connectivity. The system must be resilient to intermittent **network issues** or connection loss to prevent critical gaps in the data, possibly by implementing local data caching or reconnection protocols.
- **App Update:** A mobile application is not a one-time deployment. The project must consider a sustainable process for **app update** to fix bugs, introduce new features, or apply security patches, ensuring a long-term, reliable user experience.

Chapter 4 : Objectives

The primary objectives of this project are as follows:

- To design and develop a low-cost IoT hardware node capable of accurately measuring temperature, humidity, and barometric pressure.
- To establish a reliable communication channel between the hardware node and a cloud server for real-time data transmission.
- To implement a cloud-based backend for data storage, processing, and retrieval via an API.
- To create a user-friendly Android application to visualize the live and historical weather data in an intuitive manner.
- To test the prototype system for accuracy, reliability, and data transmission latency.

Chapter 5 : Methodology/Planning of work

5.1 System Architecture

The system is designed with a three-layer architecture:

1. **Hardware Layer:** This consists of the primary sensing unit. An ESP32 microcontroller will be used as the core processing unit due to its built-in Wi-Fi capabilities. It will be interfaced with a DHT22 sensor for temperature/humidity and a BMP280 sensor for barometric pressure.
2. **Communication & Cloud Layer:** The ESP32 will collect sensor data and transmit it over Wi-Fi to the ThingSpeak IoT platform. ThingSpeak will be used for its simplicity in data aggregation, visualization, and providing a RESTful API for data access.
3. **Application Layer:** An Android application will be developed using Android Studio. This app will periodically fetch the latest data from the ThingSpeak API and display it to the user through a clean interface featuring real-time gauges and historical data charts.

5.2 Work Plan

The project is divided into four main stages: hardware assembly, microcontroller programming, application development, and system integration and testing. This phased approach ensures a systematic workflow from component sourcing to final deployment.

Chapter 6 : Facilities required for proposed work

6.1 Hardware:

- ESP32 Development Board
- DHT22 (Temperature and Humidity Sensor)
- BMP280 (Barometric Pressure Sensor)
- Breadboard and Jumper Wires
- 5V Power Supply

6.2 Software:

- Arduino IDE
- Android Studio
- ThingSpeak IoT Platform Account
- Required sensor libraries

Chapter 7 : REFERENCES

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