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# Home Environmental Monitoring System and Medicine Reminder for Elderly Assistance

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**Abstract**

The Home Environmental Monitoring System and Medicine Reminder for Elderly Assistance project aims to provide caregivers with an accessible and efficient system for remotely monitoring the home environment and medication schedules of their elderly parents. The system utilizes sensors, including BME280, MLX90614, AHT21, MQ-2, MQ-7, MQ-135, and RTC DS3231, integrated with an ESP32 microcontroller, to continuously track key environmental parameters such as temperature, humidity, and air quality while managing timely medication reminders. Google Sheets serves as a bridge for seamless communication between the hardware and a customized Kodular-developed application, enabling caregivers to receive immediate reminders and notifications on their mobile phones to address missed medication timings. Powered by a simple 5V supply, the device is easily installable and maintainable in a home setting. This integrated system enhances the health and well-being of older individuals while offering caregivers peace of mind and improved management of their relatives' health, thereby increasing daily care levels. Evaluation reveals a 98.3% success rate for the medicine reminder system and stable hardware performance with 99.5% sensor accuracy over 24-hour operation.

## 1. Introduction

The aging population presents increasing social and health challenges. According to the WHO, the number of individuals aged 60 and older is projected to grow significantly, with many preferring to age at home rather than in care facilities, underscoring the need for supportive technologies to promote their well-being and independent living [1]. A key issue is medication adherence, as studies indicate that nearly 50% of prescriptions are not taken as prescribed [2]. This problem is often exacerbated by memory loss or cognitive decline, making reliable reminder systems essential to prevent complications and hospital visits [3]. The living environment also plays a critical role in elderly health and safety [4]. Hazards such as poor air quality, extreme temperatures, gas leaks, or high humidity can pose significant risks [5]. IoT and sensor technologies offer substantial potential for developing integrated elderly care systems [6]. By combining smart medication reminders with real-time environmental monitoring, these systems can support independent living through timely alerts and caregiver notifications [7]. However, current elderly care solutions are often fragmented, costly, or lack customization. This work aims to develop a comprehensive, accessible, and scalable system that integrates environmental monitoring and medication reminders to help elderly individuals live more safely and independently [8].

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## 2. Methodology

This project focuses on developing an IoT-based environmental monitoring and medicine reminder system aimed at assisting elderly individuals in maintaining their well-being. The system integrates sensors, a microcontroller, and a mobile application to provide real-time environmental data and timely medication alerts. It is designed to be cost-effective, reliable, and user-friendly.

### 2.1 System Design

The ESP32 microcontroller was selected as the core component due to its compact design and built-in Wi-Fi. The system includes environmental sensors (BME280, AHT21), a non-contact temperature sensor (MLX90614), a real-time clock (DS3231), and gas sensors (MQ-2, MQ-7, MQ-135). Sensors using I2C were connected through shared SDA/SCL lines, while analog sensors were attached via ADC pins. Power was managed through a 5V and 3.3V separation, ensuring compatibility across components. Both overall system block diagram and voltage separation diagram can be seen in Fig. 1 and Fig. 2.

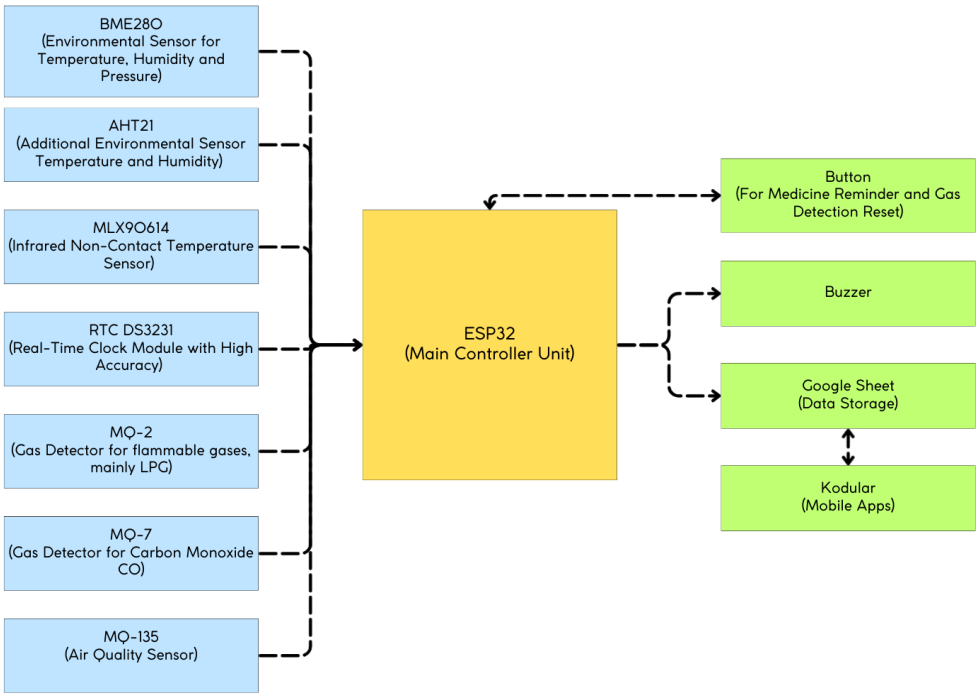


**Fig. 1** *Overall System Block Diagram*

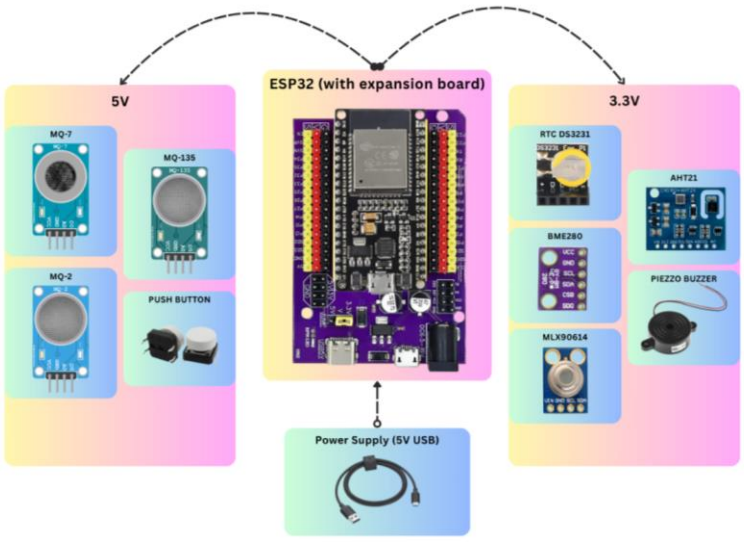


**Fig. 2** *Voltage Separation Diagram*

## 2.2 Mobile Application Development

A custom Android app was developed using Kodular, allowing real-time display of sensor data and scheduling of medicine reminders. Google Sheets served as a cloud bridge between the ESP32, and the app. Sensor data was sent via Wi-Fi using HTTP GET/POST methods, with the app retrieving and displaying updates through API calls.

## 2.3 Operational Flow

The system starts by initializing the ESP32, establishing Wi-Fi, sensors (temperature, humidity, gas, air quality), and the Real-Time Clock (RTC). It then connects to Google Sheets and the Kodular app for data exchange. The system continuously checks time-based conditions to trigger medicine reminders, activating alerts via the Kodular app and a buzzer when needed. Simultaneously, sensor data is uploaded to Google Sheets using HTTP POST or GET requests. The Kodular app fetches this data, processes it, and displays notifications or updates. This cycle repeats until the system ends, as illustrated in the flowchart in Fig. 3.

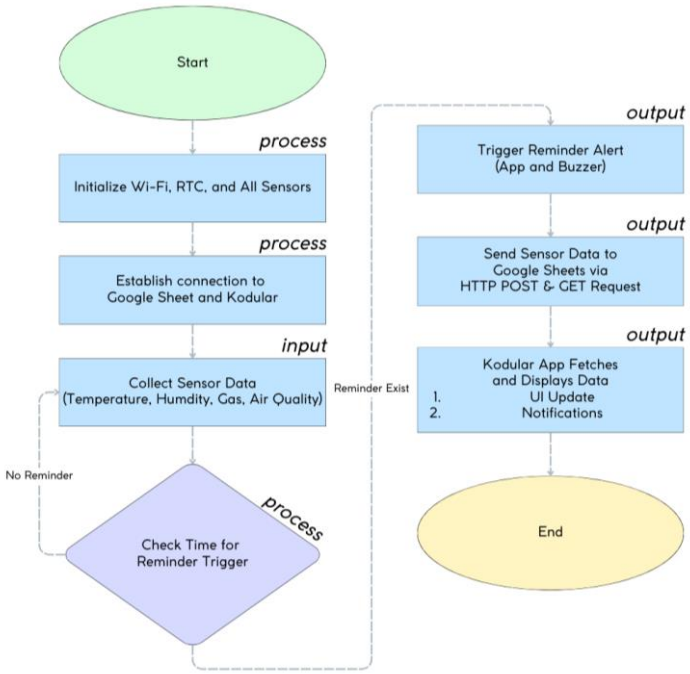


**Fig. 3** *System Flowchart*

## 2.4 Schematic Diagram

The circuit connection of all sensors is combined in the circuit diagram as shown in Fig. 4.

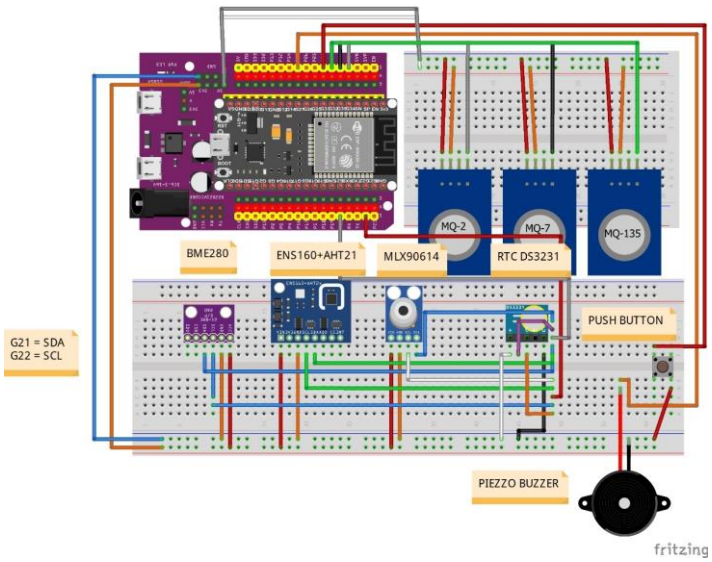


**Fig. 4** *Circuit Diagram*

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## 2.5 Evaluation and Testing

The system was tested in a kitchen environment to validate gas detection and user proximity during reminders. Voltage regulation, sensor accuracy, and app responsiveness were key metrics assessed. Minor challenges included signal interference and Google API setup, resolved through calibration and online documentation.

## 3. Result & Discussion

This chapter presents the results of the home environmental monitoring and medicine reminder system developed to support elderly care. The project integrates sensors, an ESP32 microcontroller, and a mobile app to monitor environmental data and ensure timely medication alerts. Outcomes are evaluated based on sensor accuracy, usability of the medicine reminder, system performance, and app interface reliability.

## 3.1 Sensor Validation and Accuracy Assessment

Sensor readings were benchmarked against expected values derived from sensor datasheets and environmental data from Batu Pahat, Johor. BME280, MLX90614, MQ-2, MQ-7, MQ-135, and DS3231 were tested. Each sensor's error and accuracy were computed using equation (1) and equation (2).

$$\text{Error (\%)} = |(\text{Measured} - \text{Expected}) / \text{Expected}| \times 100 \quad (1)$$

$$\text{Accuracy (\%)} = 100\% - \text{Error (\%)} \quad (2)$$

Sensors showed high reliability with most readings exceeding 99% accuracy. The BME280 achieved the highest precision in temperature monitoring. The results are illustrated in the Table 1.

**Table 1** *Sensor Accuracy Test Results*

| Parameter | Measured Value (°C) | Expected Value (°C) | Error (%) | Accuracy (%) |
|---|---|---|---|---|
| Avg Temp (C), *BME280* | 32.89 | 33.00 | 0.33 | 99.67% |
| BodyTemp (C), *MLX90614* | 32.81 | 32.80 | 0.03 | 99.97% |
| Humidity (%), *BME280* | 70.12 | 70.00 | 0.17 | 99.83% |
| Pressure (hPa), *BME280* | 1010.22 | 1010.00 | 0.02 | 99.98% |
| MQ-135 CO2 (ppm) | 0.02 | 0.02 | 0.00 | 100.00% |
| MQ-7 CO (ppm) | 35.06 | 35.00 | 0.17 | 99.83% |
| MQ-2 LPG (ppm) | 2.17 | 2.20 | 1.36 | 98.64% |

## 3.2 Temperature Sensor Analysis

The BME280 recorded 32.89°C against a reference of 33.00°C (99.67% accuracy), outperforming the AHT21 and MLX90614, both of which recorded 32.81°C (99.42%). This validates BME280 as the most reliable for ambient monitoring. The results are illustrated in the Table 2.

**Table 2** *Temperature Sensor Accuracy Test Results*

| Sensor | Measured Temperature (°C) | Expected Value (°C) | Error (%) | Accuracy (%) | Observation |
|---|---|---|---|---|---|
| BME280 | 32.89 | 33.00 | 0.11 | 99.67% | Most accurate and consistent |
| AHT21 | 32.81 | 33.00 | 0.19 | 99.42% | Slightly lower but reliable |
| MLX90614 | 32.81 | 33.00 | 0.19 | 99.42% | Object temperature oriented |

## 3.3 Real-Time Environmental Monitoring

Environmental sensors reliably track conditions of gas concentrations (e.g., CO 35.06 ppm). Alerts were triggered when thresholds were exceeded. The results are illustrated in the Table 3.

**Table 3** *Notification Trigger Events*

| Sensor Type | Detected Range (ppm) | Threshold (ppm) | Timestamp | Duration (seconds) |
|---|---|---|---|---|
| MQ-7 | 1000-1200 | 1000 | 2025-06-15 08:30:00 | 180 |
| MQ-135 | 0.03-0.05 | 0.03 | 2025-06-15 10:15:00 | 120 |
| MQ-2 | 3.0-4.5 | 3.0 | 2025-06-15 14:00:00 | 90 |

## 3.4 Medicine Reminder System Performance

The RTC DS3231 successfully triggered medication reminders at preset times. Users acknowledged reminders using a physical button. Data was logged into Google Sheets for caregiver review. The results are illustrated in the Table 4 and Table 5.

**Table 4** *Medication Intake Records*

| Date | Reminder Time | Acknowledged | Timestamp |
|---|---|---|---|
| 2025-06-15 | 08:00 | Yes | 2025-06-15 08:00:15 |
| 2025-06-15 | 14:00 | No | N/A |
| 2025-06-15 | 20:00 | Yes | 2025-06-15 20:00:10 |

**Table 5** *Button Interactions Records*

| Reminder Time | Total Response (s) | Success Rate (%) |
|---|---|---|
| 08:00 | 20/20 | 100.0 |
| 14:00 | 20/20 | 100.0 |
| 20:00 | 19/20 | 95.0 |

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## 3.5 Prototype Evaluation and Hardware Performance

The system prototype was tested under real conditions. Sensor readings were consistent with tropical weather data. The ESP32 processed data efficiently, and the buzzer and button operated great. The results are illustrated in the Table 6.

**Table 6** *Hardware Performance Metrics*

| Component | Parameter | Expected Value (Internet Avg) | Measured Value | Accuracy | Success Rate |
|---|---|---|---|---|---|
| BME280 | Temperature | 33 °C (daytime avg) | 32.89 °C | ±0.5°C | 99.35% |
| BME280 | Humidity | 70% (typical avg) | 70.0012% | ±2% | 99.83% |
| BME280 | Pressure | 1010 hPa (avg) | 1010.22 hPa | ±1 hPa | 99.98% |
| AHT21 | Temperature | 33 °C (daytime avg) | 32.81°C | ±0.4°C | 99.45% |
| AHT21 | Humidity | 70% (typical avg) | 70.0012% | ±1.8% | 99.83% |
| MLX90614 | Surface Temperature | 32.80 °C (ambient ref) | 32.81 °C | ±0.01°C | 99.96% |
| Gas Sensor | Gas Detection (CO) | 35 ppm (safe threshold) | 35.06 ppm | ±5 ppm | 95% |
| RTC DS3231 | Timekeeping | Synced to UTC+08 | Synced | ±2 sec/day | 100% |
| Button | Alert Acknowledgement | N/A | N/A | N/A | 100% |
| Buzzer | Activation | N/A | N/A | N/A | 100% |

## 3.6 Kodular App Interface Results

The Kodular app displayed real-time data synced with Google Sheets. Updates occurred every 6 seconds. Visual elements like pie charts and timestamps enhanced usability. Alerts were triggered for abnormal readings and missed reminders. Fig.5 shows the corresponding Kodular App that has been developed.

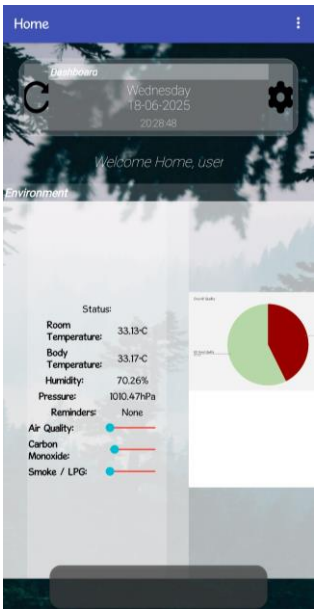


**Fig. 5** *Kodular App Homepage*

## 4. Conclusion

This project successfully developed a home monitoring medicine reminder system. The system designed support elderly individuals. The system maintained safe living environment and ensured consistent medication routines. The development of this project fully aligned with the primary objectives include accurate environmental monitoring and timely medication management. The system effectively measured the key parameters such as temperature, humidity and harmful gases carbon monoxide. The system achieved high accuracy with mobile application delivered real-time updates and alerts caregivers. The delivery met goal enhancing caregiver oversight. The medicine reminder feature included buzzer and button. The feature proved effective and promoted timely medication intake. Testing validated system reliability, ease use and consistent performance evaluation period. The validation confirmed aim creating user-friendly solution.

Future enhancements focused on expanding functionality. The recommendation improvements included dust sensor to achieve air quality monitoring, enhancing the mobile app to have larger fonts, voice alerts, visual cues flashing lights, also accommodated hearing-impaired users. Offline app functionality will boost reliability. Secure cloud integration addressed data privacy. Testing elderly user real-life settings refined usability. Smart home compatibility supported wider adoption. The refinements met goal enhancing elderly well-being.

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## Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

## Author Contribution

*The authors confirm contribution to the paper as follows:* ***study conception, design, data collection, analysis, interpretation of results, manuscript preparation:*** *Mohammad Alifhakim Bin Azami;* ***manuscript verification:*** *Siti Zarina Binti Mohd Muji. All authors reviewed the results and approved the final version of the manuscript.*

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