

AI & IOT enabled Eco-Friendly Proactive GRS System for People Sustainable Health Management (Smart City)

Members

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ABSTRACT

Deteriorating levels of in/outdoor air quality is a prominent environmental issue that results in long-lasting harmful effects on human health and wellbeing. In recent times indoor/outdoor Environment quality has attracted the attention of policymakers and researchers as an important similarity to that of external air pollution for smart cities' wealth management. In a certain sense, indoor air quality must be paid more attention than outdoor air quality as people spends more time indoors than outdoors. The indoor environments are confined and closed compared to external environments providing less opportunity for the pollutants to dilute. A concurrent multi-parameter monitoring approach accounting for the most crucial indoor pollutants is critical and essential. The challenges faced by existing conventional equipment in measuring multiple real-time pollutant concentrations include high cost, limited deployment ability, and detectability of only select pollutants. The aim of this project is to present a comprehensive indoor Environment quality monitoring system using a low-cost Raspberry Pi with Seed studio grove pi Hat-based GPS air quality sensor modules. The custom-built system measures 10 indoor environmental conditions including pollutants: Air Quality (AQI), Temperature, Relative Humidity, Pressure, Altitude, Radiation level, Light intensity, Carbon monoxide (CO), Oxygen(O₂), Carbon dioxide (CO₂), and Total Volatile Organic Compounds (TVOCs). Residential units, educational offices, and Traffic signal points were selected and monitored over a span of several months. The recorded mean Air Quality concentrations were significantly higher in the residential unit compared to the office building. The mean O₂, CO₂, and TVOC concentrations were comparatively similar for both locations. Spearman rank-order analysis displayed a strong correlation between particulate matter and Air Quality for both residential units and office buildings while the latter depicted strong Temperature and Humidity, Pressure, Altitude, correlation with sound noise levels, O₂, CO₂, Air Quality, Radiation level, Ambient light levels, IR levels, pm 2.5 air concentration when compared to the former for Smart city sustainable health management.

KEYWORDS: *IOT, AI, Android application, Analog and digital sensors, BME680, Raspberry pi, python etc.*

I. INTRODUCTION

The Internet of Things (IoT) technology is utilized to transmit the measured pollutant concentrations to an online dashboard to visualize and post-process the data. Raspberry PI is a versatile SCB that can be integrated with a wireless sensor network (WSN) to determine Air Quality, CO₂, O₂, Temperature, Pressure, Humidity, Altitude, etc. Attaching multiple gas sensors to a Raspberry Pi 4B board the measured data can be visualized in real-time and also extracted remotely using a local network by the end-user. The aim of this project is to present a comprehensive indoor air quality monitoring system using a low-cost Raspberry Pi-based air quality sensor module. The proposed system measures environmental parameters such as temperature, Relative Humidity, PM_{2.5}, PM₁₀, O₂, CO₂, CO, O₃, Noise, Radiation level, and TVOC in real time to determine air quality. The remainder of this paper is structured as follows. It describes the GRS system with its constituent sensors and the GPS module was connected through the UART port and Grove pi Hat is used for connecting with multiple I2C devices on Raspberry PI. The monitoring methods and different data analysis techniques employed are also detailed.

II. Related Works: Various attempts and research were made to overcome the Environment Global warming issue and still it undergoes.

1. Design AI & IOT-based GRS System:

The first step towards connecting with multiple sensors on a single system with the integration of wireless sensor networks Hence this system has provided user and eco friendly

2. Data Analytics:

In the second level of the system continuously try all the possible combinations of sensor values populating within seconds of time to store the logs in understandable formats (CSV, JSON, etc.) for present and future reference on global warming issues.

3. Android deployment:

As an end system for user experience simplification, A mobile app has been provided with Custom screens, an alert mechanism, and Analytical reports for better tracking of the GRS system.

III. Hardware Platform

The hardware part mainly consists of a small capacitive DSI touch display and a Raspberry Pi 4B Kit, Seed Grove studio pi hat, GPS module, seeedgroveBme680, Oxygen, CO2, SGP30, Air Quality, Radiation levels, Noise, Industrial sensors, pm 2.5 Air Quality, CO, etc. which is being discussed along with their specific functions.

1. Raspberry Pi Kit: The Raspberry Pi is a series of small single-board computers developed by the United Kingdom by the Raspberry Foundation to promote the teaching of computer science in schools and developing countries. Peripherals (including keyboard, mice, and cases) are not included with the Raspberry Pi. It is bundled with onboard Wi-Fi, Bluetooth, and USB boot capabilities. It has a Broadcom System-On-Chip, which includes an ARM-compatible central processing unit (CPU) and an on-chip graphics processing unit (GPU, a video core). CPU speed ranges from 700 to 1.2GHz for Pi 4 and onboard memory ranges from 1GB to 8GB. Secure Digital (SD) cards are used to store the operating system and program memory either in SDHC or microSD sizes. Lower-level output is produced by a number of GPIO pins that support common protocols. It supports Raspbian, a Debian-based Linux distribution for download as well as the third-party Ubuntu, Windows 10 IT Core, RISC OS, and centralized media center distributions. It promotes Python and Scratch as the main programming languages with support for many other languages. The Raspberry Pi 4 supports 8GB RAM.

2. Seed Grove pi hat:

Today, the grove series of sensors, actuators, and displays have grown into a large family. More and more grove modules will join the Grove ecosystem in the future. We see the Grove helps makers, engineers, teachers, students, and even artists to build, to make, to create...We always feel it is our responsibility to make the Grove module compatible with more platforms. Now we bring you the Grove Base Hat for Raspberry Pi and Grove Base Hat for Raspberry Pi Zero, in another word, we bring the Raspberry Pi the Grove System. The Grove Base Hat for Raspberry Pi provides a Digital/Analog/I2C/PWM/UART port to meet all your needs. With the help of a built-in MCU, a 12-bit 8-channel ADC is also available for Raspberry Pi.

3. Capacitive DSI Display interface:

4.3-inch Capacitive Touch Display was for Raspberry Pi Series and CM3/3+ 800×480 IPS Wide Angle MIPI DSI Interface Up to 5-Points Touch Driver Free. it Supports Pi 4B/3B+/3A+/3B/2B/B+/A+, CM3/3+(CM3/3+ requires extra adapter board)

And it Supports Raspbian, 5-point touch, driver free; Supports Ubuntu / Kali / WIN10 IoT, single point touch, driver free; Supports Retro pie, driver free Capacitive touch, up to 5-point touch (depending on the operating system)

4. GPS module:

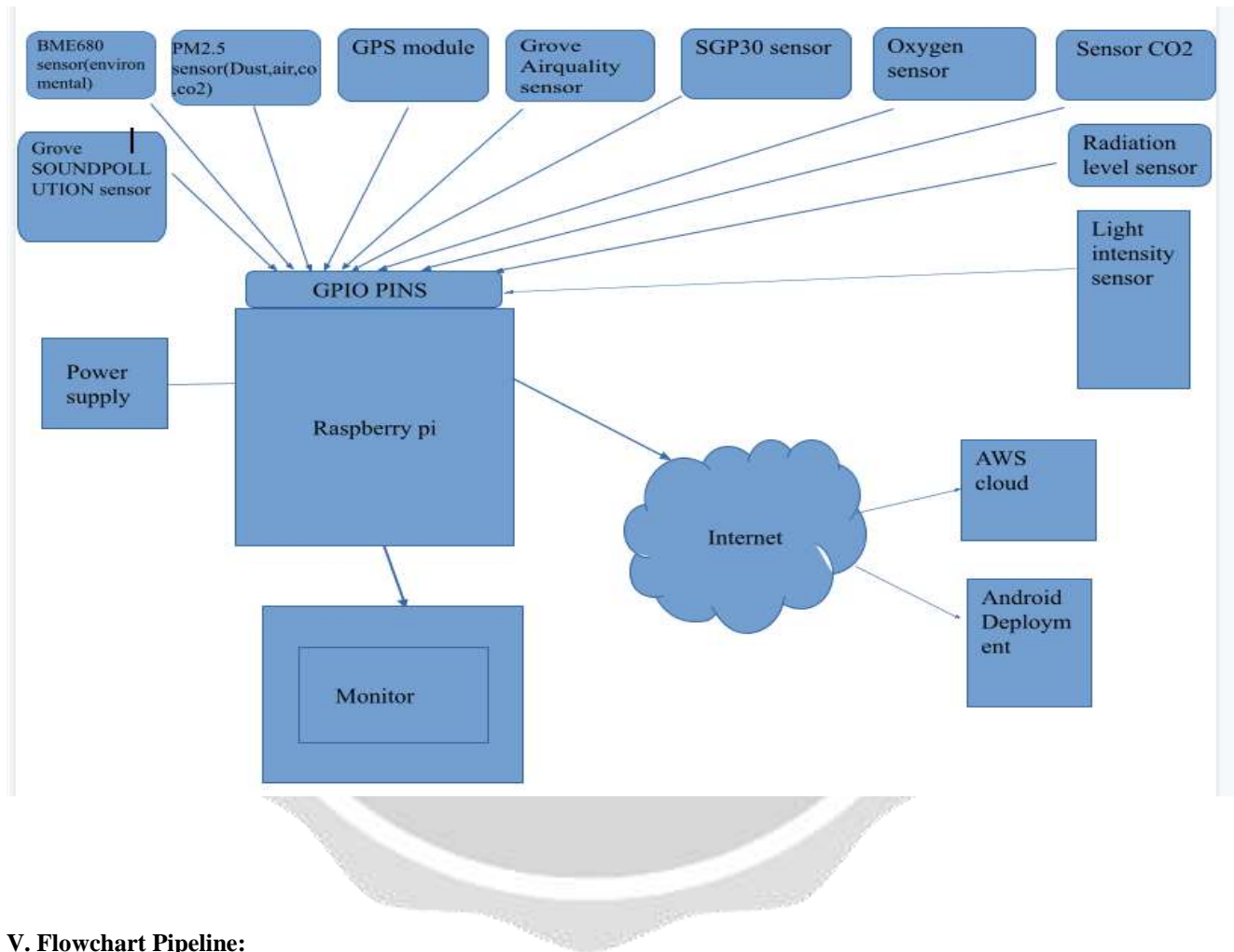
Here I will use Raspberry Pi 4 B+, but You can also use other variants like Raspberry Pi Zero, Raspberry Pi 4, etc. I am using Neo 6M as a GPS module because it's quite cheap and also very much accurate. So, we need the VCC of Neo 6M to be connected with 5v of Raspberry pi, GND of Neo 6M with GND of Raspberry pi and TX of Neo 6M with RX of Raspberry Pi so that the GPS module can

5. Seed Grove sensors:

Grove is a system of some nicely packaged sensors designed to be used with Seed Studio's Grove shields for Raspberry pi 4b. Since many of them are analog sensors like Air Quality, Oxygen, Noise levels, etc. digital sensors you'd need an external ADC for the Raspberry Pi. Alternatively, some of the I2C sensors are connected as listed SGP30, CO2, and UV sensors. What really makes it easy to connect Grove Connectors to the Raspberry Pi, is to add a Grove shield to the Raspberry Pi, like the Pi2Grover connector.

IV. Methodology

In this model, our aim is to propose a smart city GRS system for people's Health & wealth management in figure 1.1 below.



V. Flowchart Pipeline:

Step 1: Connected with Seed grove different multiple sensors on the raspberry pi Edge device.

Step 2: All Grove Analog, Digital, I2c, and Raspberry Pi GPIO sensors are properly fitted with grove shields corresponding with an edge.

Step 3: GPS modules are connected to Raspberry Pi.

Step4: When the system was ready just give the power supply for Raspberry Pi 4b

Step5: Now check that all sensors' values are populating

Step6: Storing the values in JSON format

Step7: Push the JSON file into AWS Cloud

Step 8: Android Mobile displays the data in a user-friendly way.

VI. R&D Implementation:

The custom-built GRS monitoring system used for this project was developed on a Raspberry Pi 4B Plus module. This module is a low-power, compact, easily configurable SBC that is powered by an ARM Cortex-A53 processor. The Raspberry Pi module encompasses features such as a Micro SD port for external storage access, Bluetooth, wireless LAN, USB ports, and GPIO pins for external communication. A nine-port expansion board was integrated into the Raspberry Pi module. A Wi-Fi USB adapter was connected to the Gigabit Ethernet port to establish access to the internet. In order to dissipate excess operational heat, a dual fan and heat sink module was attached to the Raspberry Pi system. Figure 1.2 shows the custom-built GRS monitoring system. Figure 1.2 depicts a detailed block diagram with all electrical connections. The aim of this project is to present a comprehensive indoor Environment quality monitoring system using a low-cost Raspberry Pi with Seed studio grove pi Hat-based GPS air quality sensor modules. The custom-built system measures 10 indoor environmental conditions including pollutants: Air Quality (AQI), Temperature, relative humidity, pressure, Altitude, Radiation level, Light intensity, Carbon monoxide (CO), Oxygen(O₂), Carbon dioxide (CO₂), and Total Volatile Organic Compounds (TVOCs). A residential unit and an educational office building, traffic signal points, were selected and monitored over a span of several months. The recorded mean air quality concentrations were significantly higher in the residential unit compared to the office building. The mean O₂, CO₂, and TVOC concentrations were comparatively similar for both locations.

VII. Specifications of sensors used in the GRS system

Measured Parameter	Example Product	Manufacturer	Measuring Range	Accuracy (Repeatability)	Approx. Price (USD). 2019
Temp	BME680	CISCO	40 C–80 C;	0.5 C; 1%	\$20
RHT	BME680	CISCO	0% to 100% 0% to 100%	0.5 C; 1%	\$10
Smoke	SDS011	Nova Fitness	0.0–999.9 g/m ³	15%; 10 g/m ³	\$30
Air Quality	Grove Air Quality	Seed studio	0–10 ppm	15%	\$75
SO ₂	Grove	Seed studio	0–20 ppm	15%	\$75
CO ₂	Grove SP30	Seed studio	0–5000 ppm	30%	\$80
O ₂	Grove oxygen	Seed studio	0–1000 ppm	15%	\$75
Radiation level, light intensity	Grove UV sensor	Seed studio	0–10 index	30%	\$75
TVOC	Grove SGP30	Seed studio	0–500 IAQ index	30%	\$95
Noise levels	Grove noise level	Seed studio	0-1024 range	30%	\$20

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