SMART TOILET ALERT MANAGEMENT AND PREDICTION USING DATA ANALYSIS

A PROJECT REPORT

Submitted by

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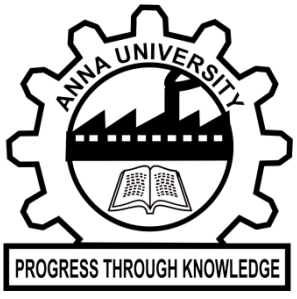

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BONAFIDE CERTIFICATE

Certified that this project report titled SMART TOILET ALERT MANAGEMENT AND PREDICTION USING DATA ANALYSIS is the bonafide work of AKASHRAM J (2019115113) and THARANYAA R (2019115113) who carried out project work under my supervision. Certified further that to the best of my knowledge and belief, the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or an award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

One would be surprised to know that the toiletry-based diseases play a major role in world hygiene. Many times, it has even been fatal, killing so many. One side there are no toilets and people are still using open spaces. On the other hand, there are toilets, but they lack maintenance. Both are dangerous. Not only at home, lavatories as everyone knows, are everywhere. From the simplest of the bus stands in interior villages, to the most sophisticated airports, toilets play a major role. Also, lavatories inside the train, flight or any other mode of transport is included in the list. All of these lavatories, if not maintained well, would lead to many disastrous and dangerous diseases like, Staphylococcus, Escherichia and Streptococcus.

Surveys reveal that these unclean lavatories are agents which mostly target the children and victims are mostly under 5. Hence, it is important with this much abundant technology growth to provide a technical solution to monitor the quality of the lavatories, so as to maintain it as and when required.

Here, our aim is to get a frugal IoT based solution towards monitoring the quality of the lavatories, on the go while alerting the concerned one to carry out the necessary action using android application. Also we did data analytics by using iot data for future reference. We capitalized the exploration of iot and data analytics to build this system. The system is tested for its working and it is observed that, if implemented, it would be a definite value add for the users and would help in building a healthy chain of lavatories.

திட்டப்பணிச் சுருக்கம்

உலக சுகாதாரத்தில் கழிப்பறை சார்ந்த நோய்கள் முக்கிய பங்கு வகிக்கின்றன என்பதை அறிந்தால் ஒருவர் ஆச்சரியப்படுவார். பல சமயங்களில், பலரைக் கொன்று, உயிரிழக்கக் கூட செய்திருக்கிறது. ஒருபுறம் கழிப்பறை இல்லாததால், மக்கள் திறந்தவெளியையே பயன்படுத்தி வருகின்றனர். மற்றொரு பக்கம், கழிப்பறைகள் உள்ளன, ஆனால், அவை பராமரிப்பின்றி உள்ளன. இரண்டுமே ஆபத்தானவை. வீட்டில் மட்டுமல்ல, கழிவறைகள் அனைவருக்கும் தெரியும், எல்லா இடங்களிலும் உள்ளன. உட்புற கிராமங்களில் உள்ள எளிய பேருந்து நிலையங்கள் முதல் அதிநவீன விமான நிலையங்கள் வரை கழிவறைகள் முக்கிய பங்கு வகிக்கின்றன. மேலும், ரயிலில் உள்ள கழிவறைகள், விமானம் அல்லது வேறு எந்த போக்குவரத்து முறையும் பட்டியலில் உள்ளடங்கும். இந்த கழிவறைகள் அனைத்தும் சரியாக பராமரிக்கப்படாவிட்டால், ஸ்டேஃபிளோகோகஸ், எஸ்கெரிச்சியா மற்றும் ஸ்ட்ரெப்டோகாக்கஸ் போன்ற பல பேரழிவு மற்றும் ஆபத்தான நோய்களுக்கு வழிவகுக்கும்.

இந்த அசுத்தமான கழிவறைகள் பெரும்பாலும் 5 வயதுக்குட்பட்ட குழந்தைகளை குறிவைக்கும் முகவர்கள் என்றும் பாதிக்கப்பட்டவர்கள் பெரும்பாலும் 5 வயதிற்குட்பட்டவர்கள் என்றும் ஆய்வுகள் வெளிப்படுத்துகின்றன. எனவே, இந்த ஏராளமான தொழில்நுட்ப வளர்ச்சியுடன் தரத்தை கண்காணிக்க தொழில்நுட்ப தீர்வை வழங்குவது முக்கியம்.

இங்கு, கழிவறைகளின் தரத்தை கண்காணிப்பதில் சிக்கனமான இணையஉலகம் அடிப்படையிலான தீர்வைப் பெறுவதை இலக்காகக் கொண்டுள்ளோம், அதே நேரத்தில்அண்ட்ராய்டு பயன்பாட்டைப் பயன்படுத்தி தேவையான நடவடிக்கையை மேற்கொள்ள சம்பந்தப்பட்ட நபரை எச்சரிக்கிறோம். எதிர்கால குறிப்புக்காக ஐஓடி தரவைப் பயன்படுத்தி தரவு பகுப்பாய்வு செய்தோம். இந்த அமைப்பை உருவாக்க IoT மற்றும் டேட்டா அனலிட்டிக்ஸ் பற்றிய ஆய்வுகளை மூலதனமாக்கினோம். இந்த அமைப்பு அதன் செயல்பாட்டிற்காக சோதிக்கப்பட்டது மற்றும் செயல்படுத்தப்பட்டால், இது பயனர்களுக்கு திட்டவட்டமான மதிப்பு சேர்க்கும் மற்றும் கட்டமைப்பிற்கு உதவும்.

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AKASHRAM J.
THARANYAA R.

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LIST OF ABBREVIATIONS

IOT	Internet of Things
PIR	Passive Infrared
EDA	Exploratory Data Analysis
OLED	Organic Light Emitting Diode
IDE	Integrated Development

CHAPTER 1
INTRODUCTION

Considering India, it is really good to appreciate that the government is focusing towards Swatch Bharath and the government has initiated building a lot of lavatories in the underprivileged sector. India is now free of open defecation with 110 million toilets built in five years and 600 million people gaining access to them.

The fact that many still go for open defecation which is certainly a very threatening concern. Why would they opt for open defecation when there is government-built toiletries? Before answering this question, it is important to analyze the way the toiletries in the bus stands and trains, railway stations etc. are maintained. Many would opt not use, as they are in such a pathetic condition. The cleanliness of the lavatories in these places is still a concern. We have devised a system to address this issue.

1.1 PROBLEM STATEMENT

Public toilets need to be hygienic or they would affect the health of people because hygiene is directly connected to the badly maintained toilets. In an existing system, the focus is towards reducing water wastage on toilets, by the implementation of automatic flusher.

1.2 OBJECTIVE

To provide a technical solution to monitor the quality of the lavatories, so as to maintain it as and when required. Our aim is to provide an IoT based solution towards monitoring the quality of the lavatories, on the go while alerting the concerned one to carry out the necessary action using android application. Data analysis of lavatory gives us the solution to prevent the future causes.

The system is tested for its working and it is observed that implementing them in real time would help in building a healthy chain of lavatories.

1.3 MOTIVATION

All the public toilets should be clean and hygienic. From the simplest of the bus stands in interior villages, to the most sophisticated airports, toilets play a major role. Lavatories inside the train, flight or any other mode of transport is included in the list. All of these lavatories, if not maintained well, would lead to many disastrous and dangerous diseases like, Staphylococcus, Escherichia and Streptococcus.

Surveys reveal that these unclean lavatories are agents which mostly target the children and victims are mostly under 5.

1.4 NOVELTY IN THE PROJECT

Overall, our proposed product provide a frugal, cost-effective and completely viable solution for the major factor that causes a lot of human losses through infections and side effects. Though the cleaning process is not automated, the monitoring is completely automated and thus require only minimal maintenance.

CHAPTER 2
LITERATURE SURVEY

This chapter deals about the existing work carried out in the field of IoT and data analytics.

2.1 BLOGSPOT

2.1.1 IoT smart restroom solution for your convenience and well-being

https://quintagroup.com/blog/iot-smart-restroom-solution-for-your-convenience%20-and-%20well-%20being-2

This blogspot focus on IoT based hand hygiene. This help us to understand about various sensors and how they are implemented in real time.

2.1.2 IoT in facility management

https://vighnaharta.in/blogs/iot-in-facility-management/

This blogspot focus on building management systems. New breed of sensors is helping to monitor various existing systems like Fire Fighting & Alarm Systems, Intrusion Detection Systems. It can also monitor Occupancy of office desks, meeting rooms, cabins etc, Indoor Air Quality (parameters like Temp, Humidity, VOC, CO2 gasses), Vibes of the place (Lux level, Noise level).

2.1.3 Exploratory Data Analysis(beginner), Univariate, Bivariate and Multivariate — Habberman dataset

https://medium.com/swlh/an-open-architecture-iot-washroom-e71af755f96d

This blogspot focus on EDA using Univariate visualizations, bivariate visualization, and multivariate visualization and some plots. This blog was helpful to get an idea of using EDA.

2.1.2 Exploratory Data Analysis (EDA) in Python

https://www.analyticssteps.com/blogs/what-data-analytics-and-its-types

This blogspot gave an idea about how to explore a Data set and perform exploratory data analysis in python.

2.3.4 A Beginner's Guide to Exploratory Data Analysis with Linear Regression

https://blog.exploratory.io/a-practical-guide-of-exploratory-data-analysis-with-linear-regression-part-1-9f3a182d7a92

In this article, they have explained about EDA with linear regression analysis.

2.2 WEBSITE

2.2.1. Smart-Alert-App

https://github.com/mariosp/Smart-Alert-App

This application notifies the user when an earthquake occurs. Also, it sends a text message to close contacts on fall detection of the user.

2.2.2. IOT_ toilet

https://github.com/nileshpandey31/IOT_toilet

This application solves public toilet hygiene issue by giving alert to concerned exploratory data analysis in python.

2.3 RESEARCH PUBLICATION

2.3.1 Developing smart toilet using IoT

http://www.aadpubl.eu/hub/2018-119-14/articles/1/67.pdf

This website is a project published by Academic publications. This paper is based on IOT and image-processing concepts using different sensors like smell sensor,

IR sensor etc. By using these sensors, we can create smart toilets. This website was helpful in learning about different sensors.

2.3.2 An IoT Implementation for Optimization of Resources

http://www.kmice.cms.net.my/ProcKMICe/KMICe2018/pdf/CR28.pdf

In this conference paper the efforts which have been done for the smart toilet is only for the toilet bowls cleansing.

2.4 CONCLUSION FROM LITERATURE SURVEY

From the literary survey, we can conclude that there have been various attempts to solve toilet hygiene. Most work has been focused on complete toilet management with full cleaning automation. The use of automation will require more costs. There is a need for a cost effective and completely viable solution with data analytics for future references.

CHAPTER 3

SYSTEM DESIGN

3.1 MODULE DESCRIPTION

Sensors model

Description: sensors will send data to the microcontroller and it will get displayed on the serial monitor. (Figure 3.1)

Input: sensors

Output: digital values

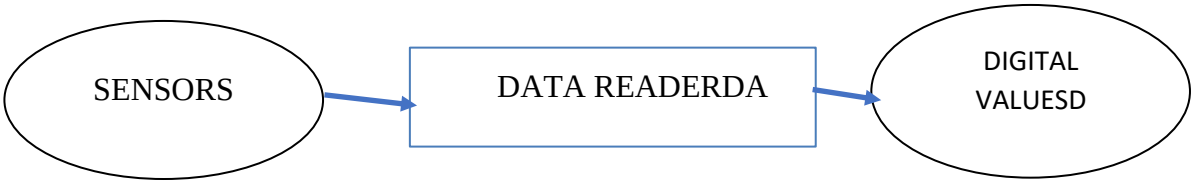

Figure 3.1 Sensors model

Splitting Date into month, year, date, day, time, season, time

Description: segmenting date into month, year, date, day, time, season, time (Figure3.2)

Input: date

Output: month, year, date, day, time, season, time

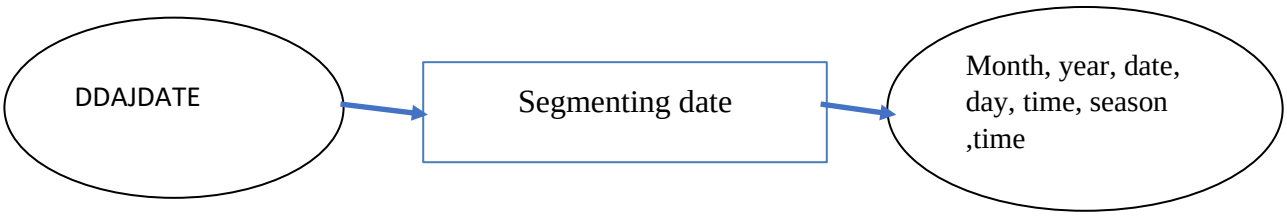

Figure 3.2 Splitting Date into month, year, date, day, time, season, time

Linear regression model

Description: Getting unknown gas sensor value for the respective known hour. Get_cofficients used to get the slope(m)and intercept(c) values from get_variance, get_covariance, get_mean. (Figure 3.3)

Input: test and train data

Output: month, year, date, day, time, season, time

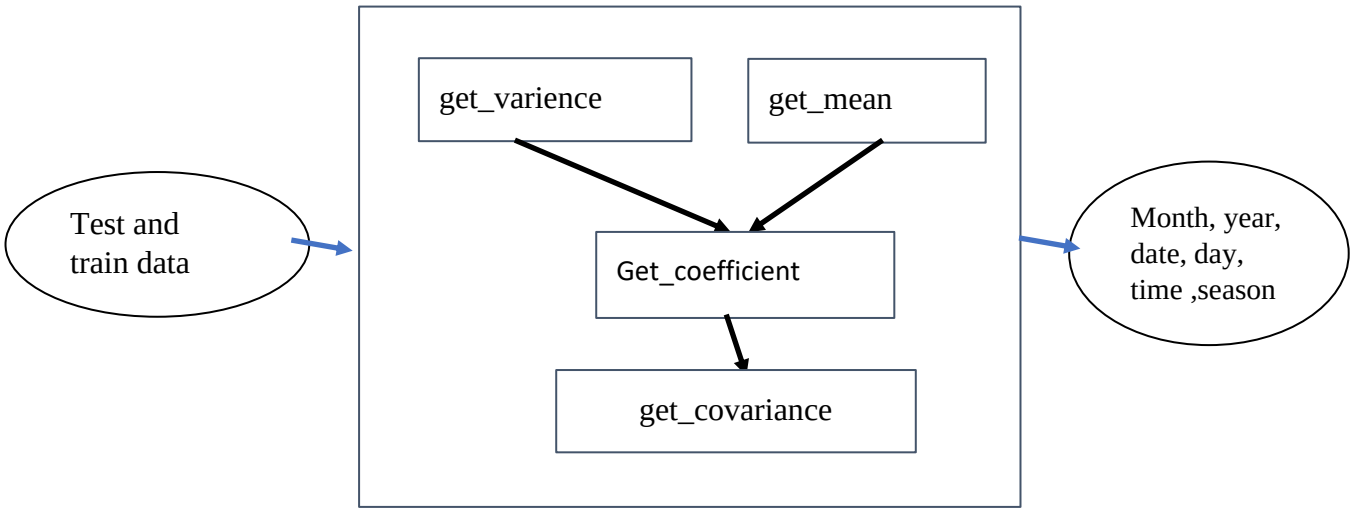

Figure 3.3 Linear regression model

3.2 ARCHITECTURE DIAGRAM

The data from the gas sensor (MQ-05) can be used to collect the Methane level present in the Lavatory and PIR sensor for motion detection. The sensors implanted in the lavatory shall be sending data to the microcontroller. The process happens in a microcontroller and data is stored in the cloud for the future prediction or reference.

If the methane level is higher for a period of time, then it means that the toilet is not clean, and an alarm is sent to notify the concerned team that Lavatory needs to be cleaned. To get the best prediction possible about the lavatory cleanliness, an OLED display is mounted outside the toilet to inform people whether we can use it or not. Toilet details and employee

details will be sent to firebase for management. Gas sensor value and Person count value will be continuously sent to firebase from microcontroller with certain time interval.

Android app continuously fetch the data and check whether the gas value is higher than the threshold value or not, if yes app will automatically send a message to the person who is allocated by the app user or admin at that time. (Figure 3.4)

The technical flow of data analysis,

1)Importing Libraries & Loading Dataset

2)Data Pre-processing

3)Exploratory Data Analysis (EDA)

- Univariate Analysis
- Multivariate Analysis

4)Using linear regression predicting the unknown methane value of known time. (Figure 3.5)

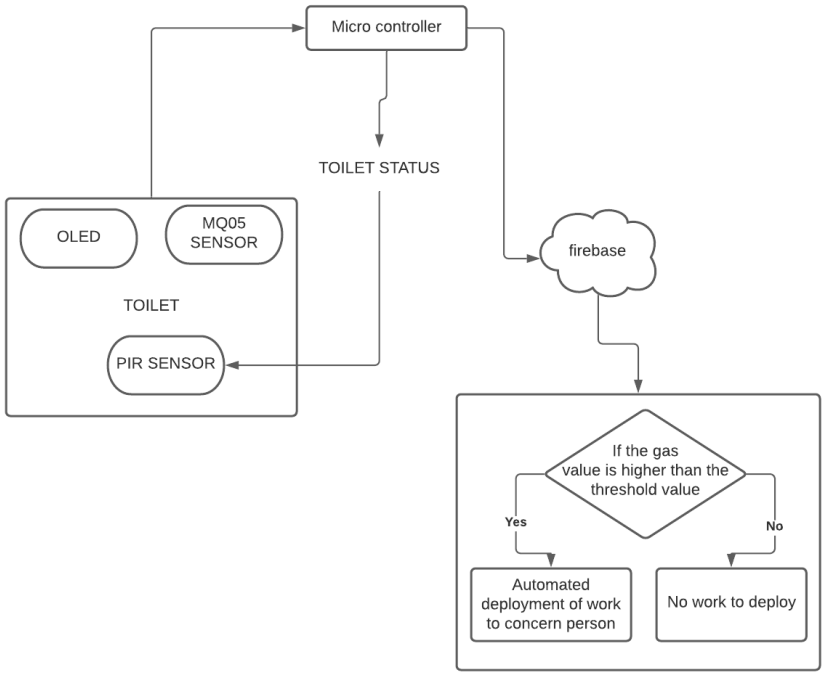

Figure 3.4 Flowchart -Alert message generation using android application & microcontroller

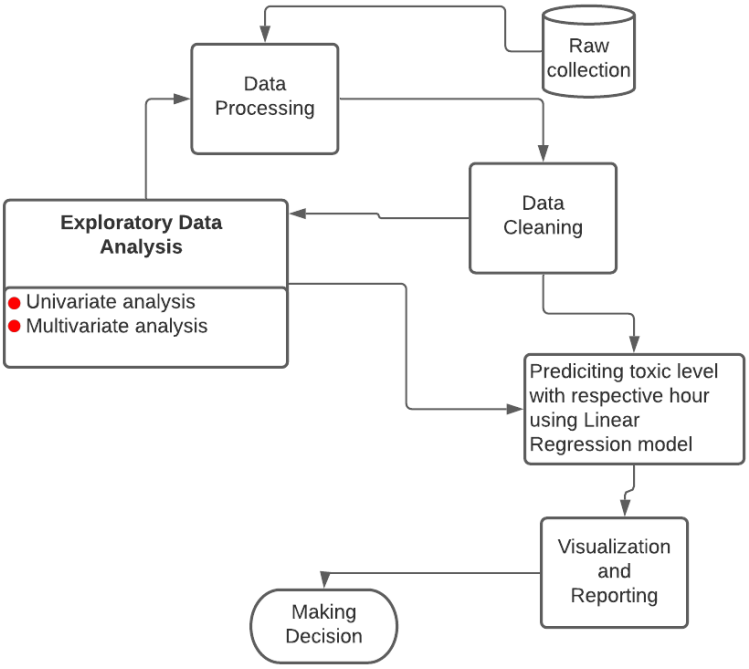

Figure 3.5 Flowchart-Data analysis

3.3 TOOLS AND APPLICATIONS

SOFTWARE REQUIREMENTS:

ARDUINO - Arduino Integrated Development - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the ESP32 hardware to upload programs and communicate with them.

FIREBASE - The Firebase Realtime Database is a cloud-hosted database in which data is stored as JSON. The data is synchronized in real-time to every connected client. All of our clients share one Realtime Database instances and automatically receive updates with the newest data, when we build cross-platform applications with our iOS, and JavaScript SDKs. The Firebase Realtime Database is a NoSQL database from which we can store and sync the

data between our users in real-time. It is a big JSON object which the developers can manage in real-time. By using a single API, the Firebase database provides the application with the current value of the data and updates to that data.

ANDROID STUDIO - Android Studio is the official integrated development environment (IDE)for Android application development. It is based on the IntelliJ IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools. To support application development within the Android operating system, Android Studio uses a Gradle-based build system, emulator, code templates, and GitHub integration. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and Google App Engine modules. Android Studio uses an Instant Push feature to push code and resource changes to a running application.

ANACONDA - JUPYTER NOTEBOOK-The Jupyter Notebook is an open-source web application that allow to create and share documents that contain live code, equations, visualizations, and narrative text. Its uses include data cleaning and transformation, numerical simulation, statistical modeling, data visualization, machine learning, and much more. Jupyter Notebook (formerly IPython Notebooks) is a web-based interactive computational environment for creating Jupyter notebook documents.

HARDWARE REQUIREMENTS:

NODEMCU BOARD -The Esp32 Devkit v1 is one of the development board created to evaluate the ESP-WROOM-32 module. It is based on the ESP32 microcontroller that boasts WIFI, Bluetooth, Ethernet and Low Power support all in a single chip. The entire solution takes up the least amount of printed circuit board area.

PIR SENSOR - A passive infrared sensor is an electronic sensor that measures infrared light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

MQ05 SENSOR -They are used in gas leakage detecting equipment's in family and industry, are suitable for detecting LPG, natural gas, town gas, cigarette smoke etc. MQ-05 SENSOR consists of 6pins. 4 of them are used to fetch signals other 2 for providing heat current.

OLED – [Organic Light Emitting Diode**]** is a relatively new technology with the potential to replace current LCD and LED televisions, monitors, and cell phone displays. An OLED module display is made up of many layers; first it is sealed on the top or bottom by a transparent material, usually glass or plastic.

BREADBOARD - A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode).

CHAPTER 4

IMPLEMENTATION & RESULT

4.1 ALGORITHM DESCRIPTION

ALGORITHM 1 :

Step 1. Start

Step 2. Start get_coefficients(x, y):

Step 3. define x_mean = sum(x)/len(x y_mean = sum(y)/len(y)

Step 4. define final_arr = (x - x_mean)*(y - y_mean)

Step 5. define m = sum(final_arr)/(x -x_mean)**2

Step 6. define c= y_mean - x_mean*m

Step 7. return m, c

Step 8. End get_coefficients

Step 9. Start linear_regression(x_train, y_train, x_test, y_test):

Step 10. define prediction = []

Step 11. define m, c = get_coefficients(x_train, y_train)

Step 12. Start for x in x_test:

Step 13. y = m*x + c

Step 14. End loop

Step 16. prediction.append(y)

Step 17. return prediction

Step 18. End linear_regression

Step 19. define linear_regression(x[:6960], y[:6960], x[6960:], y[6960:])

Step 20. Stop

4.2 FLOWCHART

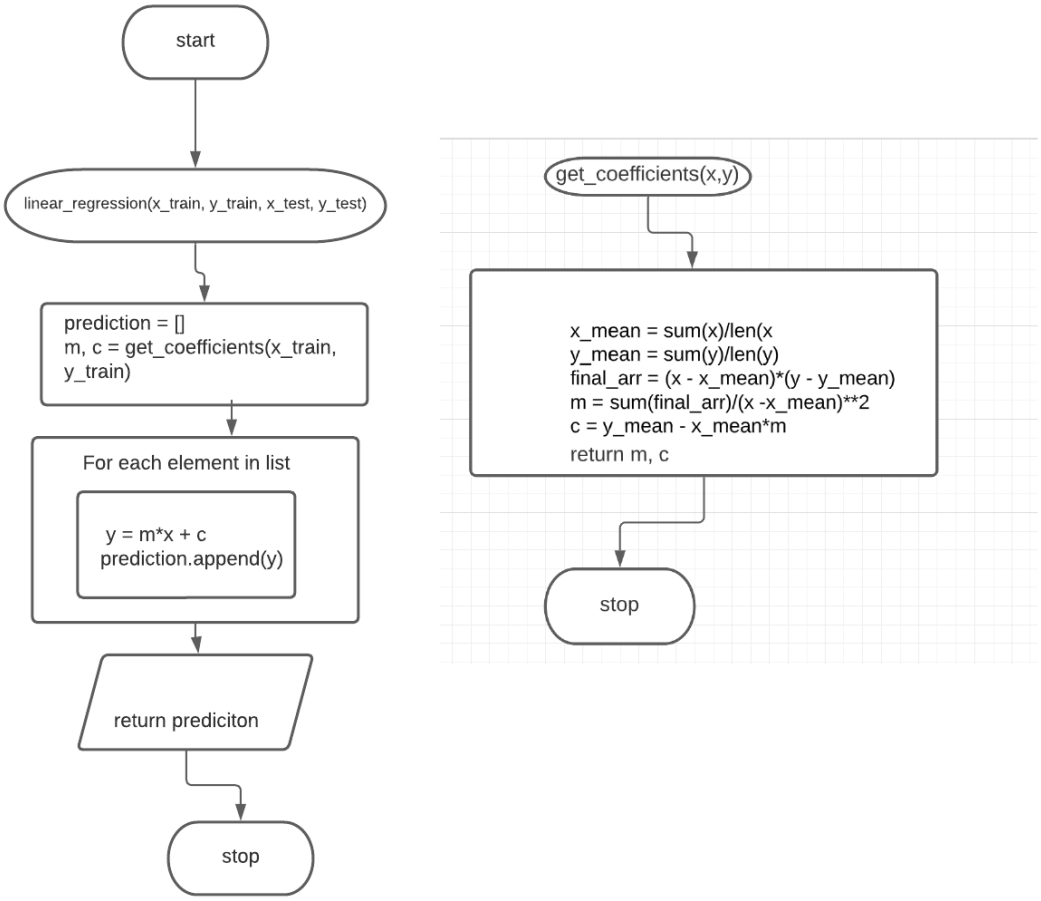

Figure 4.1 Flowchart-Linear Regression

The get coefficients function return slope(m) and coefficient value of each data which helps to find the linear regression line (Figure 4.1)

4.3 RESULT AND DISCUSSION

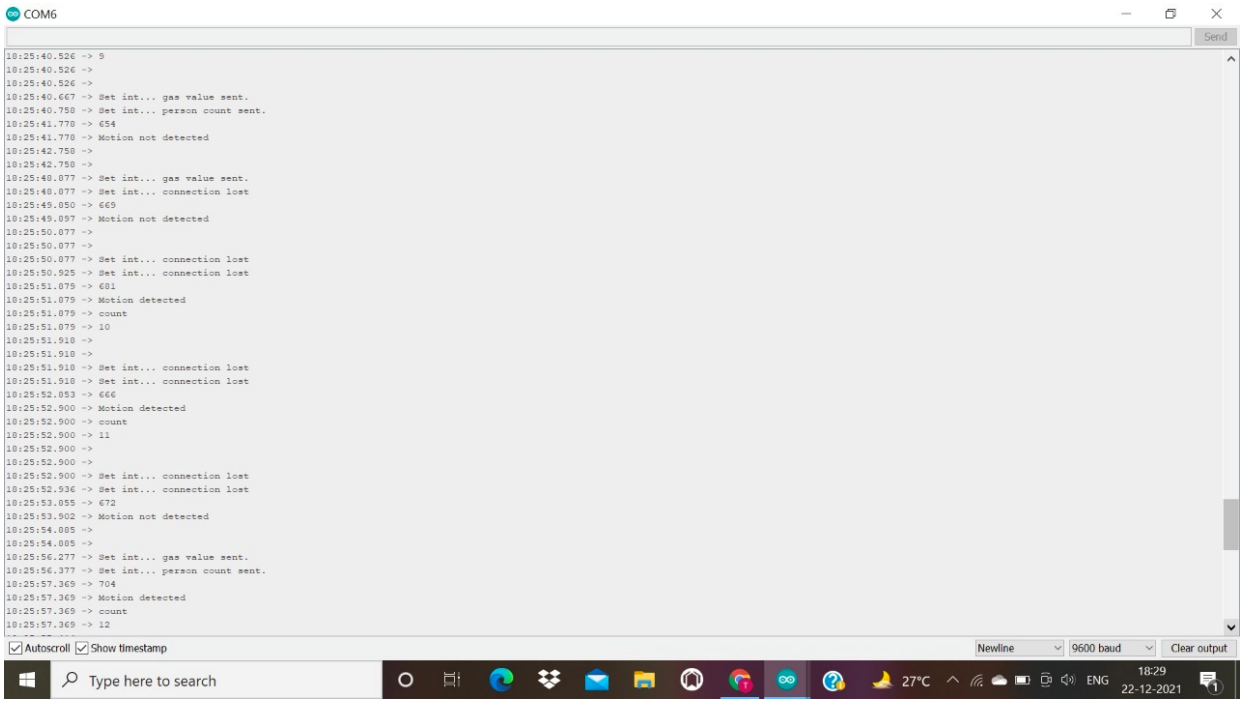

Figure 4.2 Sensor value

In this Figure 4.2 shows the output of sensors (MQ5 , PIR) values on serial monitor.

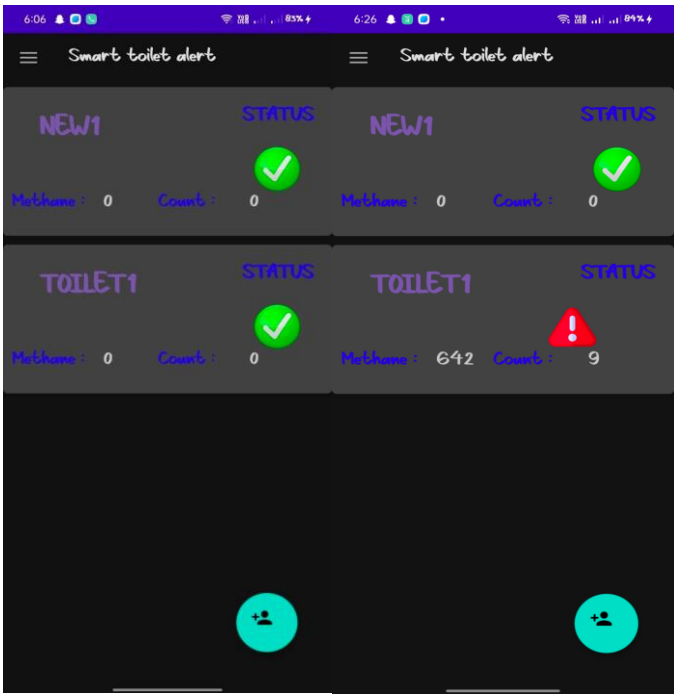

Figure 4.3 Homepage before and after connected with IOT

In this Figure 4.3 shows the output of homepage before and after connected with IOT in android application.

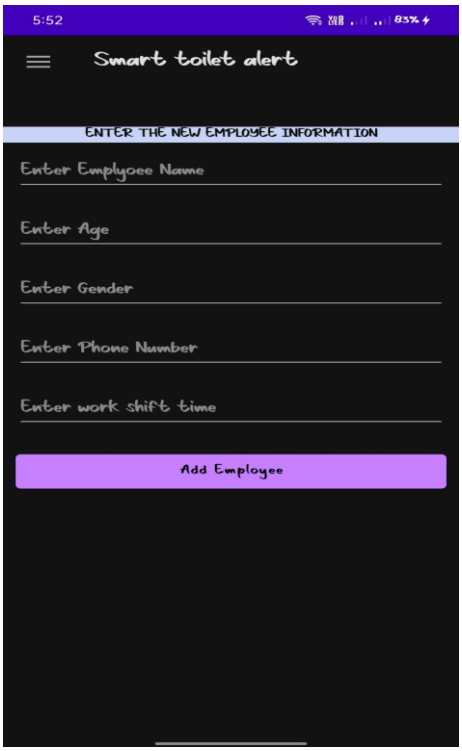

Figure 4.4 Employee page

In this Figure 4.4 shows the output of employee page where the employee details can be added.

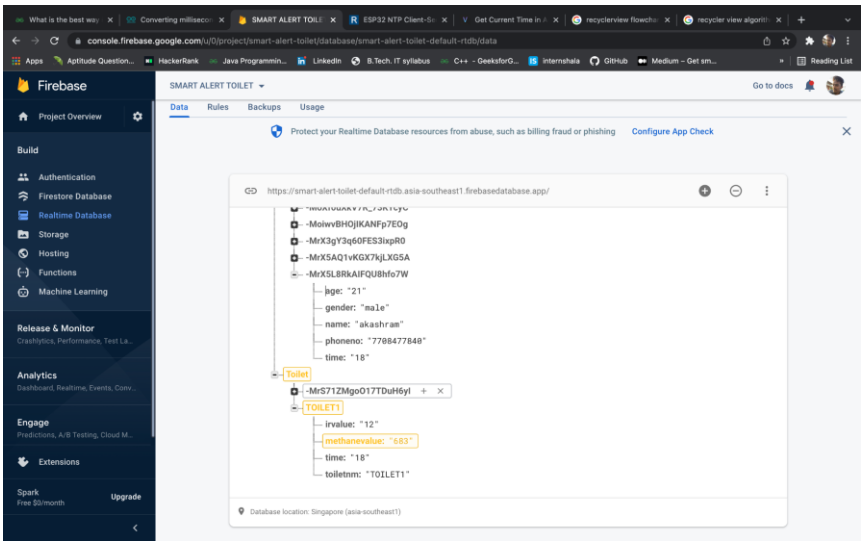

Figure 4.5 Firebase

In this Figure 4.5 shows the output of data stored in firebase.

Figure 4.6 Alert message recorded in employee phone

In this Figure 4.6 shows the screenshot of employee phone where the alert message was received.

Figure 4.7 Univariate Analysis of IR and Methane sensors

In this Figure 4.7 shows the output of univariate analysis of IR and methane sensor.

Figure 4.8 Univariate Analysis of Monthly readings count

In this Figure 4.8 shows the output of univariate analysis of monthly readings count.

Figure 4.9 Multivariate analysis of day with methane.

In this Figure 4.9 shows the output of multivariate analysis of day with methane.

Figure 4.10 Multivariate analysis of inside toilet temperature with outside temperature

In this Figure 4.10 shows the output of multivariate analysis of inside toilet temperature with outside temperature

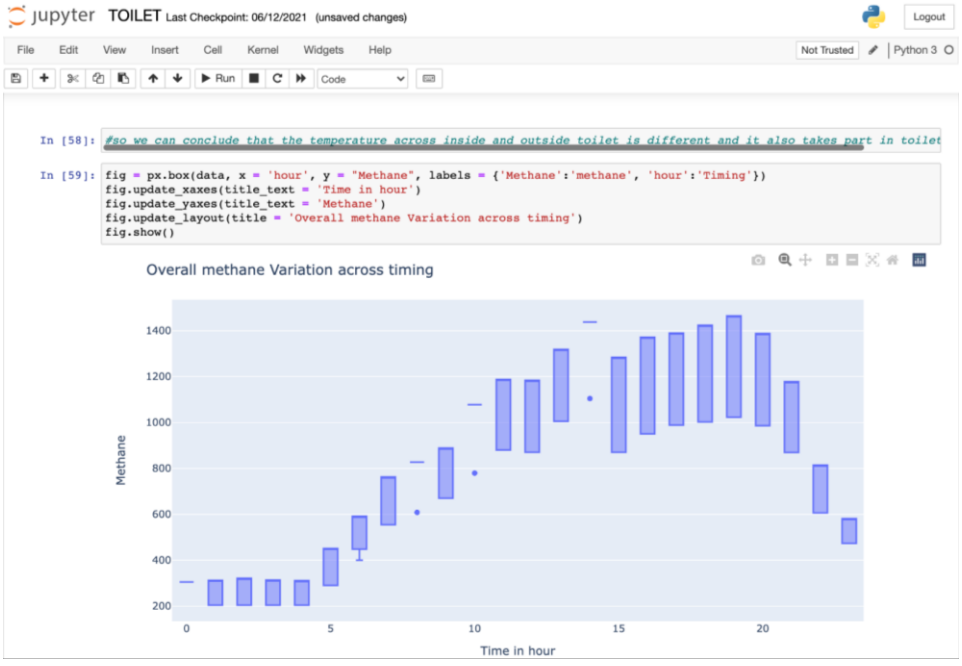

Figure 4.11 Multivariate analysis of overall temperature vary across months inside and outside

In this Figure 4.11 shows the output of multivariate analysis of inside toilet temperature with outside temperature

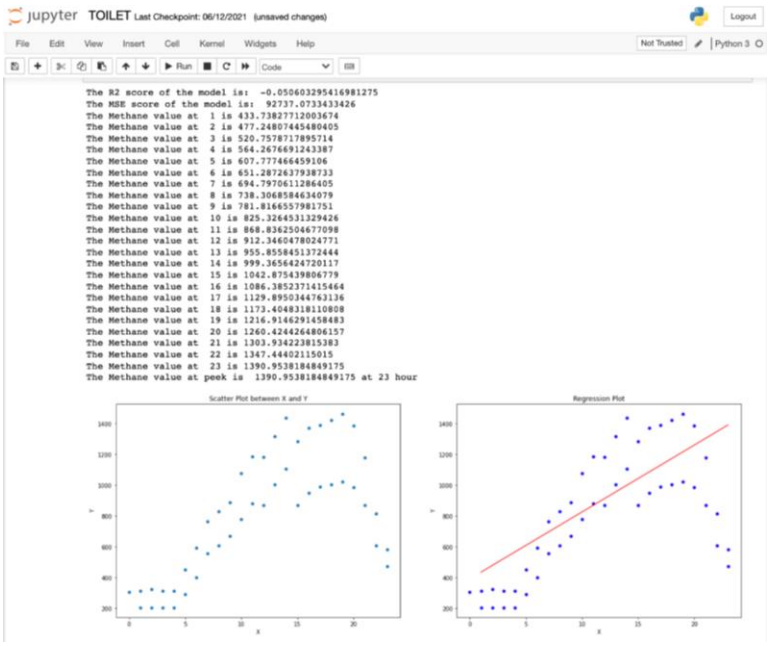

Figure 4.12 Using linear regression predicting the methane value

In this Figure 4.12 shows the output of predicted methane value of known time and also the visualization of graph.

CHAPTER 5

CONCLUSION & FUTURE WORK

5.1 CONCLUSION

The system monitors the quality of the lavatory without any manual interruption through the sensor inputs and an appropriate alert will be generated to the concerned person**.** This data is collected on the go which really is the major appreciable factor. The cost incurred towards implementing this would be very viable and minimum. Overall, we have provided a frugal, cost-effective and completely viable solution for the major factor that causes a lot of human losses through infections and side effects. Though the cleaning process is not automated, the monitoring is completely automated and does require only minimal maintenance. The system also utilizes the technology to the best possible extent which is visible through the use of sensors, IoT, data analytics**.** The predicted value from linear regression gives a better solution for the toilet management team to deploy more employees to clean the toilet for particular time. Thus, with this approach and system in place, it is very much possible to evade all the toiletry-based diseases such as Norovirus, Staphylococcus, Escherichia and Streptococcus. This can not only be implemented in bus stands or railway stations, the same can as well be brought home to make sure the lavatories are never the source of any infections.

5.2 FUTURE ENHANCEMENT

Future work is focused towards machine learning included in it as a core component. Also, our product can further be improvised with solutions towards women safety and emergency panic alerts. The aspect of logistics analytics can also be included in the product.

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