EasyChair Preprint

№ 2514

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January 31, 2020

WASTE MANAGEMENT SYSTEM: APPROACH WITH IoT, PREDICTION AND DASHBOARD

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Abstract :

After the mechanical transformation and development in innovation in recent decades, there has been a fast increment in the assembling ventures and its squanders as a result of which huge amounts of wastes are generated. These wastes contain harmful elements, gases, and toxic substances. The decomposition and degradation of certain wastes generate landfill harmful gases. The wastes and the gases lead to soil, air and water pollution. To manage these wastes in an effective way we propose an approach that can provide a way of monitoring the wastes and the gas levels and managing it by taking measures. The idea is to make use of certain sensors or cells that detect changes in the wastes and gas levels. Making use of concepts of IoT, machine learning and graphical representations to provide the information about the current and future level changes in the wastes and gases in the regions where sensors are located. In this paper, we are focusing on the levels of changes in gaseous wastes including landfill gases generated due to the wastes in the various regions. The prediction results of the gas levels can help in taking preventive and precautionary measures for proper management and disposal of these wastes.

Keywords: Waste Management, Prediction, IoT, Technical analyst, Dashboard.

I.INTRODUCTION

After the industrial revolution and evolution in technology over the past few decades, there has been a rapid increase in the manufacturing industries, thus producing a huge number of various products. Along with useful and good quality products, a lot of solid, liquid, as well as gaseous wastes are generated. Emission and disposal of these directly into the environment adds up to the ever-rising greenhouse effects, global warming problems and also other environmental problems. To keep a check on the statistics of all such harmful wastes, we propose a framework.

The framework consists of the design where we collect data about the wastes, perform some analysis that predicts the values in the percentages and levels of certain harmful substances and gases and displays it on a dashboard. We make use of certain electrochemical sensors [21], semiconductor metal oxide sensors [13] or cells that detect changes in the levels of the wastes, the data collected is stored on the cloud. A set of predictive analysis algorithms are applied to the collected datasets to give information about the current as well as future level changes that might take place in these toxic wastes. All the statistics and analysis [2] regarding the waste-related data will be displayed on the dashboard in the form of graphs and pie charts [1]. This data can be used by certain government organizations, environmental activists and other waste management organizations to implement certain preventive and precautionary measures.

2. SURVEY OF EXISTING WORK

Waste management has become an important factor in our ecosystem. We have searched our papers by using certain keywords like IOT sensors, detecting gases, Dashboards, Visualization, Prediction analysis, and recommendations. For detecting the different gases and monitoring the temperature and levels of Ph., different devices/sensors are used like Electronic Nose, IOT (UVI-01) and RFID device,

semiconductor metal oxide sensors [4][10][11][13]. For prediction analysis and data analytics and also for effective refurbishment, the EMARP algorithm is used. And also for efficient analysis, there are different algorithms like Neural Networks which is used to identify efficient dimensions i.e. cost, time, quality [1][2]. The definition of dashboard might be depending on performance and visual effect [6] and also it must be flexible and user-friendly [7]. For visual management, LP Steen Kamp and the team used the Automation Pyramid tool[3]. Hence in our project, we're going to use the concepts of IoT sensors, predictive analytics algorithms and dashboard techniques to display the analysis of data related to all sorts of wastes.

3. PROPOSED SYSTEM DESIGN

In the proposed idea we have sensors located at N different regions. The sensors are classified into sets such as sensors detecting a particular gas/element that belongs to that particular sensor set. Every sensor set has its unique id and also every region has its reg_ID. As shown in Figure.1. IoT based Approach various areas like Area 1, Area 2 and Area 3 where sensor sets are placed that detect various harmful gases.

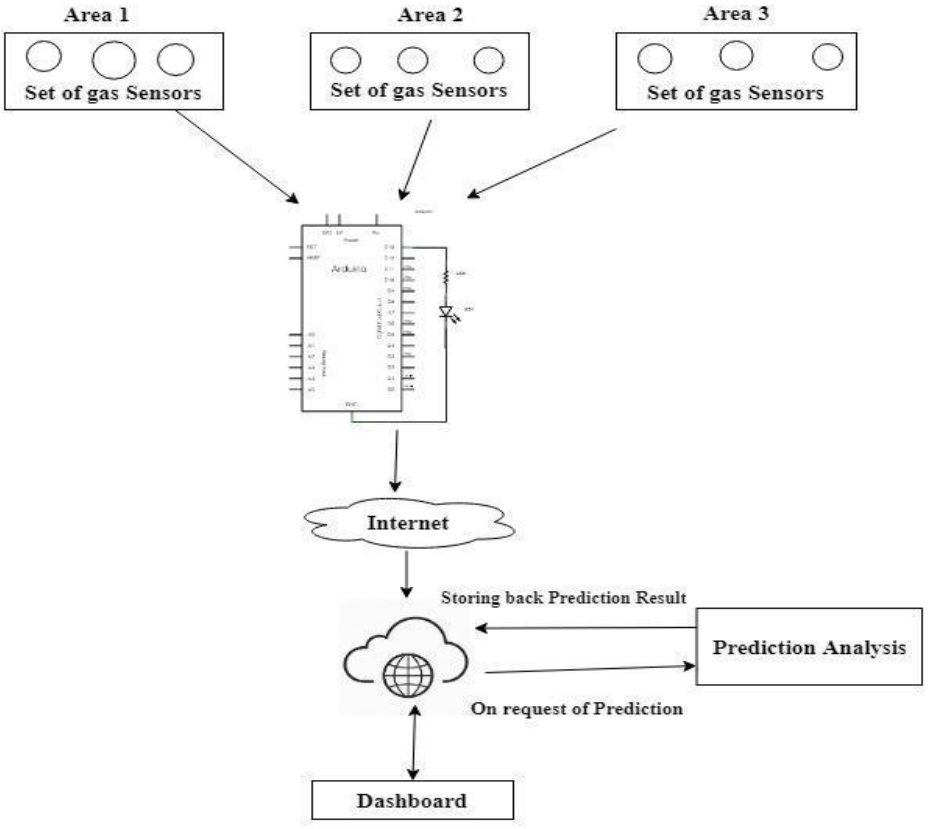

Fig.1. IoT based Approach

The set of Arduino boards act as the middleware that gets the data from sensors and classifies and identifies the data based on the sensors. The data is sent on the cloud where it is stored based on region and sensor's respective ids. The dashboard is a graphical user interface that simplifies the complex data. In this dashboard phase, we are displaying the data in different patterns. For displaying data we are retrieving the data from the cloud. For that data, we are performing different display operations i.e. line-chart, pie-chart, radial-chart and so on. When a prediction request is made on the dashboard, the prediction analysis is applied to the respective datasets on the cloud and the data is stored back. The dashboard retrieves this data and displays it. This data analysis can be used to incorporate effective steps and manage the wastes – causing the gases in the respective regions.

A. Functional Flow of the IoT Approach

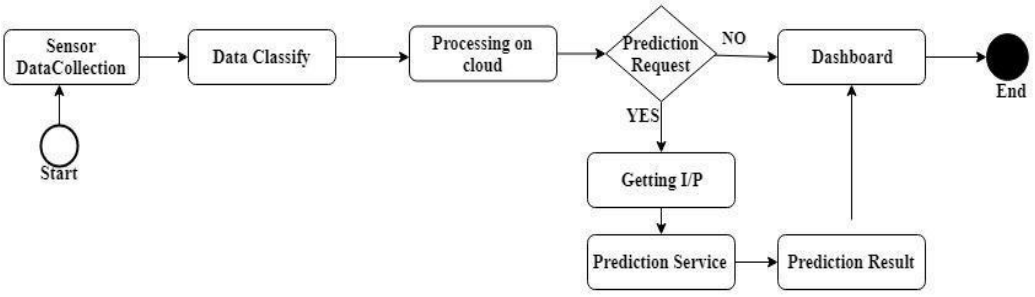

Fig.2. Functional Flow Diagram

The steps to be followed in functional flow diagram are:

1. Sensors collect the data.
2. Arduino board acting as a middleware stores the information on the cloud, data classification data based on sensor ids.
3. Data processing is done on the cloud. The cloud server continues checking whether the information is in the necessary format. At the point when the information is ready , it stores on the cloud.
4. The home screen is shown to the client as an interface. The client can make demands for information with respect to level changes of different gases and furthermore for forecasts about the gas levels.
5. On demand from the client the information will be shown. At the point when a prediction is made, in the event that it is for simply showing the level changes in the gases as for time, amount of wastes and other such parameters, then the information is sent legitimately on the dashboard and showed in graphical portrayals.
6. In the event that the prediction is accomplished for forecast, at that point the datasets are given to analysis model.
7. Then the predictive analysis applied on datasets.
8. Then the result will be displayed on the dashboard.

4. IMPLEMENTATION AND RESULT

As discussed in the previous section, this work is addressing an IoT prediction and dashboard making the whole framework modular and compact to different environments.

The particular components used to execute the modules are given below:

A. Sensor Module as Input Phase

Various landfill gases are released in the environment on/after the waste disposal. The sensors sets in various regions detect values of gas levels. In this System, we can use various sensors like Ionization Detectors used for detecting hydrocarbons (HC) such as acetylene (C2H2), ethane (C2H6), methane (CH4), etc. Suppose there are 10 sensors in the sensor set of Methane detectors, each sensor gives a value for the same gas. That means sensors id1, id2, .. id10 denoting ionization detectors detect values v1,v2, ,v10. These are sent on the cloud, to store values of the gases. The values stored in the cloud in a schema with attributes as weights/amounts of wastes dumped, gas levels, time, date, etc.

In this state diagram at first sensors are in idle state, on an hourly basis intervals the sensor

data is collected and the state of the sensor changes to Active state. Inactive state continuous detection and sensing of the gas levels in the environment are done. The data collected is sent to the cloud with the help of the Arduino board. Arduino board classifies the data in Type of sensors and stores it into the cloud. In some cases, if the gas levels cross the threshold level which is set in the sensor, the data is sent directly to the Cloud. Used.

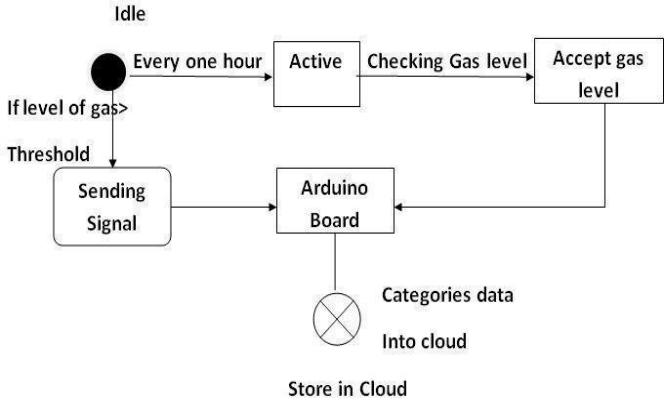

Fig.3 Working Model of Sensors

B. Prediction Analysis Phase

In the whole process, a lot of data will be collected and stored on the cloud, which can be used to make predictions about levels of several gases. Predictive analysis uses statistical techniques from data mining, predictive modeling and machine learning that analyze the current and historical facts to make predictions let's consider one of the regions where our setup is established, for example, Area 1. Various sensor sets are placed that detect the changes in values of gases. To make predictions regarding the Methane gas levels, analysis is applied to the cloud data. The dependency on Methane gas and some fixed parameters like weight. Preprocessing is done on this data. The data obtained is analyzed for patterns and trends. In our Methane gas example, the dataset shows a dependency on the weights of wastes with the Methane gas. The prediction algorithm that best suits this case is Regression. In our pre-processed dataset available, the modeling can be done to identify what sort of dependencies are present. We get that there is a linear dependency between the weight of wastes dumped (kgs) and gas released. In the linear regression model, a line is found that most closely fits the data according to the specific mathematical criterion.

In our Methane gas case from the graph we realize that a linear line can be fitted the equation can be shown as:

$$MG = a + b * (W) \qquad (1)$$

MG - Methane Gas levels W - Weight of wastes dumped a - y intercept, b - slope of line. A generalized equation for any gas can be written as:

$$G = a + b *(W) \qquad (2)$$

The weight (W) is an independent variable while the Methane gas levels (MG) depends on it. Thus depending on the trends and patterns in our dataset the analysis is done and the regression technique is decided. The modelling contains data training thus finding the values of unknowns a and b of the equation. The values of a and b can be found by:

$$a = \frac{\left(\sum G\right)*\left(\sum (W)^2\right)-\left(\left(\sum W\right)*\left(\sum (W*G)\right)\right)}{n*\left(\sum \left(W^2\right)\right)-\left(\sum W\right)^2} \qquad (3)$$

$$b = \frac{n*\left(\sum(G*W)\right)-\left(\left(\sum W\right)*\left(\sum G\right)\right)}{n*\left(\sum\left(W^2\right)\right)-\left(\sum W\right)^2} \quad (4)$$

Where G is generalized for all gas levels, W is weight of wastes dumped, n is the number of datasets.

Thus calculating a and b we get the line equation which is used to predict a gas level value given the weight of wastes dumped in the region. The predicted values are sent to the dashboard for display.

C. Dashboard Phase

The results can be represented in different formats like line-chart, radial-chart, pie-chart, bar-chart. Here the collected data is displayed using line chart as shown in figure 5.Here the data focuses called markers and it showed by straight line fragments.

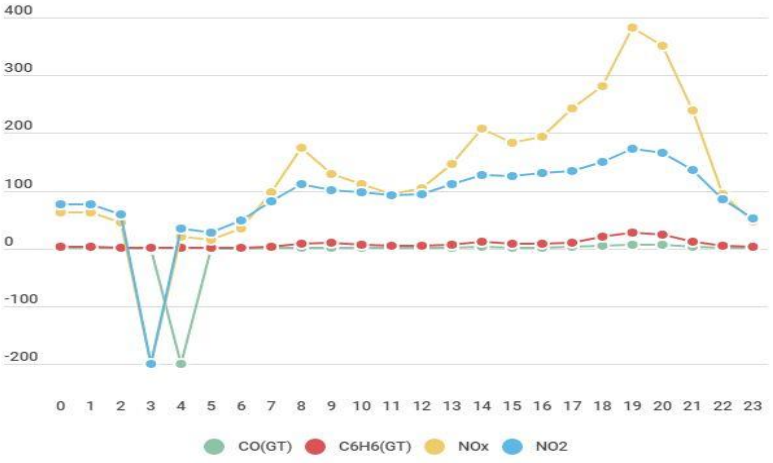

Fig.5 Line chart for different levels of gases

The representation can also be done as a radial Chart or Spider Chart. It is graphical strategy which shows multiple information in two dimensional formats. In this at least we have to provide three factors. Here we have given 4 quantitative factors i.e. CO, C6H6, NOx, NO2 is shown in figure 6.

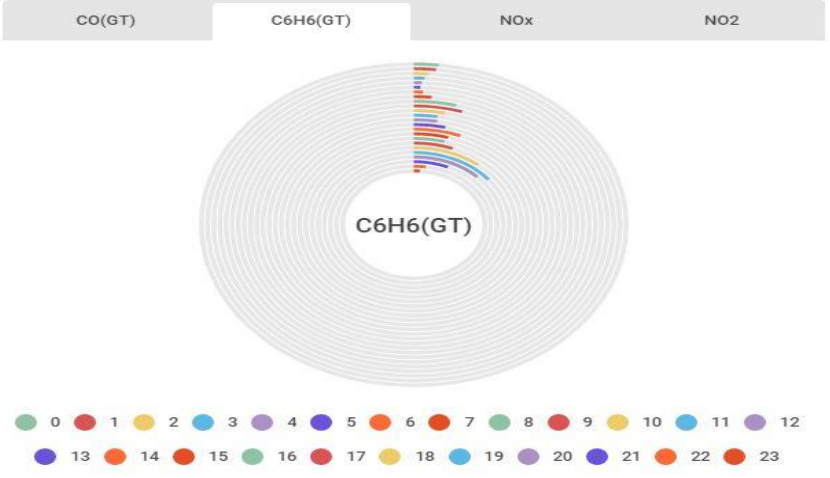

Fig.6 Radial chart for C6H6 gas

5. CONCLUSION

The system has been designed as per the requirements. The system successfully retrieves sensor datasets from the source of gas sensors, prediction analyses the benchmark values of gas and delivers a prediction in an easily understandable manner to the user with a dashboard with graphs. The single predicted value and the graphs displayed help the user to understand gas levels better. The dashboard interface is minimal and easy to use.

For future enhancement, we can consider improving the prediction mechanism by applying neural, and support for user-level analysis. There can be a notification system that can alert the subsequent phases of the waste management system to get alert based on the gas values. Finally, sensors, prediction analysis efficiency can be increased further so that the dataset retrieval can be quick.

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