Integrated use of IoT, SMAC and Gamification for effective Pollution control

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Abstract- This paper demonstrates a use case for using Internet of Things (IoT) along with Gamification, Social, Analytics, Mobile and Cloud (SMAC), for effective pollution monitoring, awareness and control. We also propose a solution and show these latest technologies can be integrated and used for an effective solution.

Keywords – Pollution, IoT, Social Gamification, Analytics, Cloud, Mobile

I. INTRODUCTION

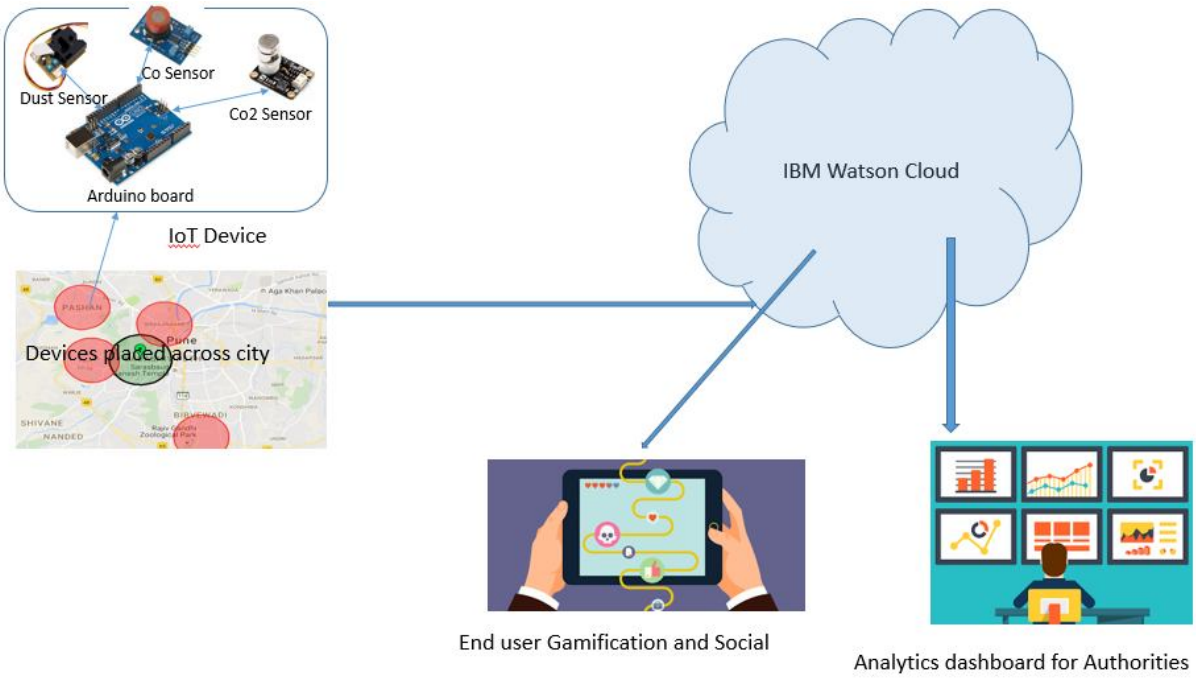
A pollution control system performs the following actions: Gathering pollution data, analyzing data to identify pollution levels and initiating corrective measures. With the advent of new technologies, we can achieve effective pollution monitoring and control using use a combination of different technologies. Internet of Things (IoT) can be used for data collection and monitoring via various sensors. Similarly, Data analytics and machine learning can be used for better prediction. In this paper we will see how we can integrate these technologies to have more effective pollution monitoring and control measures.

II. PROPOSED SOLUTION

2.1 Multiple technolgies at work –

Our proposed solution will work with the following steps:

1. Gather pollution data using IoT
2. Apply data analytics and machine learning to predict future pollution data
3. Use cloud infrastructure for better scaling and quick and cost effective deployment.
4. Use social to involve citizens in pollution monitoring and awareness.
5. Use gamification to motivate citizens to take actions
6. Use mobile for instant on-the-go delivery of pollution notifications on mobile and recording actionable



We will look at each of this steps in detail below.

IoT-

Internet of Things (IoT) includes smart devices that can collect pollution data and send over internet. Various smart sensors that can be used in this solution are:

1. Co2 Sensor
2. Co Sensor
3. Particulate matter sensor
4. Sulphur sensor
5. No2 sensors
6. Temperature & Humidity sensors

When connected to a Raspberry pi and Arduino Uno microcontroller, the sensors + microcontroller controller unit (referred to IoT unit), can send Pollution data for further processing. The data sent by these units can be secured using various security techniques like security key management. Cloud systems provide support for such security features.

IoT unit locations:

Such units can be placed all over a city at identified locations. The locations can be identified based on traffic patterns, to measure vehicular pollution, as well as, based on at critical pollution like Garbage dumps, River waters, Sewer processing unit outlets, Industrial zones, near industrial chimneys etc. Pollution control boards can

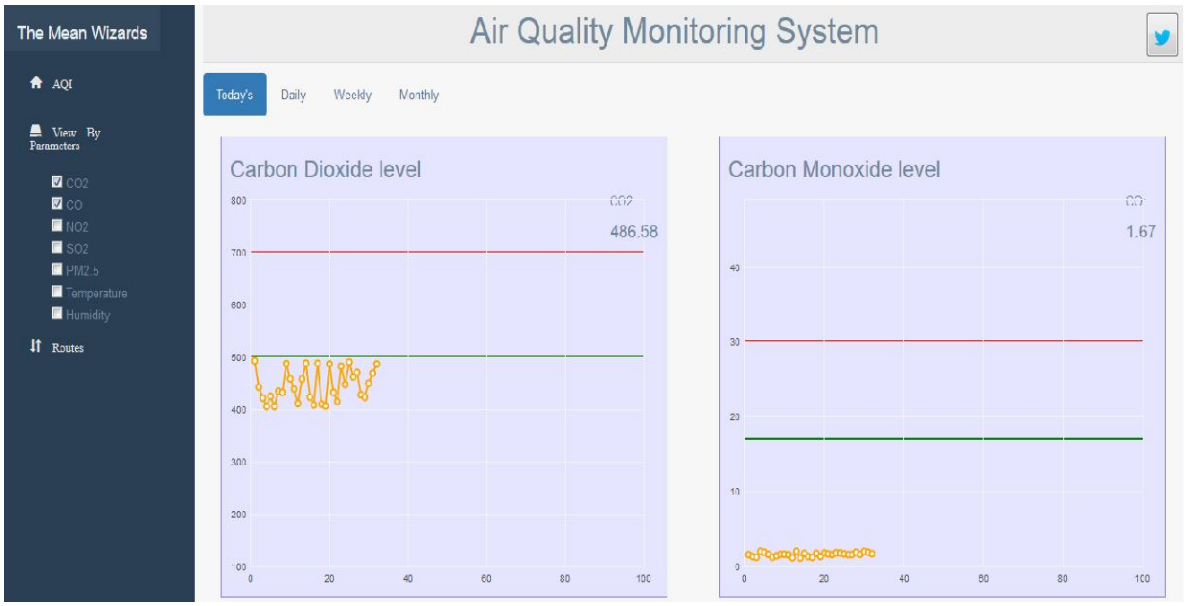
use such units to continuously monitor industrial pollution from various industrial units by installing such IoT units.

Cloud

The IoT units will send data to the backend system/server for further processing. Backend systems will be hosted on cloud infrastructures like Amazon AWS, Microsoft AZURE, or Google's Compute Engine. These Cloud platforms also provide IoT specific platform solutions, and hence reduce the effort and time required to deploy applications. For example, AWS IoT platform provides device security, device shadow state maintenance, and support for device communication protocols like MQTT, which are best suited for IoT. AWS IoT also provides easy integration with data storage options like DynamoDb and API management tools provided by AWS Cloud. Such integration reduce development effort. Using cloud platforms, we can scale the system to collect periodic data from hundreds or thousands of IoT units across multiple cities. We can have a highly scalable systems, as most cloud systems have scalability inbuilt.

Analytics

Pollution monitoring IoT units that are placed all over the city, will send data to backend for processing. Since the pollution data is collected at regular intervals, plotting it against time can give us an understanding of pollution patterns. We can get such pollution patterns for different locations over a period of time. This data can also be combined with traffic data, to correlate the impact of traffic on pollution. Weather data can also be correlated with pollution data. Some of the parameters that can be correlated are: Location, Time, Traffic, Weather, and Pollution.



Using analytics we can get some of the below data

1. Monitor pollution level of the area – measure harmful gas levels present.
    - Carbon monoxide levels
    - Carbon dioxide levels
    - Sulphur dioxide levels
    - Nitrogen dioxide levels
    - Particulate matter
2. Daily, weekly, monthly reports of air quality.
3. Reports will be in the form of graphs, charts and tables.
4. Users will also be able to view historical data of previous months and years.
5. Google map integration with UI to show best route based on air quality.
6. Display air quality levels of different locations in the map.
7. Future prediction of pollution levels in an area depending on past pollution and weather data using machine learning.

Machine learning

Various machine learning models can be applied on the correlated data. It will also help to get insights on the impact of the collected factors over pollution. Machine Learning can be applied for better prediction of future pollution levels. Weather prediction data, past traffic and weather data together can help make better predictions.

Mobile

The user can interface with this system using Mobile devices. Mobile notifications can be sent to users about pollution. Also, using GPS, the system can give information about the pollution level at his present location. Mobile systems also help in on-the-go gamification and other actionable that the user can take. For example, users can click images of garbage burnings and upload to site and get gaming points for this. We will look at this in more detail in the gamification section.

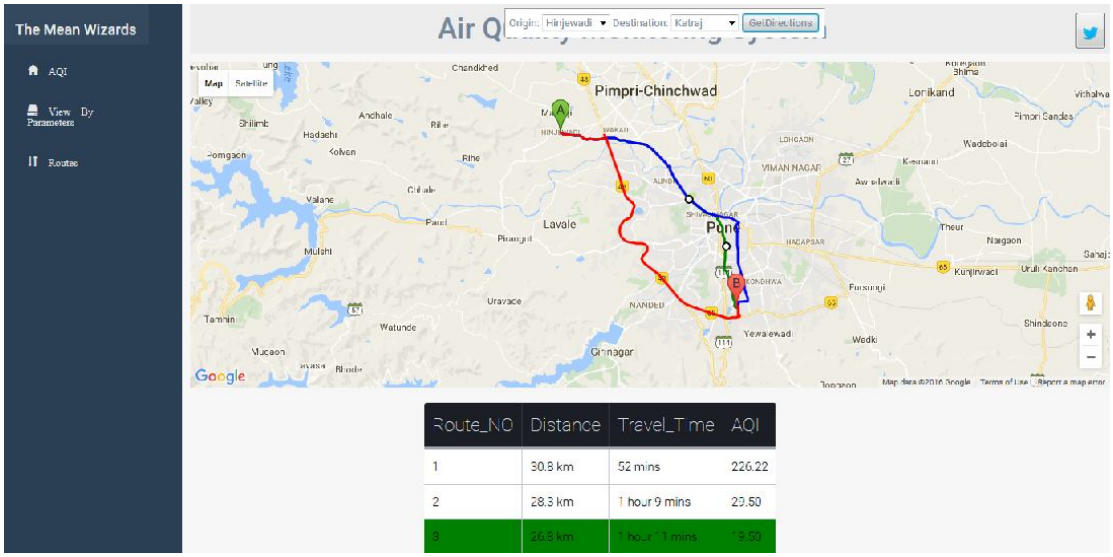
Social

To have citizens involved in pollution monitoring and control measures social media can be used. Users can subscribe to pollution related alerts for particular area, e.g. his residence area or work area. They can take following actions on pollution data

1. Share pollution data about their area on Face Book , Twitter
2. Prompt friends to check pollution levels in their respective localities.
3. Send message to friends when pollution area in his locality increases
4. Share on social sites pollution control measures taken by individual self.

Gamification:

Gamification can be used to engage citizens on ongoing basis to take active measures for pollution control and monitoring. Citizens will be able to login to the system and create accounts. They will get rewards for activities towards pollution measures. Activities involve monitoring pollution, engaging community and friends, social sharing, reporting to authorities. Mobile app will be the key for gamification and citizens can take actions on the go. The system can also suggest the least polluted route for going from one place to another. When the user takes least polluted route he can be rewarded with points.



Some of the gamification ideas are

1. Giving points to users for checking pollution levels
2. Giving points to user for sharing content on social networks
3. Giving points for inviting friends from social network for Air quality activities.
4. Giving points for forming groups on pollution.
5. Giving points to user for taking a less polluted route
6. Giving points to user for reporting any open air burning
7. Expressing discontent to authorities if system detects a sudden rise in pollution due to burning
8. Honoring citizens with max points
9. Finding citizens using this system in your neighborhood and being able to connect with them.

Above and various other gamification rewards and points can be used to motivate citizens and keep them engaged about Air quality monitoring and control measures in their city

IV.CONCLUSION

Technologies used in silos are not effective in increasing citizen's participation on Air quality monitoring and control measures. When gamut of technologies are put together, an effective solution can be built so that the citizens feel motivated and remain engaged in air quality monitoring and control activities.

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