Air Pollution and Traffic Monitoring Device based on ML & IoT

Akhil Bagathaliya
Department of Computer Engineering
Prime Institute of Engineering & Technology, Surat, India

Abstract— In this modern world air pollution become a major problem which cause direct impact on environment and human health. Where another issue of human violation and traffic jams also become primary focus for government to solve. Industrialization and increasing number of vehicles and firms are the primary source of pollution as well as traffic jams. This emission from vehicles cannot be fully dodged, but it definitely can be organized. The aim of the research reported here is the research of applicability of machine learning methods with the help of Internet of Things (IoT) devices for air quality, human violation and traffic monitoring. Obtain the solution from combining the IoT devices with a new era machine learning technique to make prediction of air pollution and traffics. The aim of project is to develop a device which predicts and monitor air quality as well as traffic jams. The device is in 3D-hexagonal shape where at bottom various sensors to measure pollution and above that 4-advance camera set up to measure traffics in each direction. Above that Solar panels for power supply for device and at top a hanger to attach with the pole. Devices placed in each cities for monitoring and it also accessible for everyone (via App) to know the current status.

Key words: Machine Learning, Generic Algorithms, IoT Devices, High-Definition Cameras

I. Introduction

As we know, Air pollution and Traffic jam become a major issue to solve. Air pollution may cause breath problems, allergies and even death to living beings. Where in traffic jam wasted fuel increasing air pollution and carbon dioxide emissions owing to increased idling, acceleration and braking. Human activities emitting gases such as Carbon dioxide (CO_2), Sulfur oxides (SO_x), Nitrogen oxides (NO_x), Carbon monoxide (CO), Volatile organic compounds (VOC), Chlorofluorocarbons (CFCs), Ammonia (NH_3) and so on. Detection and control of these gases is primary work. It is important task to protect our life and surroundings with some proper management. Where increasing number of vehicle in cities can causes high amount of traffics and violation of the rules. This causes serves various destruction to people. These are the two mainly task to be solve. As a solution for monitoring Detection and control of these gases is an important area of work. to the above problems our aim is to design a device which is combinational method of machine learning with IoT.

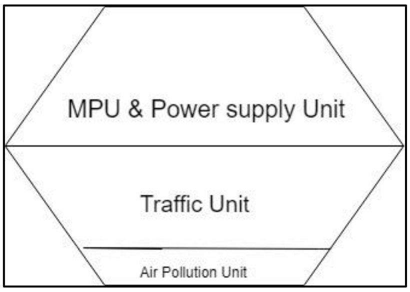

Fig. 1: Structure of Device

Device consist of three parts as shown in figure 1:
1) Air pollution Unit
2) Traffic Unit
3) Power supply Unit

All above mentioned parts of device have independent task as per respectively and air pollution and traffic parts are also depend on power supply unit. Machine learning algorithms in operational conditions of air quality monitoring for predicting the daily peak as same time also perform task for the traffic jam. Many Device place at different parts of cities to get live data for predictions.

A Case-Based Reasoning system developed for air quality monitoring is introduced and discussed.

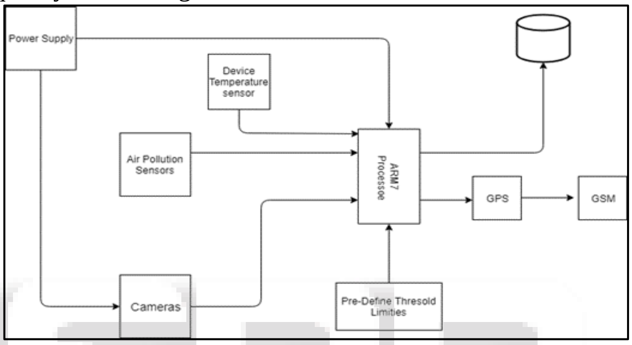

Fig 2. Working of Device

As shown in above figure 2. It is overall working model of hexagonal device. As you can see Air pollution Sensors and cameras both send data to the ARM 7 processor. ARM7 Processor take input and send it to server with the collected data location. In microprocessor I have set a pre define threshold limit for sensors and camaras if the collected data is above that that limit then an alert message send to the server. Collection of data take place every hour, after collection it return back to zero and aging process of collection take place. To control the inner environment for device there is a temperature sensor to check regularly for the temperature. At server side all the machine learning algoriths are being for prediction. I use python as programming language with tensorflow, pandas and numpy libraries for implimentaion.

II. Air Pollution Unit

A. *Use of Method*

In this section I use only two method for Pollution Monitoring

1) *Black Smoke Method*

The black smoke technique collects the particulate matter (PM) on a paper filter over 24 hour period though a size selective inlet. A reflectometer is used to measure the darkness of the paper filter which is converted to the PM's mass concentration. This type of monitoring instrument is cost-efficent, simple and robust. After that, the mass concentration is obtained by measuring the darkness of the filter paper and this varies in different locations. This means the darkness-tomass coefficient changes with time and locations. [1]

2) β-Attenuation Method (BAM)

The β-Attenuation Method or β-Attenuation Monitors (BAM) are the most widely used particulate matter (PM) measurement equipment in the conventional air pollution monitoring systems. With the help of a size selective inlet (PM10 or PM2.5) the air is first sampled either with heater or without heater that minimizes the water contained in the air. After that air is passed through a paper filter which catches the PM and later on this paper filter is subjected to the β-attenuation source. By measuring the radiation intensity of the filter and the interval, one can calculate the mass of the PM on the filter [1].

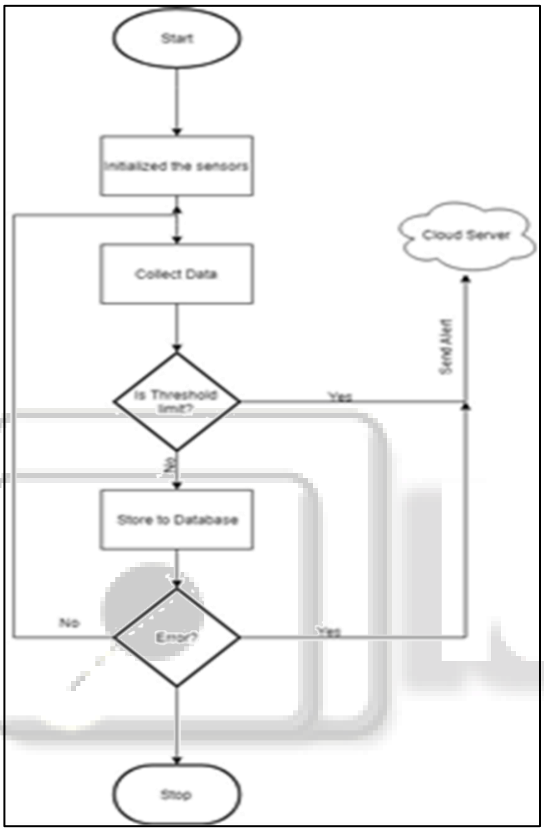

Fig 3. Working Flow Chart

In this device at initial position sensors are being activated and start collecting the data as shown in figure 3? In every hour it sends collected data to database and check the condition if air pollution range are above threshold limit then sends an emergency signals to the main server or if it is below the threshold limit then simply store the data to database. This process are continue till an error occurs.

B. *Machine Learning Approach for Prediction*

My goal is to predict the concentration of air pollutants of the next day on the basis of the historical meteorological and air pollutant data. In this work, I have focused on using the former day's data to predict the next day's hourly pollutants. In particular, Let (xi;yi) denote the it h training data, where yi ∈R24×1 denotes the concentration of a certain air pollutant on a day, and xi = (ui;vi) denotes the observed data on the previous day that include two components, where a semicolon ";" represents the column layout. The first component ui = (ui,1;...;ui,D) ∈ R24·D×1 includes all meteorological data over 24 h for the previous day, where ui,j ∈R24×1 denotes the jth meteorological feature of the 24 h and D is the number of meteorological features; the second component vi ∈R24×1 includes the hourly concentration of the same air pollutant on the previous day. The general formulation can be expressed as

$$\min_{W} \frac{1}{n}\sum_{i=1}^{n} \|f(W,\mathbf{x}_i) - y_i\|_2^2 + \varphi(W) \qquad (1)$$

Where W denotes the parameters of the model, f(W,xi) denotes the prediction of the air pollutant concentration, and ϕ(·) denotes a regularization function of the model parameters W. Next, we introduce two levels of model regularization. The first level is to explicitly control the number of model parameters. The second level is to explicitly impose a certain regularization on the model parameter. For the first level, we consider three models that are described below: • Baseline Model. The first model is a baseline model that has been considered in existing studies and has the fewest number of parameters. In particular, the prediction of the air pollutant concentration is given by

f k(W,xi) =D ∑ j=1e> k ui,j·wj +e> k vi·wD+1 +w0, k = 1,...,24

where e of k ∈ R24×1 is a basis vector with 1 at only the kth position and 0 at other positions; w0,w1,...,wD,wD+1 ∈R are the model parameters, where w0 is the bias term. We denote this model by W = (w0,w1,...,wD+1)>. It is not able that this model predicts the hourly concentration onthebasisofthesamehourlyhistoricaldataofthepreviousdayandthatithas D+2parameters. This simple model assumes that all 24 h share the same model parameter.[3]

III. TRAFFIC UNIT

A. *Machine Learning Algorithm used*

We focused on Genetic algorithm (GA) for monitoring. A genetic algorithm (GA) is a metaheuristic extract by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to take out high-quality solutions to optimal solution by relying on bio-inspired operators (i.e mutation, crossover and selection)[4]. The focus on this algorithm because this export to optimal solution for monitoring.

Working Model:

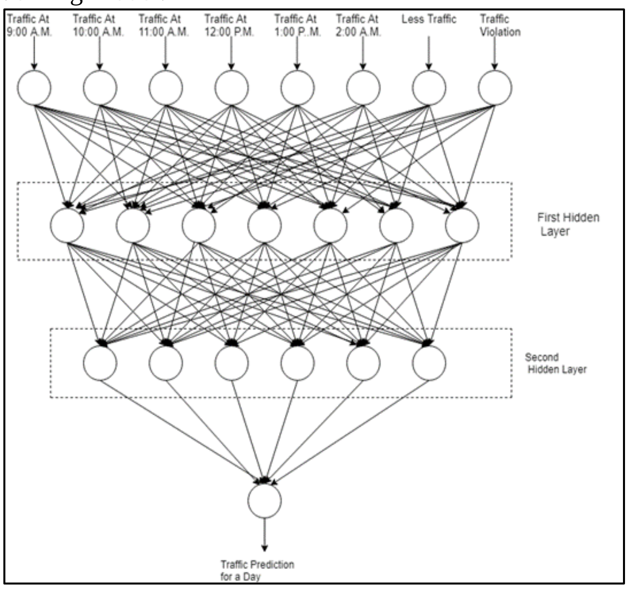

Fig. 4: Working of Neural Network

A feed forward multi-perceptron network was used consisting of 8 input nodes, 2 hidden layers of 7 and 6 nodes respectively, and 1 output node (figure 4). The step functions at the nodes of the hidden layers are all Gaussian. The training process has been the error back propagation (McCelland Rumelhart 1986), where there has been 5-6 working hours until the network performed well against the training set. Many less successful trials have been made, trying networks with different architectures.

B. Components of Model

The focus of this paper is to implement a machine vision for traffic violation detection system through genetic algorithm. A primary components are the cameras. The input data to this system is the captured during constantly video recording, gathered from a specific traffic CCTV camera. The output will send to the main city server, there all monitored data are saved then perform prediction process on data. If there is violation during recording then an alert message is sent to near police station automatically for solving that particular problem.

IV. MPU AND POWER SUPPLY UNIT

A remote online air pollution and traffic monitoring system is developed, based on the technologies of wireless sensor networks. The remote online monitoring system consists of monitoring equipment, a data center server, and the clients. The monitoring equipment is composed of a central processing unit (CPU), air pollution sensors array, global positioning system (GPS) receiver module, in-built memory storage module and general packet radio service (GPRS) wireless transmission module. Sensors used to collect data and the GPS receiver module is adopted to collect location and time information. The CPU automatically stores the collected data in the memory data storage module in real-time. Afterwards, the GPRS module continuously wirelessly transmits the collected information to the data center server [5]. For power there are 2 solar panel at the top and battery unit to give regular power to the device.

V. CONCLUSIONS

In this paper, I have developed efficient machine learning methods for air pollution and traffic jam prediction. I have apply many formulas from that my prime focused on optimal solution of the problems. I have discussed on easing model complexity by reducing the number of model parameters and on improving the performance. The results from the algorithms are not qualitative but they can indicate a binary or discrete decision. The fact that the algorithms have not been tested on a rich historical database containing many episodes, since this would require many years of data that do not actually exist, limits their role to a human expert decision support system. But the assumptions may give better performance and nearby can also boost the performance of predictions. For future work, I will further focused on the new techniques such as improving of IoT devices and better ML algorithms for traffic and for air pollution which may provide a further boosting for the prediction.

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