Smart City Framework using Sensor Data & Internet of Things with Linking of Technologies - Smart City Initiative

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Abstract: **The Revolution in the Information Technology has certainly bonded the human to device interactions. This massive revolution of introducing smart devices has made the technology smarter to transform the massive data into useful patterns. The concept of smartness was initiated across the globe and many cities were taken into consideration and Smart city proposal was declared. IoT, has been considered as a major trend to consider real time scenarios where in interconnection across objects are done. Major constraints in the locality are put forth and finding a suitable solution to the problem has to be implemented. While there are many applications of IoT, applying this to create a Smart City Solution can and will make the trend setter for Smart City initiatives. Cloud infrastructure has been created for storing massive data from sensor devices of IoT and with the availability of many Analytics tools it makes it easy for making Data Analysis and arriving at pain points in the city. With rapid urbanization, smart city initiatives have become magisterial.**

Index Terms—Internet of Things, Cloud, Social Networking, Data Analysis

A. INTRODUCTION

In developing countries like India where people face at most difficulties even for a daily living, few areas must certainly be addressed: Transportation, Health care management, Waste management, Education, energy efficiency, etc. This proposal highlights mainly on the traffic system and other automation. For other areas, suggestions are given for maximum utilization of available sources.

Traffic System, narrow roads without lane system, lack of volume and capacity planning makes the traffic more complex. Also diverse vehicles from cycles, to Auto-rickshaws, to cars, to buses and lorries, without driving in lanes causes not only congestion but also endangers fellow vehicles and pedestrians. This proposal specifically tries to address a few specific scenarios in Traffic Management[1]. But it can be well extended.

The zonal areas across the city and the traffic system supporting the areas must have an equivalence ratio to handle the traffic and to monitor the traffic congestion. The pedestrian crossing is implemented but only fewer signals have this supporting system. Major areas remain helpless for pedestrians walking[5], with bicycle, and on wheel chairs wheelchairs as there are no separate pedestrian pathways and crossing. Parking spaces for general public is still of major concern in busy areas across the city.

Paving way for emergency ambulance vehicles to cross roads on busy hours remains as a major issue in the city. Also the Government vehicles moving across the city majorly used as means of local transport must be made smarter with few smoke emission and speed governance as complaints are added at a regular basis. With regard to improvisation in the life style of the people and making the people aware of the facilities already available and proper utilization of these must be given high priority as we move into being Smart. Smart homes and home automation system is implemented at few places.

B. SOCIAL CONSIDERATIONS

Diverting the traffic – Re-route: Considering the present living conditions in the city, majority of the roads are been diverted, to be particular, [1] flyover connecting the road is been closed and been diverted. All these diversions of the road is taking place to avoid the traffic congestion.

*Psychology of Drivers :*To be with ease of timings, overall psychology of people in driving mode has been changed. Many surveys taken recently had supported this.

Increase in Accidents and incidents: Road accidents and incidents over the past year is reported to be 454. The accidents may be fatal or minor and is categorized accordingly.

Traffic diversion for Ambulance Crossing: Panic occurs whenever ambulance cross-by during peak hours of traffic. Clearing the traffic and re-routing the vehicles causes a chaotic situation for public.

Information Availability: The general problem lies in proper usage. With recent technological innovations many of the applications are been under-utilized. Proper directions and the overall perspective of the application must be clearly defined and put to proper usage.

C. ARCHITECTURE

The Internet-of-Things (IoT) is a network of uniquely identifiable, cloud-enabled devices connected to and communicating over the Internet. The devices are uniquely identifiable because they each contain their own distinct IP address, and they are cloud-enabled5][because they utilize recently developed communication protocol and remote server network technology to communicate over a network of computers, rather than a single machine.

Fig describes the architecture of the Internet of Things (IoT). The IoT can enable virtually anything, from personal smart devices to large, industrial machinery, with technology that communicates and adapts to fit your lifestyle or business needs. If you have ever imagined your home or business enhanced, streamlined and made easier by allowing your devices to be wirelessly connected, the Internet of Things is the network that makes this idea a reality.The figure describes the architecture of Internet of things.

The IoT system begins with the devices that gather or "sense" information and then, unique to the IoT, periodically and automatically report data over the cloud -- without the need for human intervention.

The following aspects are formulated into business and been carried out across various organizations.

a. *Communicating*

Moving from devices, the next required element of an IoT system is the communication interface -- the hardware and software elements that allow the devices to communicate with oneanother and the Internet.

b. *Capturing*

In the third required element of an IoT system, a server pulls in and captures the sensor data received over the Internet. The server identifies the source and topic of each component, and stores it in a structured database so it can be handled according to rules for generating alerts and reports.

c. *Delivery And Control*

Delivering the information from the sensors to the end user and providing a way to control the network is the last step in the IoT process. Whether on, for example, a tablet, smart phone, vending machine or desktop PC, your reporting must be designed to deliver an experience that works for the end user.

d. *Home Security Architecture*

IoT solutions can come in many flavors and any concrete explanation of how a particular business can leverage a collection of Internet-connected devices would require insight into that specific business context. However with even a basic understanding of the core components of IoT architecture and their functions it becomes very easy to begin visualizing a range of possible deployment.

IoT architectures are usually comprised of a set of sensors that collect different types of data and transmit them to a "base station" that uploads the data to the cloud. From there it can be accessed by consumers and/or businesses as actionable intelligence. While there are IoT architectures that leverage ubiquitous computing devices such as smart phones as either "base stations" or "sensors[4] The outcome focuses on the ones that employ actual sensors to detect certain conditions or states(e.g. movement, temperature, moisture, et al) and present this information to businesses in ways that enable them to be more responsive, lower operating costs, gain a competitive advantage, and increase efficiency.

Capturing data and Linking of Technologies is the major innovative step where in the data analysis can be performed and the results there by can be seen and visualized with a smarter perspective. Considering a scenario, as with IoT being implemented on traffic signals, the analysis on traffic can be helpful in providing complete traffic analysis on the area and ways to overcome the chaos.

This can further be implemented across various fields like GPS trackers where the city buses and vehicles associated with other private organizations can also be tracked providing a safer and secured environment. The mobile application data can also be analyzed so that the government sectors can directly interact with people and understand the need of the hour. Health care data sets are also collected and been sectored across different zones so that much commutation can be avoided. Emergency vehicles associated with each hospital can also be tracked and been alerted. There by this awareness can bring in lot many hospitals to serve the people and is always proven to be beneficial.

As the data is been stored in the cloud, proper security schema is to be implemented on the data that is collected from the sensor. This data is further refined, processed and put to proper classifier algorithms to extract the meaningful information and form proper data sets. This involves real time data feed to be put into proper analytics schema. This is where in the smart city initiatives may be fruitful . As proper data and processing of data can be streamlined. This is an essential move towards the smart city initiative for government sectors to take up the projects and involve the private organizations into the initiatives. Streamlining of applications specific to domains is to be differentiated. The IoT boards are set up across various zonal regions and the analysis on data has been formulated.
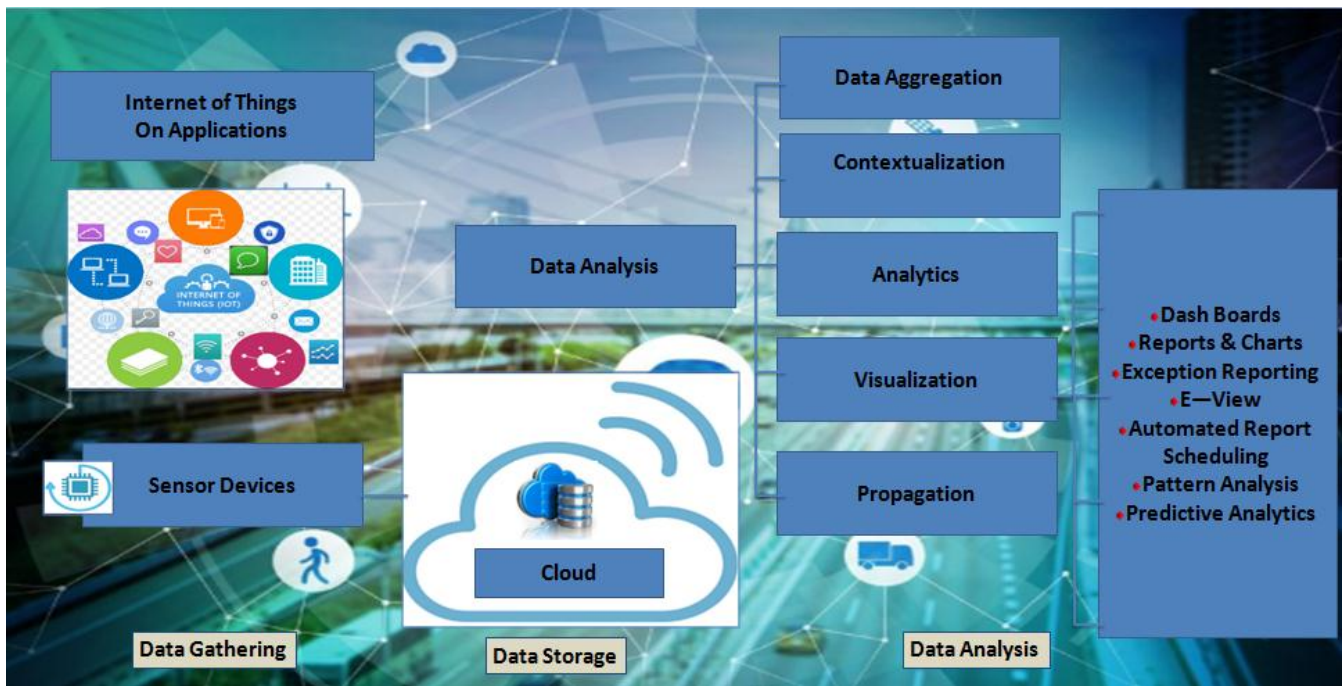
Figure 1: Capturing & Storing of Data in Cloud Environment

Data Source through IoT systems to Cloud: As mentioned, the IoT system collects the information from Traffic Management and other allied Systems like Home Security and Ambulance Systems. The information gathering is done through Sensors in the Traffic Systems, [5]Manual input from the Traffic Police on Traffic Updates and Statuses on Traffic, Location Recognition through GPS from Ambulance, Signals from Homes/Apartments. This data collected should be transmitted and stored in a secured environment where it will be used for further Analysis. Let us see the step by step flow of data from the IoT Smart Devices to the Secured Storage.

STEP1: Collection of Data to Temporary Database
Once the Data is Sensed and Gathered from the IoT Devices, it will get Stored as a Temporary Database in the Traffic Management System itself, in an attached RAM. Similarly each of the traffic Signals will have a Data Sensor which will sense Data like Pedestrian Crossing, Traffic Updates and Store it in Temporary Database with in the RAM in the Traffic Signal. Similarly in the Case of Ambulance Management there can be a direct link from the Ambulance to the Hospital through Secured Internet, wherein, in this case, the Hospital Database acts as the Temporary Database. Similarly for the input from the Home Automation, the Apartment will act as the Temporary Database.
STEP2: Movement of Data to Cloud Database
This step will be the movement of Data from Temporary Database to the Cloud. Intermediate Database is the Database which collects and consolidates data from all the IoT systems in the locality. The Cloud database will be the final repository of data for that particular region. It is in this Cloud the Analytics aspect of the Data is done for the next course of action like how the Traffic Data can be used for betterment of the Pedestrian safety, better Ambulance re-routes etc.

Core Functions In The Cloud
Aggregation: Cloud Database Aggregates data from various Intermediate Databases including Traffic Systems, Ambulatory Systems and Home based Sensors.
Contextualization: Cloud provides a structure or model to help organize, find and understand data.
Analysis: Cloud enables to analyze data across multiple sources so that quick and better decisions can be made.
Visualization: Cloud provides multiple tools for visualizing data and alerting decision makers to key information that requires action.
Propagation: Cloud ensures that data from all the systems mentioned above is other systems for further analysis like Databases at the National level.

Methods Of Visualizations In Cloud For Decision Making
Dashboards: Information dashboards provide vital data based on the need. Decision makers can get a macro level view of how the travel pattern in the city, with the ability to drill down to micro level details if necessary. The District Heads can view information about particular area. Dashboards can be configurable, so that each type of user gets the information needed, real time.
Reports and Charts: These reporting tools enable to analyze trends and locate the source of issues on the roads like congestion at the peak hour, ambulance re-routing etc.
Exception Reporting: Exception Reports and alerting mechanism like SMS can be sent whenever there is a incident or an issue or where there needs immediate attention.
E-View: For a paperless Cloud and Traffic Management system for a paperless smart city.
Automated Report Scheduling: Reports can be configured to be run at specified frequency and intervals so that appropriate decisions can be taken at the right time.

D. PROJECT IMPLEMENTATION

With the various technology initiatives, Coimbatore City is taken into consideration and analysis on the applications are carried out and considering real time environment across the city, certain project modules are being developed. The following modules are being proposed:

Traffic Light Automation Systems: The currently working Traffic Light Controllers in current use are based on micro processors and controllers. Using sound sensors and integrating with IoT, the ambulance signal can be set and using this traffic lights will be automated clearing the way for the ambulance to pass by.

- *Enabling Pedestrian Crossing Alerts:* In Coimbatore city only 4 out of 54 traffic lights are with pedestrian crossing signals. This scenario can and must be changed as there are many pedestrians using the roads and cross roads. This can be implemented simply by enabling sensors and IoT boards and automating the pedestrian alerts. Few of these signals must be properly implemented. For successful implementation, list of peak spots with pedestrian crossing are to be identified.

GPS Tracker: With technology like IoT where Internet plays a vital role and using this current location of vehicles can be tracked for monitoring. This can be implemented on a very large scale where –in not only government vehicles but private vehicles across schools, colleges and hospitals can be tracked down easily. This solution can also be enhanced with a camera connected to the Centralized server and a GPS. This way the camera would double check to ensure that all people have crossed the road. The camera will be particularly very useful around schools and colleges. There must be complete data set of vehicles associated with schools, colleges, IT Sectors, banks , hospitals, Travel agencies etc and be monitored.

Mobile Hospitals: For ensuring the safety measures, government hospitals and other private hospitals in the particular locality must be involved in making first aid possible in a short span of time. The importance of this proposal is that all hospitals must be considered equally responsible in playing a vital role during emergency situations. This will definitely create an impact if put in proper use.

At service: There must be improvisation made for people in need. This covers applications for searching nearby gas stations, car services, hospitals. Parking garages must be opened up at major hot spots and availability of parking slots can be shown online for pre-booking. Major shopping spots can use these garages and the shops can make arrangements for their private vehicles to pick the passengers. This way government is mutually benefited.

The major traffic signals on the city has to improvised with pedestrian alerts, ambulance services etc. This can be put into ease of access only when these are implemented with greater perspective and effectiveness of the people in the city. There has also been survey taken up on all the road incidents happening through out the year. Major signals in the city into play are as follows:Future progress in making (References)

- Six lanes model roads and the pedestrian pathway will be 2m wide and 150 mm high. They will be continuous and integrated with landscaping.Vehicle tracking devices for corporation vehicles for cost cutting in usage of future.

Corporation multi-level parking at Coimbatore railway junction. Coimbatore city has been declared as 18th Cleanest City in India and 2nd in Tamil Nadu. On clear perspectives of the proposal it's the right time to make Coimbatore the best smart city in the country.

E. RESULTS

R-Analytics is been used to generate the analytics on the data as generated from the sensor devices embedded with IoT. These results formulates a pattern such that government sectors can analyse these specific patterns and generate innovations needed for the applications. The following results are been formulated in R-Tool.
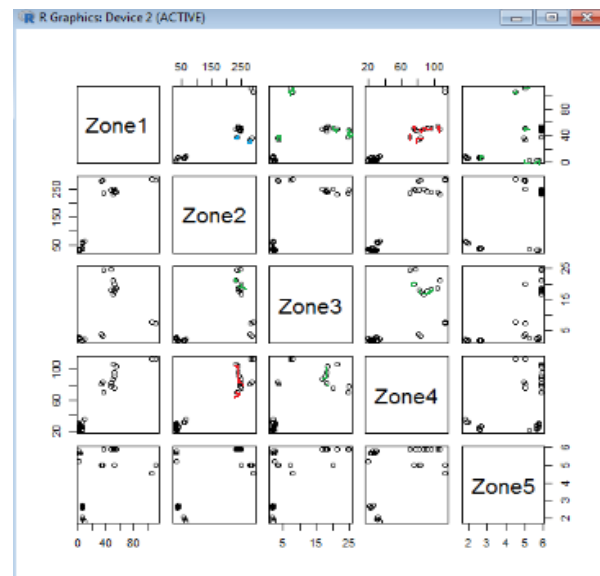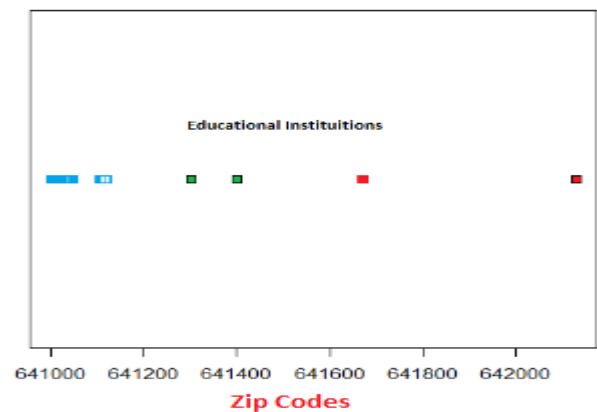

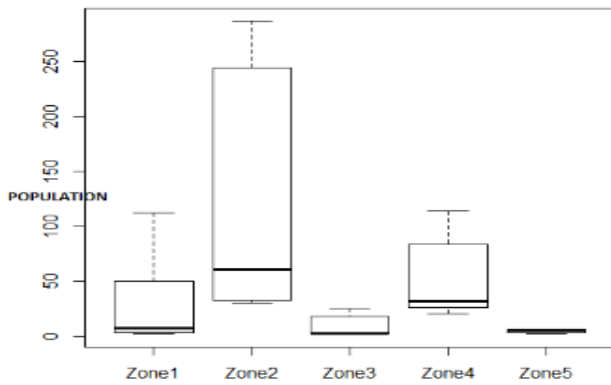Figure2: Traffic Congestion across Zonal Areas

Figure3: Traffic Analysis across Zonal Areas

F. CONCLUSION AND FUTURE WORK.

Major innovation in the smart city initiatives is only via citizen participation. All these initiatives are to be properly utilized. . The application proves better extensibility and flexibility for future enhancements. Any further requirement of the same application is possible with the same features guaranteed. This proposal targets the existing technologies to be linked in a smart way. There are many sensors that are embedded – face Recognition cameras, Human detection sensors that can be implemented for security reasons, Temperature sensors as a weather indicators, congestion control that helps in recognizing traffic congestion, etc. The future scope of the smart city initiatives lies in the extracting the sensor data , monitoring of the real time data and put forth proper classification algorithms. As overall citizen participation in Social networking is increased rapidly, the proper streaming of SUM(Status Update messages) can be extracted from APIs and processed.

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