Single Window Monitoring Solution with Predictive Analysis for IOT: A Survey

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Abstract- The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure. Monitoring objects behaviour in network, getting the parameter sensed by those objects and analyzing that data in a useful manner is challenging task. This paper is a detailed survey of different existing systems in the field of IOT and of Predictive Analysis done on IoT. The paper explains few of the systems and their advantages and drawbacks.
Keywords-Predictive Analysis, Internet of Things, Sensors

I. INTRODUCTION

Predictive analytics is the branch of data mining concerned with the prediction of future probabilities and trends. By using predictive analytics techniques and tools we can predict the values of the parameter and can be able to understand the environment very well. Our application based on the previous data received by sensors will let user know the future aspects of the parameters and intimidates the user about the misbehaviour of a sensor.

The Internet of Things (IoT) is an environment in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet.
The application that we propose to develop will have the ability to take any physical parameter that can be sensed using electronic circuits and can be communicated to the remote location i.e. the cloud(server) and also to a mobile phone. There are multiple parameters that need to be monitored simultaneously and sometimes by the same agencies it is easier to have all the data available at a single application rather than having several different applications for the different parameters. At this point monitoring applications are available but there is no single application that can be used to have access to a multitude of parameters to be monitored at the same place and these do not allow the users to customize these applications for their needs. Our aim is to fill this gap in the area of IoT by providing a single window monitoring solution also with the ability for customization according to the user's requirements.

II. LITERATURE SURVEY

In Remote monitoring information system and its applications based on the Internet of Things[1], the design program of the remote monitoring system is achieved. Human-mo`nitoring sensor chips and the internet of things used by patients automatically generate electronic medical records, which is saved into the database. The system was able to feedback the corresponding medical programs, proposals and other diagnosis after analyzing the data. The system finds applications in family health care, where the level of health monitoring intelligence and people's daily health care standard is improved. Mainly it promotes application of IoT in health care.
This system can be applied in many occasions such as observation rooms, the union of disability, community hospitals and nursing home etc., which not only can help the patients, but guide the way of supporting the medical career with the advantages of the Internet of Things.

In The remote monitoring system of transformer fault based on The internet of Things[2], the transformer failure is repaired by the use GSM (Global System for Mobile communication) of SMS technology by relevant data analyze, to achieve control transformer temperature of the transform fault remote monitoring system ,it is automatically judged and complete the software and hardware design. The damage is mainly caused by the oil immersed inside the transformer where in the removal of it was very difficult. The temperature transformer is received by the remote monitoring system of transformer fault based on the internet of Things and cools the system fan by SMS to achieve aremote control functions and Remote fault diagnosis. The system uses a data processing, the GSM network remote control, temperature measurement method single-bus multi-point combined, so that the analysis and speed of temperatureacquisition and the accuracy of determine of the system has been improved, reducing the costs of traditional transformer temperature monitoring system, and using the remote control module to avoid the failure of the transformer. The maintenance personnel grasps the operational status of each transformer at any time, controlling the temperature and find out the reasons of failure, avoiding the damage which is caused by the continuing high temperature.
In Application of Internet of Things in Power-Line Monitoring[3], architecture model which is of three layer With the help of Internet of things for smart grid (SG-IoT) is proposed. An IoT based power-lines online monitoring system is presented. An overview of the key technologies in SG-IoT is given.

Iot is used in this to avoid the following problems of power lines:
1) Power transmissions to get vulnerable from the extreme weather conditions, such as wind, snow etc.
2) Wind vibration and wind deviation of high voltage transmission lines.
3) Galloping caused by strong wind bring great damage to the high voltage transmission lines.
4) Transmission getting icing by rainy weather
5) The asymmetric pull force leading to leaning of the transmission tower which is potential risk to the safety of transmission line.
IoT networks is used to by the people to resolve the above problems which creates universal connectivity between energy grid devices and systems enhancing technical foundations of highly distributed networks on an increasingly large scale.

InFramework and case studies of intelligence monitoring platform in facility agriculture ecosystem[4], the main idea of paper is to show and develop modern urban agriculture, Making agriculture depend largely on information technology and knowledge.
IOT, Wireless technology, sensor cells devices for data management and analyze are some tools used in this project. This project mainly helps in increase of Production of agriculture. Temperature and co2 can be moderated and Can provide scientific evidence and optimize the greenhouse facilities.
Short coming in this project is, it has multiple platforms for multiple domains, By analyzing the data, it's not possible to predict future work.

In Developing an IOT smart city framework[5], The main idea isto give a framework to connect all the services automation and interact whenever and wherever its possible through IOT. A number of approaches to transport, medical assistant, electrical and water problems in city can be monitored easily, Outdoor parking management system, Environment monitoring, participatory sensing, precision irrigation and garden monitoring.
Tools used in this work are Number of network gates, Services, iot Device tier, RFID, Big data tools, cloud ,COSM(Real time control and real time management), LOD(cloud computing), IDAS(Provide set of IOT services to access), SMAP(Restful web services allows information provided by Instruments to directly publish.), Sense Web(Store data and publishing data by sensors).
Some problems faced while developing this project are privacy and security and crowd sourcing is problem due to population.

In IoT multiplatform networking to monitor and control wineries and vineyards[6], it gives an idea that, information from environment such as soli condition, wine growth and fermentation condition can be retrieved and further used to analyzing, personalization and management, Optimizing the overall management of the entire wine until the end product. Tools used are IOT, sensor cells, wireless technology, predictive analytics and zig bee.

In Agricultural Production System based on IoT[7] and Design and deployment of a wireless sensor network for landslide risk management[8], they have presented a wireless network system which helps farmers to learn about their crops and assists them to get better yields. The sensor nodes are provided with energy harvesting facilities, so these are autonomous, also easy to locate and relocate. Along with the parameters, the sensor takes the photos of trees, plants, fruits and leaves for every hour and sends it to central gateway, connected to internet. It helps biologists and agronomists to study the crop from remote area and help the farmer in getting rid of disease if any by the assistance of experts at reasonable cost. It assists to accelerate the efficiency of cultivation and improves environmental sustainability.
Tools used here are Relational and statistical analyzing tool, IOT gateways, IOT sensors, GUI visualization software.

In A survey of Internet-of-Things: Future vision, architecture, challenges and services [9],they have presentedNovel architecture model for iot. This introduces the use of semantic framework to encapsulate the processed information. Tools used here are IOT, RFID sensors, Smart fusion model, WSNCS (wireless sensors networks common Stacks) , SOA(Services oriented Architecture).
Mainly helps in Enhancing the area of coverage, reducing user movements and impact analysis, idea can connect everything and anything at anytime.
Problem with this project is, it is still in nascent stages where everybody trying to interpret, may be able to interpret on knowledge base with sensored middleware.

InImplementation of a Web of Things based Smart Grid to remotely monitor and control Renewable Energy Sources[10],they havedesigned a wireless communication system, responding to the sensor concepts applied in the scaled industrial process. Here they have considered the temperature as the parameter. They used 3 types of sensors for the system: Thermocouple, thermistor and Integrated Circuit LM35. The sensor data is stored in the cloud and it is downloaded from a computer through internet to process the data using a graphical platform to control and communicate the system with a programmable logic controller (PLC). PLC performs the actions according to the temperature value (set point) of the sensors, the implemented action is to open or close the cylinder according to temperature value. They implemented SCADA which allows visualizing and plotting the information available from the sensors.

In Wireless Sensor System According to the Concept of IoT -Internet of Things[11],they have proposed a framework which monitors the warehouse environment using sensors. The framework considers the parameters temperature, light, humidity, smoke. It has realized monitoring system on three different platforms: monitor terminal, B/S web application and mobile device. ZigBee and other wireless technology has been used to monitor the environment. It is a multi-platforminformation system which can detect environment automatically and remote control equipment in warehouse.

In Research on warehouse environment monitoring system based on wireless sensor network [12], they have presented a wireless sensor network for supervising landslides monitoring several parameters which brings risk. The parameters here are the factors and physical phenomena such as rock falls, deep failure of slopes and shallow debris flows. The data collected by sensors are stored in remote unit [RU] which is used for online analysis and altering. It's used for providing useful information for an early warning. The sensors used are air thermometer, air hygrometer, rain gauge, wind gauge and soil hygrometer.

In A wireless sensor network platform optimized for assisted sustainable agriculture[13],first they have explained what is IoT, it's applications and then their challenges. The challenges of wireless sensor networks are power backup, connection of many devices and management, integrating many protocols. So they have presented the integration of IPv6 into the WSN which has the capability to connect to numerous devices. Also they have presented how to integrate the management protocols such as 6LoWAN and COMAN. Finally they have discussed the need for integration of management protocols, SNMP and LNMP, as these increase the efficiency and reduce the load on the network, extending life span of the system.

In environmental monitoring system[14], there has been many sensor nodes installed. These require the power supply at regular intervals. Since these will be installed in remote areas, we can't go and supply energy at every time. So these have proposed a protocol which will get adapt to the constraints of the environment. The protocol is Large Scale Environmental Monitoring and Maintaining Sensing Coverage in Sensor Networks. This has two phases: initialization and sensing phase. This protocol switches off the sensor nodes in an area if any neighbouring nodes are already covering the region which the present node wanted to cover thus saving the energy consumption of the whole system and enhances the lifetime of the system.

In Large Scale Environmental Monitoring and Maintaining Sensing Coverage in Sensor Networks[15], they have designed Environmental monitoring systems to understand the pollution agents, processes and numerous instrumental methods for laboratory analysis and theoretical interpretation. Since the collection of data is huge, it's difficult to manage the pollution scenario. So in this paper they have proposed a novel concept of an integrated spectrometric sensor platform. It's a compact, portable and remotely operable sensing system. It comprises of high resolution spectral and environmental sensors. The data is sent to the cloud and the access is given to users through internet connectivity. It makes possible to perform measurements of environmental variables, real time online data visualization. The sensor used in this platform is newly designed dual-beam in-time spectrometric system, other auxiliary sensor and mechatronic components.

In An efficient wireless sensor network monitoring solution for greenhouses[16], an efficient Greenhouse monitoring system was built using IOT concept. A flexible WSN built as a plug and play module had several sensors, which were capable of sensing several parameters. A user interface was provided through web application built using ExtJS framework to get information on WSN nodes and to represent data of those nodes.

InM2M sensors for Future Internet of Things monitoring [17], they have implemented a Machine to Machine sensors system was implemented to effectively monitor devices in the network, in which Terminal equipment sensors were used to measure analogue and digital access line parameters. A web application built in PHP framework was provided to upload and store data and graphically display the measurements.
In ParaSense--A Sensor Integrated Cloud Based Internet of Things Prototype for Real Time Monitoring Applications[18], a weather monitoring application was built in large scale WSN. From an IoT point of view this application can be used in various fields. A central data repository was built to refine datasets and make them ready for representation. Web application was built to get information on sensors, to control them from remote place and to visualize the data effectively. This was extended to mobile devices also through smart phone apps. API's by web services were made compatible for easy access.
In Heterogeneous Wireless Sensor Networks for Flood Prediction Decision Support Systems[19],they have built a system in which the Sensors spread in various places of WSN are connected to server and their data is stored in there. Using which sensor data processing system will feed the data to the Belief Rule Based Expert system, which will predict the flood water level and depicts the same in GIS system.

IOT MONITORING SYSTEMS	ADVANTGES	DOMAINS WITH USED
Modern Logistics Monitoring System [2]	Unique identification of goods using EPC. Tracking the location of goods using GPS	The logistics monitoring has 3 parts front end data detection, network data transfer and background data processing.

Remote Monitoring Information System [3]	Analyzes the data and sends corresponding diagnosis.	Human monitoring sensor chips and IoT to collect data from patients
Bridge State Monitoring System [4]	It connects all kinds of equipment in a building together. People can access data through the Internet and control every device from web browser.	sensor cells, data collecting and transmitting equipment and hand-held terminal. ZigBee and WiFi technology are used
Water Quality Monitoring System [6]	It allows to monitor water quality parameters The values from sensors are processed by core controllers	It has several sensors to measure physical and chemical parameters of water. Raspberry PI B+ model.
The above mentioned systems are main papers related to IOT survey		
DISADVANTGE In all the papers we have researched, they have a few shortcomings: 1.No single window monitoring solution for all domains 2. No Customization according to customer requirements.		

III. PREDECTIVE ANALYTICS SURVEY

Predictive Analytics learns from the experience to predict the future behavior in order to drive better decisions. It finds application in several domains. In information system research[20] predictive analytics helps in improving the existing models and comparison of competing theories. PA helps in manufacture and production with respect to cost, quality, quantity and sustainability[21]. PA in aviation big data helps to find traffic in airspace and implement the service that records retrieves, analyze and visualize[22].Deploying data in the cloud[23], predicting the total number of downloads of a paper[24] are done with the help of PA. Application of PA in public safety can be found in security and intelligence setting due to its ability to process large data sets, identify actionable patterns and trends[25], and in order to gauge the impact of attack[26]. In ERP system to analyze current data and historical facts and to identify the potential risks and opportunities in organization PA is very helpful. PA helps in analyze real time data collected from the sensors that monitor the machine and equipment in a manufacturing company[28].

PA provides user with relational and statistical tools in order to analyse the data. These tools are equipped with many algorithms. Tools are not much effective in real time analysis faults may occur when analysing large queue of data. Effective productiveness is not possible if data during analysis not a real time one. We need to build a algorithm which will be flexible enough to handle request from different domain sensor networks and predict the values of those parameters, so that we can easily incorporate that into our web application.

According to survey research of predictive analytics. The top most algorithms used for prediction are:

1. **LINEAR REGRESSION:**

- Models the relationship between a scalar dependent variablee *y* and one or more independent variables denoted *X*.
- Equation is given as Yp= mX + b
- Focuses on the conditional probability distribution of *y* given *X* [29]

FORMULA: (y) = a + bx Slope(b) = (NΣXY - (ΣX)(ΣY)) / (NΣX^2 - (ΣX)^2) Intercept(a) = (ΣY - b(ΣX)) / N [29]

ADVANTAGES:

1.Used to fit predictive model according to values of X and Y

2.Shows optimal results when relationships between the independent variables and the dependent variable are almost linear.[29]

DISDAVANTAGES

1.Linear regression is limited to predicting numeric output.

2.Data Must Be Independent.

2. **MULTILAYER PERCEPTRON:**

- A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs.[30]
- An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one.[30]
- **Mathematically this can be written as**

$$y = \varphi(\sum_{i=1}^{n} w_i x_i + b) = \varphi(\mathbf{w}^T \mathbf{x} + b)$$

ADVANTAGES

- Generalisation
- Fault Tolerance
- Financial applications

DISADVANTGES:

- Computationally expensive learning process
- No guaranteed solution
- Scaling problem

1. **GAUSSIAN PROCESS:**

- Gaussian is a probabalitic distribution over a number of variables [30]
- It allows us to ignore values that we have no knowledge about that[31]

$$P(t_{N+1}|\mathbf{t}_N) = \frac{1}{Z}\exp\left[-\frac{(t_{N+1}-\hat{t}_{N+1})^2}{2\sigma^2_{\hat{t}_{N+1}}}\right]$$

ADVANTAGES:

- Gaussian Process Latent Variable Models (GPLVM)
- Style Based Inverse Kinematics
  Gaussian Process Dynamic Model (GPDM)[30][31]

DISADVANTAGES:

- Difficult for a large input data set (Matrix inversion O(N^3))[31]

3. **SMOREG**

SMOreg implements the support vector machine for regression. The parameters can be learned using various algorithms. The algorithm is selected by setting the RegOptimizer.[33]

$$\max_{\alpha} \sum_{i=1}^{n} \alpha_i - \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} y_i y_j K(x_i, x_j)\alpha_i \alpha_j,$$

SMO is an iterative algorithm for solving the optimization problem[33]

ADVANTAGES

- SMO ignores examples whose Lagrange multipliers are at *C*.
- Involved with kernel (kernel optimizations do not greatly effect time).[33]

DISADVANTAGE:

- Inefficient because of its way of computing and maintaining a single threshold value[33]
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Predictive analytics systems	Tools used	Advantage
Information System Research[9]	Electronic design automation (EDA)	Analyze entire semiconductor chips in design flow of circuits
Public Safety [11]	Analytical tools like GNU Octave	analysts must frequently balance accuracy and operationally-actionable out- put
Predictive Analytics Using Data Mining Technique[25]	WEKA	management to identify the problem areas and reasons that affect dropout the most
Social media analysis[13]	R and WEKA	Presents an interactive framework integrating social media
The above papers are some systems related to survey		

IV. CONCLUSION

After going through lot many papers and seeing the previous implementations, there are many kinds of sensors[table 2] available which are capable of sensing different parameters in different domain[table 2]. However there is no such single platform where all the domains are carried out simultaneously. So we have come up with a new idea of combining all the domains in a single platform and monitor it[table 1] . The application we propose also has the ability to monitor different parameters under single website and customize the representation of the parameter values according to the user required format[table 2]. Our application will predict the parameters value and misbehavior of the sensor if any[table 3]. Alongside, it will constantly give updates to the user through mail and messages. Predicting the values of the parameter sent by sensor will helpful in analyzing the environment and will be having much scope in the future[table 3].

Our project adds to impact on society as it can be used to improve the quality of life by ensuring water quality, air quality and other factors affecting society. The applications of this can be used for weather monitoring, irrigation system monitoring and control, water plant monitoring, factory automation or any other application in which sensors are capable of sensing physical parameters and sending those data to remote location through internet.

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