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Application Framework and Data Processing in IoT based Email System

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Abstract: Internet of Things (IoT) is the concept of connecting multiple objects together in an Internet-based architecture. Applications built around this concept are constantly growing in variety and quantity. The Internet of Things (IoT) has provided a promising opportunity to build powerful applications by leveraging the growing ubiquity of Radio Frequency Identification (RFID) and wireless sensors devices. In IoT enabled systems data from all connected devices can be generated quite rapidly the volume may be huge and types of data can be various. Processing & Analysis provides proper management of data. There are various email systems available worldwide. The idea IoT based email system is extension to existing email system. In such a system devices can send the notifications in email format, automatic actions are performed if necessary. For such a system, Application framework is necessary and which aims to provide a framework which would allow or facilitates the users to create their IoT applications. In this paper we explained how the IoT based email system is designed with suitable framework and how data can be processed for further analysis

Keywords: Internet of Things, Framework, Microcontroller Module, Cloud Layer, Heterogeneous data.

I. INTRODUCTION

Internet of Things allows people and things to be connected anytime, anywhere with anything and anyone, ideally using any path/network and any service. Multi-sensors or actuators continuously send the information or alert messages. There is need to store, process and analyze the data generated by those things. By using mail server we can store these data generated by things and there is no need of special server for storing the information created by things.The number of worldwide email accounts is expected to increase from an installed base of 3.1 billion in 2011 to nearly 4.1 billion by year-end 2015. This represents an average annual growth rate of 7% over the next four years. Integration of email system and Internet of things will be useful people to know easily what actually the Internet of Things application looks like. Because as mentioned earlier there are many people worldwide using email accounts.

Application framework for this is necessary to provide framework which would allow or facilitate users to create their own IoT applications. Data generated by things are quite rapid, volume may be huge and types of data can be various. Processing and analysis of data provides proper management of data. In existing email system, which provides normal human to human interaction by storing mails & other information on mail server. In our proposed work we extend this existing mail system to implement Internet of Things application i.e. IoT based email system in which human to human as well as human to things interaction will be possible. In such a system we focus on Application Framework & data processing of the information sent by sensors and actuators connected to the Internet. It can be possible to send the information from thing to human and human to thing via email.

II. RELATED WORK

Worldwide email use continues to grow at a healthy pace [1]. In 2015, the number of worldwide email users will be nearly 2.6 billion. By the end of 2019, the number of worldwide email users will increase to over 2.9 billion. Over one-third of the worldwide population will be using email by year-end 2019. In 2015, the number of emails sent and received per day total over 205 billion. This figure is expected to grow at an average annual rate of 3% over the next four years, reaching over 246 billion by the end of 2019. Over the next four years, the average number of email accounts per user ratio will grow from an average of 1.7 accounts per user to an average of 1.9 accounts per user. Fabrice Anon, Vijith Navarathinarasah [2] focused on developing a framework upon which IoT applications can be easily built using different technologies, e.g., Arduino or Raspberry Pi microcontrollers. By using the framework, users can expect to improve the flexibility and extensibility of their applications, or to facilitate technology evaluation for specific IoT applications, also presents a project that we have managed to successfully design and implement a framework upon which users can pick their hardware and build their own IoT applications. We aimed to promote flexibility in hardware choice so we designed the framework to allow users to swap in and out the main central processor of their choice. Currently, the framework can support Arduino and Raspberry Pi microcontrollers. With this design, users can easily add extra device to the framework without having to worry about redesigning or breaking the system. Julien Mineraud [3] described IoT landscape with respect to the support of heterogeneous hardware, the capabilities of the platform for data management, the support of application developers, the extensibility of the different platforms for

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the formation of ecosystems, as well as the availability of dedicated marketplaces to the IoT. In [4], Survey described technologies needed for Internet of Things.

III. IDEA OF PROPOSED WORK

Internet of Things consists of spatially distributed sensors which gather information from the physical world. It is used for monitoring environmental factors like temperature, pressure moisture etc. and send this data to owner of a device or to some storage framework. IoT based email system is extension to the existing email system which makes use of email server to store the data generated by things and also send the control to device through control facility or by sending control via messaging facility available in mobile. When the alert is sent to the user, user can see this on email account or on message. For implementing this system we used open source system i.e. squirrel mail system which is configured on Linux platform (CentOS). We first configured this system on CentOS by using mail server installation and DNS configurations by connecting it to the sql database server. Application Framework for this system is based on cloud layer which is basically a closed-relaxed layered architecture which allows users of email account to add their own devices in email application. In this users can add their devices using New Thing Option and control the devices using new control option. There is one more section is available in inbox is IoT Inbox which contains all the emails generated or alerts generated by devices registered in email account and further processing and analysis can be done on data stored on mail server and this analysis contains graphs and bar charts which can be published on the social networking which is connected to that particular user's email account. Data generated by things connected to internet is not just a plain text data. But it can be heterogeneous, non linear and multidimensional. In our system the massive data can be collected from heterogeneous sensors (e.g., cameras, vehicles, drivers, and passengers), which in turn may provide heterogeneous sensing data (e.g., text, video, and voice). Heterogeneous data processing (e.g., fusion, classification) brings unique challenges and also offers several advantages and new possibilities for system improvement. So in our system we focus on data processing and analysis of heterogeneous, non linear, multidimensional data generated by things or devices which can be distributed in the various geographical locations. Stored data can be of two types structured and unstructured. Structured data can be sent to database management model and non structured data will be stored in File repository which can be further processed by using other techniques.

IV. APPLICATION FRAMEWORK FOR IOT BASED EMAIL SYSTEM

Application framework for IoT based email system should be reliable, flexible and adaptable so that users can pick their own hardware register in its own email system which will be saved on mail server for further monitoring, control, processing and analysis of data generated by devices. We aim at developing a framework upon which IoT applications can be easily built using different technologies, e.g., Arduino or Raspberry Pi microcontrollers. By using the framework, users can expect to improve the flexibility and extensibility of their applications, or to facilitate technology evaluation for specific IoT applications.

V. FRAMEWORK DESIGN

A. Device Layer

The Device Layer is directly connected to the end-devices which are also called "things" in the context of IoT.

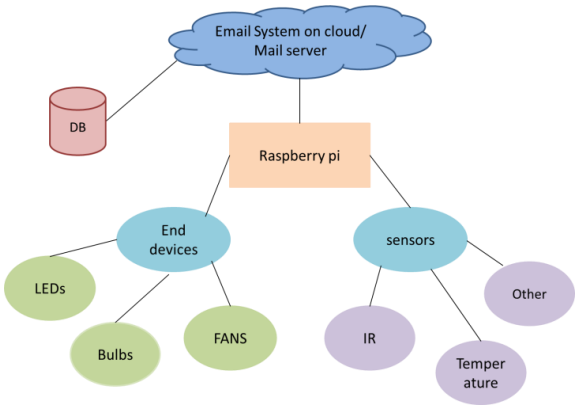

Fig. 1. Framework for building IoT applications

The purpose of the Device Layer is to embed intelligence within the devices to allow them to communicate with the Central Hub, as shown in Figure 1. To achieve this objective, the Device Layer requires 2 main modules: microcontroller and communication module. With this design, the Central Hub Layer eliminates the need for the Cloud Layer to know the location of the devices it has to control. The design also reduces the number of connections an application in the cloud has to establish. An application in the Cloud Layer now only has to maintain the addresses of the Central Hub of which the devices it controls are connected to. New device can be added to the system by simply registering the device with the Central Hub of that device's local network. Another challenge of the diverse devices is the incompatible interface between the Cloud Layer and the Device Layer. The Central Hub Layer offers parsing and formatting services for emails and data coming through the layer. Furthermore, with this approach, the devices in the Device Layer do not need to know the address of the application in the Cloud Layer to be able to send data over. The Central Hub takes care of storing the address of the application. Data coming in from the Device Layer is extracted and wrapped in HTTP packets then sent to the application in the Cloud Layer. In the other direction, messages coming from the Cloud Layer are extracted and put in packets of type used by the short-ranged wireless technology of the local network and1 then delivered to the device the original messages were directed to. The Cloud

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Layer provides the user interface while also being responsible for processing and storing all the information sent from the Central Hub Layer, on which email server lies. Information processing and analysis on mail server will be discussed in next section.

VI. PROPOSED WORK

In our proposed work we extend this existing mail system to implement Internet of Things application i.e. IoT based email system in which human to human as well as human to things interaction will be possible. Use case diagram for our proposed work is as follows:

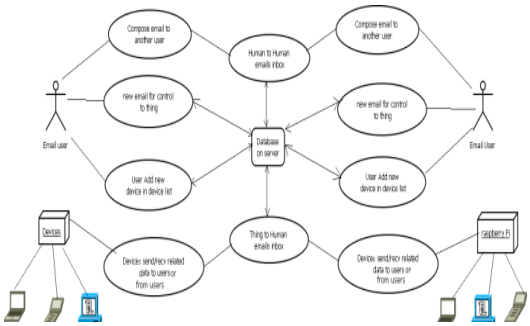

Fig 2: Use case diagram

In our system user of our email system can send data to another user or thing configured can send the reading or value of particular parameter to that email user and users can take the action immediately i.e. on/off that device. Devices can send alert via email and alert is sent in the form of notification in mobile. All values or data generated by things can be stored on email server and further processing and analysis can be done on data. If we take example of smart home in our case, the readings of temperature, humidity, fan, AC will be received via email notification. We can set particular threshold so that if the value generated by things mentioned above crossed threshold, the alert should be sent via email and notification in mobile to the owner of home. Flowchart below explains the above idea:
Consider there is smart Home application and Temperature sensor is sensing room temperature of house
T1=Threshold temperature (Highest)
T2=Threshold temperature (lowest)
A=Actual Temperature reading received through email
Below flowchart explains particular analysis oftemperature data.

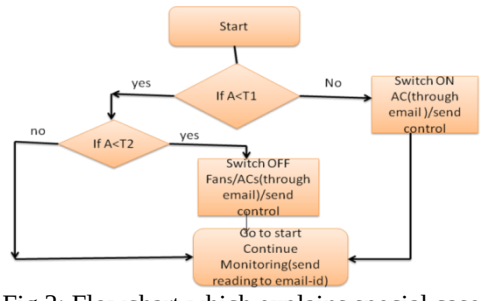

Fig 3: Flowchart which explains special case

Above flowchart explains how data can be processed and analyzed in our system. Data processing will be explained in next sections.
Inbox for our system is divided into 2 partitions:
1) Human to human 2) Thing to Human
In Human to Human inbox emails are displayed as usual. Emails from our colleagues, friends or other individuals will be displayed in this panel.
The notifications from things are displayed in the form of email in Thing to human panel. The owner of things can send specified control.

VII. PROPOSED WORK DATA PROCESSING IN IOT BASED EMAIL SYSTEM

Data generated by things connected to internet is not just a plain text data. But it can be heterogeneous, non linear and multidimensional. In our system the massive data can be collected from heterogeneous sensors (e.g., cameras, vehicles, drivers, and passén- gers), which in turn may provide heterogeneous sensing data (e.g., text, video, and voice). Heterogeneous data processing (e.g., fusion, classification) brings unique challenges. and also offers several advantages and new possibilities for system improvement. IoT applications, the massive data are generally collected from heterogeneous sensors [12] (e.g., cameras, vehicles, drivers, and passengers), which in turn may provide heterogeneous sensing data (e.g., text, video, and voice). Heterogeneous data processing (e.g., fusion, classification) brings unique challenges and also offers several advantages and new possibilities for system improvement.

A. Mathematical Model

Data generated by sensors can be text, audio, video, etc. Mathematically, random variables that characterize the data from heterogeneous sensors may follow disparate Probability distributions.

D= Set of data generated by sensors connected to devices in network.

$D= \{di: 1 \leq i \leq n\}$

$D= \{d1, d2, d3, \ldots, dn\}$ where n= no. of sensors or devices connected to sensors.
D contains mixed data audio, video, text. There are two frameworks one for structured data one for unstructured data. The sensors which generate values, we can say it is structured data. The sensors which are recording videos and audios through cameras we can say this data is unstructured.
Data can be classified as follows:

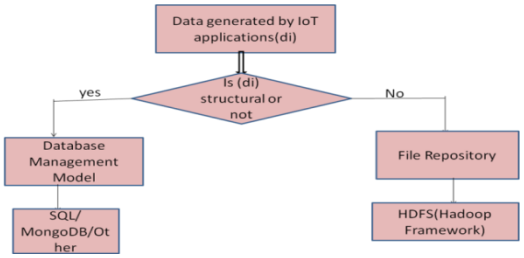

Fig 4: Classification of data

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Sensors which are used for monitoring generate values like temperature, power, etc. Data generated by these type of sensors can be stored in database management model in the form of relational database and query processing can be performed on such relational databases.
Notations:

TABLE I
NOTATATIONS

Z	$\{z_1, z_2, z_3, \ldots, z_n\}$
n	No. of sensors
s_j	Sensor identifier means jth sensor
F	N-dimensional cumulative distribution function (cdf)
C	Copula Function

It is well-known that large quantity of sensor data is being generated by every hour. Data generated by multiple IoT devices are heterogeneous, high dimensional. Consider that one random variable for each device or sensors that generate data. According to probability theory when dealing with simultaneously more than one random variables, the joint Cumulative Distribution Function can be defined.

$$F(x, y) = P(X \leq x, Y \leq y)$$

Where P is the probability that random variable X takes on a value less than or equal to x that variable Y takes on a value less than or equal to y simultaneously. In our system we can say that the data generated above the value x can be an alert from the value.
Data prediction and probability can be calculated by using copula and sklar's theorem. So we used here copula based theory. For data processing and analysis from sensors derived in the mathematical equation here for future predictions, conclusion or analysis on the data stored on mail server. Copulas have been successfully applied to the database formulation for reliability analysis. Copulas have been extensively used in climate & weather related research. Therefore on the basis of Copula model we can derive our mathematical model.
Copula formula:
Random variables:

$$\text{CDF is } Fi(x) = P[Xi \leq x]$$

Denote zn as the data from the n-th sensor and n=1..N as the heterogeneous data set, the marginal n=1..N are generally non-identically or heterogeneously distributed. are generally non-identically or heterogeneously distributed. In many IoT applications, problems are often modeled as multi-sensor data fusion, distribution estimation or distributed detection. In these cases, joint probability density function (pdf) f(Z) of the heterogeneous data set Z is needed to obtain from the marginal pdfs.

$$F(z1, z2, \ldots zn) = C\big(F1(z1), \ldots, Fn(zn)\big) \quad \ldots\ldots\ldots(1)$$

The joint pdf can now be obtained by taking the N-order derivative of

$$f(z1, z2 \ldots zn) = \frac{\partial^N}{\partial z1\, \partial z2 \ldots \partial zn} C(F_1(z_1), F_2(z_2) \ldots F_n(z_n))$$
$$= fp(z1, z2 \ldots zn)c(F_1(z_1), F_2(z_2) \ldots F_n(z_n))$$

Where $f_p(z_1\, z_{2,\ldots,}\, z_{1,})$denotes the product of the marginal pdfs.

VIII. RESULTS AND DISCUSSION

In IoT based email system we used cloud based framework for communication. We have configured open source squirrel mail email system and modified that system according to our requirement.
The proposed system is also providing the facility to user for controlling their configured devices things. We are providing automatic as well as manual control to devices configured by users. In emergency case, actions are performed automatically; but in normal case users can manually on and off devices configured.

A. Efficiency
The proposed system is IoT enabled smart system which is efficient. We have tested our system for Home automation wastage of electricity is reduced with IoT enabled system as compared to normal system. The graphs are as shown below.

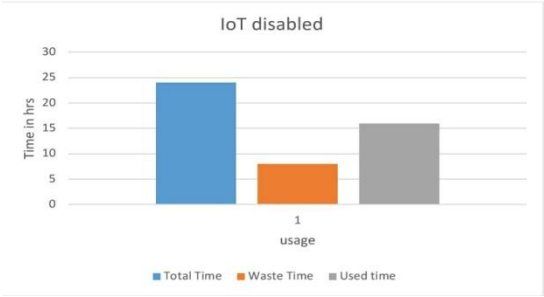

Fig 5:

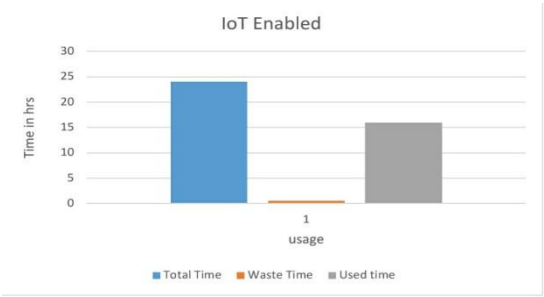

Fig 6:

IX. CONCLUSION

Main idea of this work is to design IoT based email system with suitable framework and processing the data generated by devices in this framework. In proposed system, we have designed IoT based email system with suitable framework to help construct and manage IoT applications

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for users. More variations can be further identified and built into the framework to improve flexibility, extensibility, adaptability and the range of applicability. With such a framework, users are able to build any application of their choice using our framework. Users can configure multiple applications and devices too.

Data processing we have explained here includes processing of heterogeneous data generated by devices in IoT network. IoT applications, the obtained massive sensing data can be of mixed characteristics, which is much more challenging. Here we described the basic level data processing and analysis with proper mathematical model for future prediction.

The proposed system can be extended for multiple applications like vehicle automation and traffic monitoring and agriculture field and data received by sensors is stored on email server and processing and analysis can finding the root cause, future predictions.

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REFERENCES

[1] "Email Statistics Report, 2015-2019" The Radicati Group, Inc. A Technology Market Research Firm Palo Alto, Ca, USA
[2] Fabrice Anon, Vijith Navarathinarasah, Chung-Horng LungCarleton University, Ottawa, Ontario, Canada, "Building a Framework for Internet of Things and Cloud Computing", 2014 IEEE International Conference on Internet of Things
[3] Julien Mineraud, Oleksiy Mazhelis, Xiang Su, Sasu Tarkoma,"A gap analysis of Internet-of-Things platforms",2015
[4] Li Da Xu, Senior Member, IEEE, Wu He, and Shancang Li, "Internet of Things in Industries: A Survey", IEEE Transactions On Industrial Informatics, Vol. 10, No. 4, November 2014
[5] "Big Data Analytics in Future Internet of Things", White paper Internet of Things 2015
[6] Lihong Jiang, Li Da Xu, Senior Member, IEEE, Hongming Cai, Zuhai Jiang, Fenglin Bu, And Boyi Xu, "An IoT-Oriented Data Storage Framework In Cloud Computing Platform", IEEE Transactions On Industrial Informatics, Vol. 10, No. 2, May 2014
[7] Charu C. Aggarwal, "Managing And Mining Sensor Data", IBM T. J. Watson Research Center Yorktown Heights, NY.
[8] Hongming Cai, Li Da Xu, Senior Member, IEEE, Boyi Xu, Cheng Xie, Shaojun Qin, and Lihong Jiang , "IoT-Based Configurable Information Service Platform for Product Lifecycle Management", IEEE Transactions On Industrial Informatics, Vol. 10, No. 2, May 2014
[9] Shifeng Fang, Li Da Xu, Senior Member, IEEE, Yunqiang Zhu, Jiaerheng Ahati, Huan Pei, Jianwu Yan, and Zhihui Liu,"An Integrated System for Regional Environmental Monitoring and Management Based on Internet of Things", IEEE Transactions On Industrial Informatics, Vol. 10, No. 2, May 2014
[10] "Inside the Internet of Things (IoT)", Deloitte University press
[11] Soumya Kanti Datta, Rui Pedro Ferreira Da Costa, Christian Bonnet, "Resource Discovery in Internet of Things: Current Trends and Future Standardization Aspects", IEEE Transaction.
[12] Guoru Ding, Long Wang, Qihui Wu College of Communications Engineering, PLA University of Science and Technology, Nanjing, "Big Data Analytics in Future Internet of Things".

BIOGRAPHIES

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Prof. Raghib Nasri At present, he is working as a Assistant Professor in the Department of Computer Engineering at Smt. Kashibai Navale College of Engineering, Pune. He has received his Masters Degree in Software Systems from BITS-Pilani. He has Industrial Experience of two years. He has two International Publications and also published a book on Software Testing.