IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661, p- ISSN: 2278-8727Volume 16, Issue 3, Ver. II (May-Jun. 2014), PP 01-05
www.iosrjournals.org

A Cost Efficient Method to Prevent Fire Accidents in Garbage Dumps of Trichirapalli Corporation Using an Internet of Things Middleware

[1]P. Ponmalar, [2]Dr. V. Sampath Kumar
[1]*Finalyear PG student, M.E Computer Science and Engineering*
[2]*Professor, Deparment of Computer Science and Engineering*

Abstract: *This paper aims at development of a prevention mechanism for avoiding major fire accidents in garbage dumps with the help of Internet of Things Middleware. Internet of Thing Middleware enables communication between objects; which are completely heterogeneous with the nodes in network. This proposed methodology will divide the garbage area into sectors according to the coverage of thermal cameras and each sector will be divided into four parts; so that it will be easier for the authorities to locate the fire and solve the problem with less effort. This architecture incorporates an infrared thermal camera, a micro controller which will act as a gateway device & an adaptable user interface to intimate the fire stations at the initial stage of the problem.*

I. Introduction:

In places like Ariyamangalam (Trichy to Tanjore National Highway -67, India) the garbage dump gets on fire every year because of the high temperature in environment. The garbage is dumped in a large area (47 acres approx).12, 00,000 tons of garbage is already there and 400 tons garbage is being dumped there, daily. The chemical contents in the garbage make it to get on fire. In this year two times this fire accident happened (21 May 2013, 24 July 2013).After a long struggle the fire engines stopped the fire[10].

The problem is, the area where the garbage is located is very large; and it is impossible to find the problem in the initial stage itself. The residents near the garbage dump get affected by the smoke evolving from the fire. It causes a major trouble for the people. Little children are getting breathing problems due to this smoke. This thick smoke affects the traffic near the garbage dump.

An expert group from Japan came for providing solution for this problem. They suggested incineration will be the solution for the problem. But it will be very costly to implement & the energy consumption for doing this job is very large. The people near the garbage dump area are suggesting taking compound around the area and spreading sand all over the garbage dump. This is also a costly method and filling sand for 47 acres is a time consuming job. The proposed work will provide a simple and cost efficient solution for this problem.

II. Background:

Middleware: Middleware [4] is the basic term in the emerging client server technologies. Basically it is a software that connects (enables communication) between client and server. Middleware is a term that covers all the distributed software needed to support interactions between client and server. Middleware starts with an API set on the client side that is used to invoke a service & it covers the transmission of the request over the network and the resulting response. Middleware Application Programming Interfaces provide a more functional set of capabilities than the OS and network services provide on their own.

Internet of Things Middleware: The Internet of Things (IoT) [1] aims to interconnect our everyday life items. It provides them with information processing capabilities to enable computers to sense, integrate, present, and react to all aspects of the physical world. This move from "interconnected computers" to "interconnected things" requires simplifying the development of new applications and services by supporting interoperability among heterogeneous devices; so that the programmer can focus on the development of applications enabled by the infrastructure of IoT. Middleware[9] is a software layer interposed between the infrastructure and the applications using it that basically aims to support important requirements for these applications.

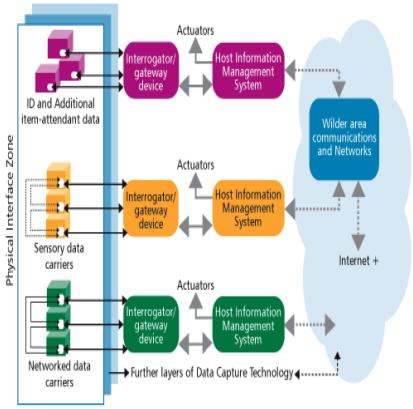

Figure1. IoT Middleware Architecture

Middleware for IoT[2] is required for various reasons. The summary of reasons is as follows:

- Difficult to define and enforce a common standard among all the diverse devices belonging to diverse domain in IoT.
- Middleware acts as a bond joining the heterogeneous components together.
- Applications of diverse domains demand abstraction /adaptation layer.
- Middleware provides API (application programming interfacing) for physical layer communications, and required services to the applications, hiding all the details of diversity.

The above stated reasons generate the need for various functional components the IoT Middleware must support.

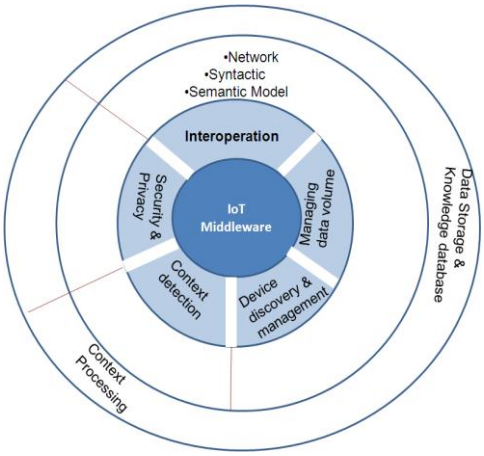

Figure2. Functional components of IoT

We can classify different types of IoT-Middleware[8] based on the various features like interoperation, device management, platform portability, context awareness, security and privacy, and the support of various interface protocols. Table1[2] depict the classifications of various IoT-Middleware systems based on the various features and interface protocol support respectively. All the listed Middleware support device discovery and management. Context aware functionality is supported by HYDRA, UBIWARE, UBIROAD and SMEPP. On the other hand, SOCRADES, SMEPP, GSN, UBIROAD and HYDRA are some examples of Middleware implementing security and user privacy in their architecture. Based on platform portability, syntactic resolution, HYDRA, SMEPP and ASPIRE are OSGi compliant, UBIROAD uses JAVA and XML, UBISOAP uses J2SE and J2ME, GSN uses XML and SQL, SIRENA and SOCRADES use DPWS while SOCRADES also uses SAP NetWeaver platform and ISMB uses any JAVA compliant platform. WhereX is developed using J2EE architecture and is integrated with Oracle Application Server 10g.It also uses Rhino rule engine which is implementation of Java Script.

IoT Middleware	Features of Middleware				
	Device Management	Interoperation	Platform Portability	Context Awareness	Security and Privacy
HYDRA	√	√	√	√	√
ISMB	√	x	√	x	x
ASPIRE	√	x	√	x	x
UBIWARE	√	x	√	√	x
UBISOAP	√	√	√	x	x
UBIROAD	√	√	√	√	√
GSN	√	x	√	x	√
SMEPP	√	x	√	√	√
SOCRADES	√	√	√	x	√
SIRENA	√	√	√	x	√
WHEREX	√	√	√	x	x

Table1. IoT Middleware comparisons

Link Smart Middleware(HYDRA):As stated in[1] HYDRA project developed a software named LinkSmart Middleware which enables transparent communication between lower layers. This Linksmart Middleware works based on Service Oriented Architecture.

III. Proposed System:

This system includes a thermal camera, a gateway device (Arduino microcontroller)& link smart middleware. These are the basic components of this system as shown in Figure3.

Thermal camera:The 47 acres of garbage area will be divided into parts based on the range of the thermal camera. Each of the thermal cameras will be placed in a tower of 100 feet height & it will be connected with a gateway device.This gateway device (Micro controller) will include a temperature sensor which will sense the environment temperature. The device connected with this Micro controller will calculate the difference between the temperatures (environmental temperature and thermal camera observed temperature). If there is a large amount of difference in the temperature, then through the gateway device the information will be sent to the link smart middleware.

LinkSmart Middleware:The link smart middleware implements applications that communicate with the gateway device (Micro controller) using the HTTP, IPv6 protocol.These applications capture data regarding the temperature and it will be compared with the threshold value (this value will be set by the fire station professionals).

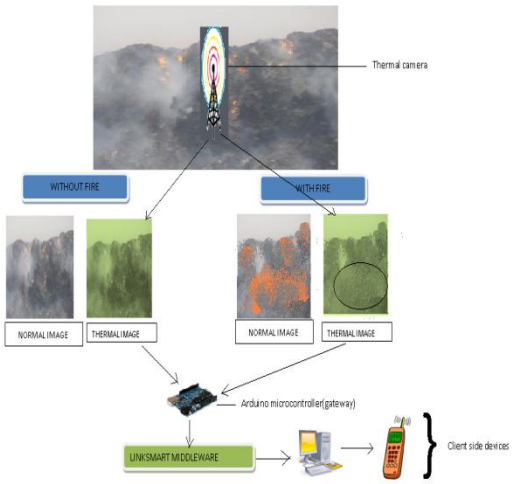

Figure3: Architecture for the implementation of the proposed system.

If the calculated temperature exceeds the threshold value then the intimation will be sent to the fire station & corporation office. The intimation will be a mail to the correspondents and message to the corresponding people's mobile.

System Architecture: The architecture of the proposed system consists of five layers as shown in Figure4. It can be described as follows.

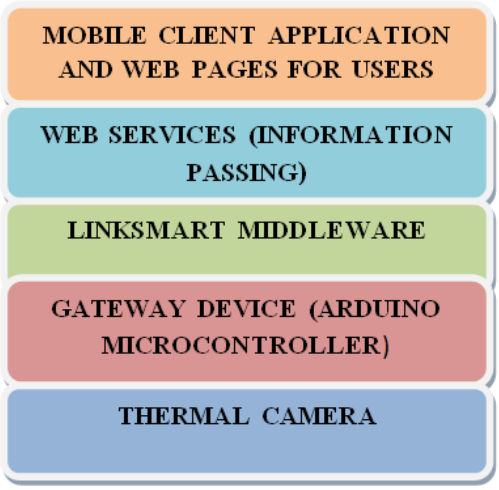

Figure4 .Layered architecture of the proposed system.

1. Thermal camera: First layer of the architecture consist of the thermal camera. This part of application is directly connected with environment. This camera observes the thermal activities of the dump constantly.
2. Gateway device: This layer is represented by Arduino microcontroller that has a firmware that interprets a set of messages, publishes the data or provides the interaction of environment with the devices.
3. Link Smart Middleware: This is the first layer of software that uses Link Smart platform. It implements applications that communicate with gateway devices[6] using the HTTP and IPv6 protocol. This layer has interfaces that receive commands from the upper layers from the upper layer and sends them to the gateway device in order to act upon the environment.
4. Web services: This layer connects to the LinkSmart Middleware layer and enables client applications to retrieve data, and act upon the environment.
5. Client applications: The top layer is represented by the applications user interface (mobile & web applications). This layer allows user to set the threshold value for temperature. When there is a symptom of fire the information will be sent by the lower layers to these applications.These mobile applications will be developed with the help of J2ME language[7].

IV. Working Of Proposed System:

The fire station professionals can check the status of the dump in a timely manner. Based on the camera number and the sector number the affected area can be identified. If there is a problem in the dump the it will be intimated to the authorities by sending short messages to their mobile phones. It is the responsibility of LinkSmart middleware to do that process.

The following data flow diagram depicts the flow of control and data of the system clearly.

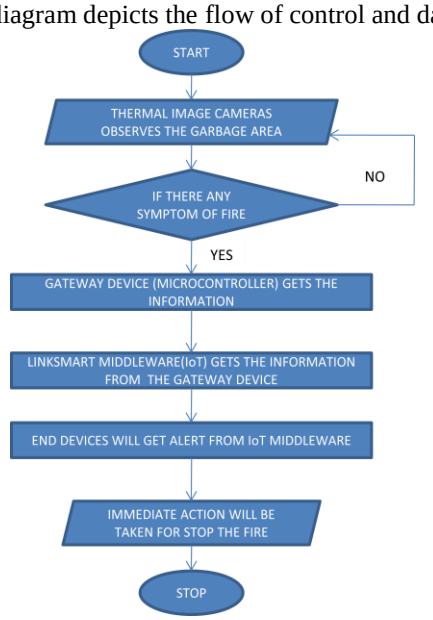

Figure5. Data Flow Diagram

As shown in the diagram the camera already observes the garbage area under it. If it find any symptom of fire; the information will be sent to the microcontroller. The LinkSmart middleware gets information from the gateway device.then it is the responsibility of the middleware to alert the end user.

V. Conclusion And Future work:

This proposed methodology makes use of IoT Middleware for connecting gateway device (microcontroller) with the end user devices. It will act as a connecting mechanism for connecting the thermal image camera with end user devices (mobile, PC).

The technique used in this methodology will find out the fire on the dump at the initial stage itself; so that it will be easier for the fire stations to locate and solve the problem with less effort. This will be the most cost effective solution for the problem. By using this method the garbage can be stored for further processing without any problem like fire accidents.

This methodology will find out the problem after it gets started. Advanced sensor techniques can be used in future to sense the fire on the dump before it starts; and before indicating the fire to fire stations there can be initial preventive actions like trying to stop the fire automatically.

References

[1] Albreto.M.C.Souza,"A Novel Smart Home Application using an Internet of things Middleware" Smart SysTech,Erlangen/Nuremberg, Germany 2013.
[2] Soma Bandyopadhyay, Munmun Senguptha,souvik Maiti and subhajit Dutta Inovation Lab,TATA Consultancy Services Ltd. Kolkata,India, "Role of Middleware for internet of things: A study" International Journel of Computer Science and Engineering Survey(IJCSES)Vol.2,No.3,August 2011.
[3] The COTS Enterprise Architecture Workgroup, Middleware Domain Team "A middleware framework for Delivering Business Solutions" Version 1.0,May 2001.
[4] Robert Orfali, Dan Harkey and jeri Edwards, "The Essential Client/Server Survival Guide", Galgotia Publications Pvt. Ltd.,2002.
[5] Jeffrey.C.Jacson,"Web Technology-A Computer Science Perspective", Pearson Education,2007.
[6] James Keogh," The Complete Reference J2ME" Tata McGraw – Hill Education (2003).
[7] The Hindu, "Garbage gives Ariyamangalam residents a nightmare", July 29, 2013.
[8] Karl Aberer, Manfred Hauswirth, Ali Salehi," Middleware support for Internet of Things", School of Computer and Communication Sciences, Ecole Polytechnique Federale de Lausanne(EPFL), Switzerland.
[9] Dr.Antoine Bagula, "INTERNET OF THE THINGS (IoT): An introduction to wireless sensor networking middleware", ISAT Laboratory, University of Cape Town, South Africa.
[10] W. Durfee, "Arduino Microcontroller Guide", University of Minnesota.