Urban Computing and Information Management System Using Mobile Phones in Wireless Sensor Network

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Abstract

At present, information Management using mobile phone in Wireless Sensor Network is the commonest factor. Mobile phone will be the main access point in Wireless Sensor Network. The system will be as simple as possible providing all the facilities those are available in web based rather PC based applications regarding this. A wireless mesh network furnishes the WSN and the mobile phones are going to be the nodes or access points of this network Not only the queries of mobile users, some predefined activities like error messages or warning messages after sensing the system environment can also be available in this system. A simple user friendly GUI is implemented for user. There is a server to authenticate the logged in user, listen to the requests submitted by user and replies them accordingly. The user has two choices using which he/she can get the required information namely (i) get the reports regarding all/individual tags and or routes, emergency messages, sensors and also the location information; (ii) send actuation command to the server using which immediate decision about the system can be taken from server side. The user can see the report in their phone's display screen. Thus to communicate with WSN anywhere, anytime can assist any remote user most efficiently.

Keywords: WSN, node, tags, routers, actuation command, WLAN.

1. Introduction

A wireless sensor network (WSN) is a wireless network consisting of physically separated autonomous devices which use sensors to cooperatively monitor temperature, pressure, sound, motion, vibration or pollutants at different locations [1,2,3]. The applications for WSNs typically involve some kind of monitoring, tracking, as well as controlling. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor nodes. In case of area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. For example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored like heat, pressure, sound, light, vibration, humidity

etc, the event needs to be reported to one of the base stations, which in turn can take appropriate action e.g., send a message on the internet or to a satellite. The use of WSN depends on the way we want it to perform. That is why wireless sensor networks are an active research area in computer science and telecommunications.

To get the facility of WSN, we have implemented a heuristic technique which manages information in WSN. The information is managed using mobile phones in this Wireless Sensor Network. Here, the whole environment follows the Wireless Mess Network structure. A wireless mesh network (WMN) is a communications network made up of radio nodes which are organized in a mesh topology [4]. Wireless mesh networks often consist of mesh clients, mesh routers and gateways. The mesh clients are often laptops, cell phones and other wireless devices while the mesh routers forward traffic to and from the gateways which connect to the Internet. A wireless mesh network can be seen as a special type of wireless ad hoc network. To be more specific to our purpose, we have chosen cell phone as the mesh client. Any standard mobile phone (supporting Java applications as we have implemented the technique in Java platform) will be used as any node of this WSN and the single phone will be enough to send or retrieve remote information to communicate with the active tags within this WSN. Not only the queries of mobile user, some predefined activities i.e., proactive message passing based on situations (especially error messages or warning messages after sensing the system environment) can also be available in this system. To achieve all the requirements, a simple user friendly GUI will be implemented and will be treated as client side and there will be a server which, after authenticating the logged on user, will listen to the requests submitted by client and serve the requests by sending replies back to client.

2. Related Works

WSNs are used based on requirements. So we have gone through the techniques and approaches which are developed for specific reasons and get some idea to make our approach exactly what our system demands. Our basic aim is to transfer information through WSN and the information is specifically the beacons of tags and routers across the system for tracking as well as sensing the resources which are distributed over the whole system. That is why we have concentrated our work study on Real Time Locating System (RTLS) and Real Time Sensing System (RTSS) approaches.

TrackIT's RTLS provides unprecedented control over one's assets, improving disaster preparedness [5,6]. Wireless geo-location of any tagged asset or tagged person is detected by RTLS LOCATOR. RTLS VIEWER creates images of tagged assets which help to communicate spatial relationships. To query the RTLS database for up to date geo-location of any tagged asset, RTLS STORAGE SYSTEM is used. RTLS Reporter gives ability to create reports based on end users needs. A virtual trigger area is set whereas individuals entering or exiting the facility places his or her tag into a hot spot near the door. The software is capable of determining the presence of the tag entering the virtual trigger area once inside the facility, the individual sporting the tag is accounted for at every step of the way. In addition to reporting their exact location, these same transceivers are also capable of wirelessly sending and receiving data from the associated entity to which it is attached. Due to the two-way data capabilities of the transceivers, control packets could be sent wirelessly from a central command.

There is another way of utilizing wireless network for asset tracking [7]. An asset such as a vehicle can be equipped with a 3-axis geomagnetic sensor. An accelerometer along with a remote control hardware component capable of responding to SMS command transmitted from the wireless devices. If a theft of a particular asset is detected, a "Theft in progress"

SMS will be transmitted from the wireless device to the remote device attached to the asset with out wasting a fraction of second. The device then queries the geomagnetic sensor. The accelerometer transmits the X-Y-Z coordinates and acceleration values to the cell phone or computer via SMS at regular intervals.

Getting the ideas from the works done on wireless mesh networks and with the help of a proper database as well as a perfect field to apply the technique, we have given the approach so that a naïve user can get the clear idea about the system as well as all of the resources (be it a vehicle or a human being associated with the system) anytime, anywhere. All that the user must have is a mobile phone with network connection and a valid user account in the database. Only these things make the system easily maintainable and traceable in real time.

3. Our Approach

3.1 System Study

The approach which we have highlighted here is totally based on the requirement as well as the system upon which we have tested the technique. That is why it is extremely necessary to understand the overall system before going to the algorithm section.

The system which we have chosen for research is a wireless ad hoc network system which acts likes wire less mesh network. There are various tags (which can locate the resources like vehicles, other electronics goods even human beings associated with the system and/or sense the environment; more specifically the intensity of light, temperature, humidity, amount of dust in air etc), routers which receive the information from tags and transmits it to next router or gateway which in turn sends the information to main server of the system. The tags are generally attached with the objects which are to be sensed or located and these tags can feel, react and communicate with each other.

Now to understand how the whole system can be controlled by remote clients, we need to focus on the activities of tags and routers and how they react each and every moment. The routers in the system are very small in number and generally distributed 1 or 2 per zone and thus the whole system is the sum of small zones. These routers are efficient enough to sense the nearest tags in a particular zone. At the same time the tags also automated to find the nearest router of a particular zone so that it can transmit the information to the router. If a tag is moving from on zone to next, it can sense the router of new zone and continues sending and receiving messages to and from routers. If the tag is active, it will communicate with the system every fraction of second. It will stop beaconing either when it is out of service or when some thing is wrong (e.g., if it is stolen or some one has removed the tag from the object). And the controller of remote server of the system gets to know the fact instantly and thus can take the necessary action immediately. The system was using the remote computers to take care of the states of the system. A remote user gets the facilities of getting all type of information (information of the sensed object by the sensor and / or location tracking) regarding (i) all tags or a specific tag (ii) all routers or a specific router. Not only that, the user can send actuation command to specific tag(s) or router to execute e task. However, only remote server and computers are not sufficient to make the control of the system too flexible to communicate with the system even when a user is mobile and that can only be possible if some small, easily portable electronic device is able to do the same job of remote computers. And in this case mobile phone phones and PDAs are the best option to do the task. That is why we have chosen the mobile phones (which have java support as we have used J2ME to give the shape of our approach and is able to connect through internet with the system) as access points of the system. The phone will do exactly the same tasks of remote computers.

Our approach will be such that we can achieve this goal. To be more specific to our objectives we must take care of following points while implementing the technique:

a.   The technique should be a standard one such that can be used very easily by the naïve users to interact with the system most efficiently

b.   The technique will be optimized enough so that it will take minimum amount of response time to the client request

c.   Technique must provide a simple User friendly GUI in mobile phone

d.   It must support remote log in of user and user authentication

e.   An user friendly display of set of available types of reports for display as well as available actuation messages which can be sent by the user corresponding to available tags

f.   On selection of the available choices, user queries to server

g.   Server responses to the queries by showing reports

To get all the aforesaid facilities, we have implemented the algorithm which is given in next sub section. Here MAIN is the main method to call other supportive methods. VALIDATE method will take the input from the user (who must has a valid user account in the main database) and authenticate him/her by validating username and password. Now to communicate with the whole system, we have used HTTP protocol and thus STARTHTTPCONNECTION will set up the connection. In the main database, the data are queried using SQL commands based on requirements of users and it returns the data in XML file format. But to make the whole approach user friendly, we have parsed the files, extracted the required parts and shown the data in more understandable format which are supported in normal mobile phones. PARSING, POPULATE and DISPLAY methods do this task efficiently.

3.2 Algorithm

A.   MAIN()

This is the main function of our algorithm. This will monitor over the whole functionality of this process by calling all other modules like Initialize, Validate, Choice, StartHttpConnection, Parsing, Populate and Display.

a.   Start Application
b.   Call INITIALIZE()
c.   Call VALIDATE(USERID, PASSWORD)
d.   Call STARTHTTPCONNECTION(SELECTED_ITEM)
e.   Call PARSING(FILE_CONTENT)
f.   Call POPULATE(PARSED_TEXT)
g.   Call DISPLAY()
h.   Return

B.   INITIALIZE()
This method will initialize all the variables which are required in the whole process.

a.   Call the respective constructors to initialize the objects of the respective classes.

b.   Initialize all the variables with respective values
c.   Add all required components to the main form
d.   Add command listeners to the main form
e.   Set current display to the main form

f.   Return

C.   VALIDATE(USERID, PASSWORD)

This module is to validate the user details. The arguments are fed by user who would like to avail the service.

Arguments: This module takes UserID, Password as arguments and finally returns either true or false value.

a.   Call STARTHTTPCONNECTION(URL) to get connected with database
b.   Fetch use details
c.   Compares the values with the two arguments
d.   If they match, return true
e.   Else return false

D.   STARTHTTPCNNECTION(SELECTED_ITEM)

This is the main method to create a separate thread for setting up http connection. It takes one argument to dynamically select respective URL for connection to server.

Argument: This method takes SELECTED_ITEM as its argument and set connection based on url and returns a String Buffer containing data.

a.   Associate a numeric value with respect to selected item
b.   Call SETURL(ITEM_NUMBER)
c.   Start a thread for setting up connection
d.   Return String Buffer with full of data fetched from

E.   SETURL(ITEM_NUMBER)

This method is only to set respective url with respect to item number.

Argument: This takes ITEM_NUMBER as its argument and sends the url string to calling function.

a.   Get the item number
b.   Matches the item number with predefined number associated with urls
c.   If found, return the respective url
d.   Else return null

F.   PARSING(FILE_CONTENT)

This is the most important method which actually gives the required shape to the raw data.

Argument: It takes FILE_CONTENT as its argument and returns refined data stream.

a.   Store the file content in temporary variable
b.   Split them according to requirements
c.   Store them in respective arrays
d.   Match the regular expression
e.   Remove tags of xml files (as the data are send from data base in xml file format) with respect to matched expression
f.   Store the extracted data in separate variables.
g.   Return the refined data

G.   POPULATE(PARSED_TEXT)

This method is to populate the containers with respective values and add them to the main form of the application.

Argument: It takes PARSEDTEXT as its argument and then returns data containers with full of required data.

a.   Store the passed text in local variable
b.   Checks the data s that n grammatical error occurs
c.   Store them in specific container (like text box text field or table)
d.   Add the container to main form

H.   DISPLAY()

This is the last function of the process. It only sets the current display to the specific form and add command listener to that.

a. Set current display t the specific form
b. Add command listener t that
c. Return

4. Result

As we have mentioned that we implemented our approach using JAVA technology (J2ME, J2SE), the figures which are shown to explain the process are the snaps of SUN JAVA WIRELESS TOOL KIT's SDK. After implementing the technique, it is acting as software which will be installed in JAVA supported mobile phones or PDAs. **Figure 1** shows login screen of the software. Here users have to give respective UserID and Password. On clicking "OK" the values will be verified. If the use is authenticated, he/she will be able to avail the features. If fails, the alert message will pop up. User needs to reenter the details.

Figure 1. Login Screen

Now, after login user will get 2 options namely 1. Report view 2. Actuation Message. If user selects option 1, he will get a set of choices like Emergency message details, Sensor Data Information, Current transaction information of location, Tree view of Router and Tags, Transaction information of Tags, Transaction information of Routers. These are shown in **Figure 2**.

On selecting any of the items, it will lead to connect the server using respective url which is automatically selected. The result is shown in **Figure 3**. **Figure 4, Figure 5** are representing the information with respect to choice of users.

Now if one selects Actuation command then on clicking "OK", it will show list of available tags and the on selecting any of them will show available messages which to be send. After that, the selected tag and the message will be fed to the URL to insert data into table at server. On successful insertion, the acknowledgement will be send to user. The whole matter is expressed in **Figure 6, 7, 8**.
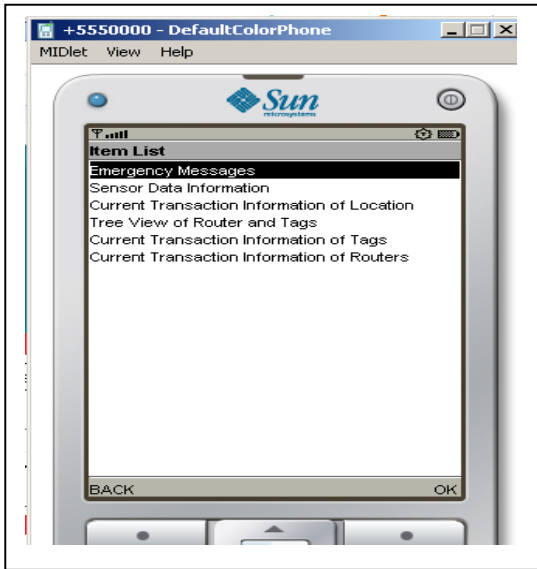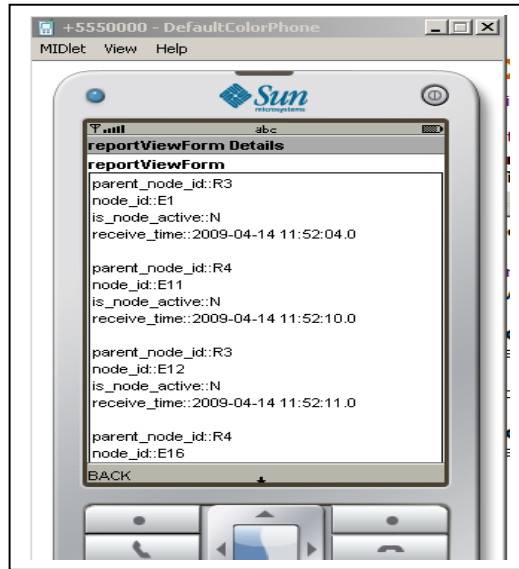
Figure 2. List of Report view types

Figure 3. Tree view of Tags and Routers

Figure4. Details of Tags

Figure 5. Details of Routes

5.   Discussion & Conclusion

The software based on our approach is a complete package to communicate with active tags, routers and all other devices in the environment in real time. The whole process is tested in series80 of Nokia whose graphical support is very poor. There are lots of limitations in this series to make the display eye catchy. Due to these limitations, the data which are shown in result section are totally text mode based. But it is highly required to add some images of the zones where the tags and routers are attached so that user can easily keep track the whole system at any moment and thus can take suitable decision like sending actuation messages to warn the wrong doer who is associated with location tracking tags or start automated actions

like starting sprinter etc with respect to the activity of sensor tags. These will make the whole process more users friendly. Beside this, the whole approach is implemented as a stand alone application which acts as a software tool to communicate with the system. But if we can use WML and other supportive methods to make the whole approach web based, then the technique will be device independent and Operation System(of mobile phones) independent.

Mobile phone based remote data access through wireless sensor network adds a new dimension to the facilities available for the users who are keeping track of the tags and routers and all other devices in this system as this approach assists the user while they are mobile. It makes the words "anytime, anywhere" true. This system provides the same facilities those are available in common web based rather PC based applications. It is easy to use and simple to handle.
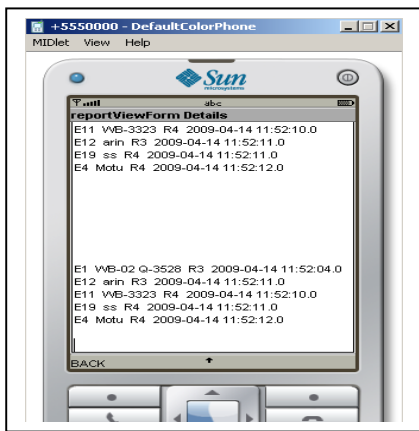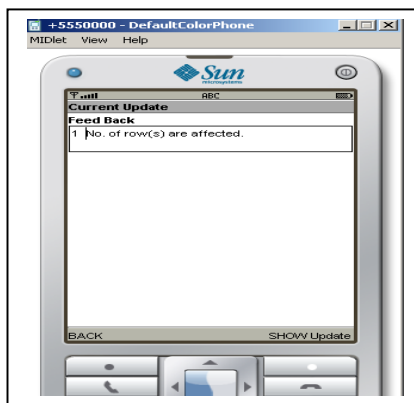

Figure 6. Available Tags

Figure 7. Available Message

Figure 8. Acknowledgement to Sender

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