Hybrid Smart Home System

Automation of electrical appliances via sms and gprs on Android Platform

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Abstract—**Technology is being on progress since the evolution and currently the main area of research is automation technology. SMS Based Home Automation System is the earlier technology that came in existence. Each technology has several limitations. This paper emphasizes on the limitations of this technology and some advancement in automation technology to overcome those limitations. This design is presented to overcome the user non-friendly behavior limitation of SMS based automation devices and mobility of internet/gprs and embedding the two technologies. This also focuses on comparison with existing technology. The main idea of paper is to provide user friendly interface.**

I. INTRODUCTION

Influence of wireless communication is enhanced daily. Because of its mobility, wireless technology is replacing wired network. Technology is in progress day by day and advancements are processed. In today's world, automation is having very high importance. In earlier times, technology or machines were operated manually. These technologies needed human control for operations. Automation makes technology free from human interruption. Home automation is one of technology emerging these days. To make it more operative and efficient, cost is reduced by low cost communication technology like Bluetooth, Wi-Fi, SMS. Bluetooth is nice technology to use in home automation. This is no operational cost technology, common in use and working in range up to 100 meters. But it is having its limitations of limited range. [12]SMS based technology is having advantage of limitless range. This is having very low operational cost.

Many few issues are considered for designing for home automation. These issues are mentioned below: (1) System must be scalable to integrate new devices (2) User Interface must be user friendly (3) Easy setup (4) Easy to monitor and control (5) Diagnostic service so that problems can be tracked down (6) Efficient communication (7) Cost Effective.

Yavuz and Hasan [2] designed telephone and PIC based control system communication took place via dedicated telephone lines, not using Bluetooth [3][4]. Other technologies [5][6] in home automation is web based automation. These had limitations of high cost. Al-Ali and Al-Rousan[7] presented low cost java based home automation system without highlighting low level devices of peripherals. Sriskanthan proposed home automation that was based on controlling home appliances by pc via Bluetooth technology [10]. Then finally R. Piyare and M. Tazil introduced home automation by using Symbian cellphones via Bluetooth [1]. This design has several limitations like range limitation and limited platform. The latest design of automation is [11] Smart Home system based on Bluetooth by establishing wireless ad hoc network. This design removed the limitation of Bluetooth range and operational and maintenance cost of the system. This system was having many limitations. One of the major limitations was the delay that was provided during communication. Later on [12]SMS based Smart Home System on Android platform came in existence but it was having very big limitation that was that there is limitation over SMS sending limit. For example, in India it was earlier around 100 per day. What to do after this limit is over was a big question-Either leave the controlling of devices or change the device every time after the limit. That is practically impossible. A solution to this problem was found and it was realized that it is better to use hybrid system using two or more technologies.

This paper introduces latest technology android platform mobiles, smartphones and tablets to control electrical appliances via SMS and GPRS both. This design overcame the limitations of earlier Smart Home Systems with ad hoc network establishment and Bluetooth home automation systems which was Bluetooth limited range and limited platform. These problems are considered, studied and solved in this design.

II. SYSTEM ARCHITECTURE

Basically, this Hybrid Smart Home System is having SMS/GPRS nodes and gprs nodes. The SMS/GPRS nodes are the smallest functioning object in this architecture. SMS/GPRS nodes are basically used for communication from each other. These nodes will be permitted by main SMS/GPRS node that is the android node having the authority to permit the nodes to communicate in the network. This node will be mobile node.

These main nodes can communicate with other main nodes directly only. These nodes will always be free for connection. These nodes will be connected, perform function and then disconnected again. This design also reduced the load from the Android sms/gprs nodes. Earlier Systems had compulsory one android node required for communication.

This design of home automation system consists of three main hardware components: (1) Android sms/gprs node [9] (2) SMS/GPRS Roboduino Node [8]. (3) GPRS Node

A. Android SMS/GPRS Node

Android sms/gprs nodes are the mobile nodes that work on Android platform. These nodes use the mobile phone as the node for communication. These nodes are basically called main Nodes. These nodes are simple android nodes but these nodes are having special power of recognizing the nodes and permitting the nodes to be a part of the network. This node is also having power of defining the electrical appliances used with the SMS/GPRS Roboduino nodes and their configuration. This configuration is to be carried out individually with each Android sms/gprs node, since there is no transmission of details to the roboduino nodes for configuration of these electrical appliances. The role of the Android sms/gprs node is given below in details:

1) *Source Nodes:* These will also be used for sending control data from the android nodes to the Roboduino nodes and update it. This node will generate the sms packet and this sms packet is received by the SMS/GPRS Roboduino node.

2) *Configuration Nodes:* Thes nodes will also be used for updating the configuration for gprs node and updating own configuration from the gprs node.

3) *Destination Nodes:* Thes nodes will also be used for receiving data from the sensor network and storing in the database.

B. SMS/GPRS Roboduino Node

Roboduino Nodes is the major part of and most used in this network. These nodes will be connected to the electrical circuits or appliances. These nodes will be playing the following role of slave node. Slave Nodes are the Roboduino nodes. These nodes will be simple nodes which will work as destination node. These nodes cannot behave as source node since these devices are not having the configuration of the electrical appliances and these nodes will be directly connected to the electrical appliances. The role of SMS/GPRS Roboduino nodes are given below in details:

1) *Destination Nodes:* These nodes are compatible to the role of destination nodes to control electrical appliances. These nodes are directly connected to the electrical appliances. These nodes can simply receive the control message from android node or gprs node or both depending on the user's usage.

2) *Source Nodes:* These will also be used for sensing the data from the sensors that are attached to these devices and send this data to the mobile application and update it. These nodes will transmit two packets. One for GPRS node and other for Android sms/gprs node. Packet for GPRS node will be put up on web server. This webserver can be accessed by the gprs to all the nodes.

Limitation of these nodes is that these nodes cannot behave as destination node for controlling electrical appliances. These nodes will receive the control signals and will be processing the signals to control the electrical appliances.

C. GPRS Node

GPRS Nodes is the major part and most used in this network. This is the advantageous part of the system over earlier systems. These nodes include all the devices capable of accessing internet. These nodes will be accessing the data that is available in database and updating the database. This data is fetched by the SMS/GPRS Roboduino nodes by using the concept of web services. These nodes will then send the acknowledgement back by the web service. The data from the sensor network is being transmitted to the database server by using the concept of web service. These nodes are having no number limitations. You can sit on any computer/laptop/mobile phone/tablet/smartphone and can access to this system. The only requirement it is having is the internet or gprs facility.

1) *Configuration Nodes:* Thes nodes will also be used for updating the configuration for itself and updating own configuration for the Android SMS/GPRS node.

2) *Destination Nodes:* Thes nodes will also be used for receivving data from the sensor network and storing in the database and making it available to android nodes.

III. WORKING

The working of this Hybrid Smart Home System is very simple. As from architecture it is clear that it is having three types of nodes. We are having android application on android node and GPRS node will be accessing the website connected to web service in background. This web service is further connected to database server. Implementation of web service in this system was very important because of the easy access from the SMS/GPRS Roboduino nodes and gprs node. Now, the configuration of electrical appliances can be done by Android sms/gprs node or GPRS node depending on user's compatibility. These configurations will be updated to other device. If configuration is being carried out by GPRS node, Android sms/gprs node will fetch data from the web service by using function defined on the web service. If android node is doing configuration of the SMS/GPRS Roboduino nodes, android node will update the configuration on the database server by using the function defined in the web service. Android node will send the sms messages and it can communicate via GPRS too. Firstly concentrating on sms and making it less confusing, SMS communication is carried out between android node and roboduino node. Communication carried out is in this way:

Control message is being sent from android node to roboduino node and this message is implemented by roboduino node. Now roboduino node will generate the acknowledgement packet and send this packet to android node and android node will update its table and table of database server will also be updated by roboduino nodes. Sensor data is being transmitted continuously from roboduino node to android node and gprs node both.

Now coming to the gprs medium, database server is updating the control packet and this control packet is received by roboduino nodes via routing checking. Then this
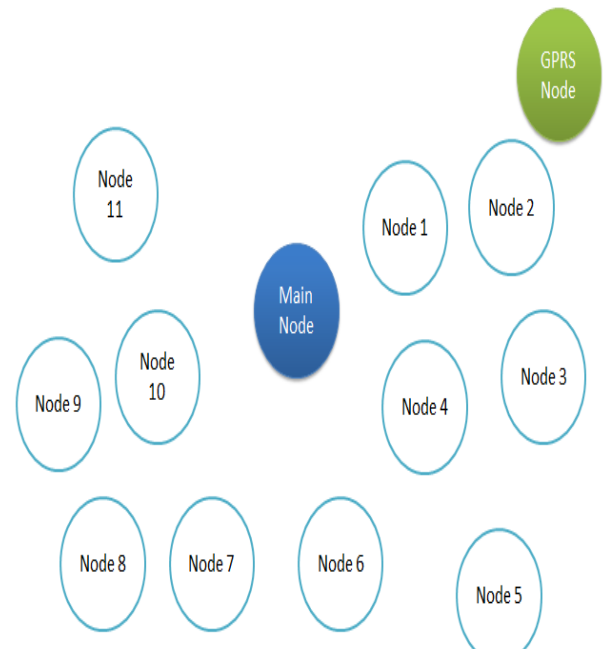

Figure 1.   Architecture of the system

packet is processed and acknowledgement is generated and this generated acknowledgement will update the database server via web services. Configuration is carried out either by android node or gprs node. When one node updates the configuration, other node updates it. In this, android node fetches the configuration packet generated by gprs node and android node updates its database. When android wants to change configuration, then it will update the database in database server which will be accessed by web services.

In this way the communication is carried out.

III. SOFTWARE DEVELOPMENT

A. Graphics User Interface(GUI) Module

The most important feature of our application is to provide easy to use user interface and using concept of multi-threading for making user not to wait for long time. By using the GUI package, we are able to configure the electrical appliances connected on the Roboduino nodes from domain node. This makes the system easy to configure and operate from domain node. Figure 2 illustrates some designs for the graphical user interface.

IV. MESSAGE PACKETS

Message packets are the messages along with some other data which is of no use on reception of data. Message

packets are basically categorized as mentioned below and the details about the size, Name, type of storage of each parameter of the packets is mentioned in the list of tables:

Figure 2. Cell Phone GUI for controlling home appliances

A. Control message

This message packet is basically used for controlling electrical appliances. This message packet is the having the main focus of the network. This is generated by the domain node or android node only. Roboduino nodes can receive this packet and process the message. Each message is having query string or keyword which is used in this message. This query string will be same for all the nodes in the network. This query string is used to identify the messages that are received whether it is control message or not. When control message is received, at that time this query string is used to separate it from other messages that are normal for all GSM modules.

1) *Without acknowledgements*: This message also includes the generation of control message from roboduino nodes which are further connected to the sensors and these kinds of control messages require no acknowledgement. These messages are basically unidirectional message having no surety of implementation of the control message that is being transmitted. This type of control messages are generated by roboduino nodes and these nodes are transferred from roboduino nodes to arduino nodes.

2) *With acknowledgements:* This message also includes the generation of control messages with the feedback providing the information about the status of the control signal. The acknowledgement is further configured in the next section. This makes

the transmission of the message to the destination nodes. Basically, this type of control message is transferred from android nodes to roboduino nodes.
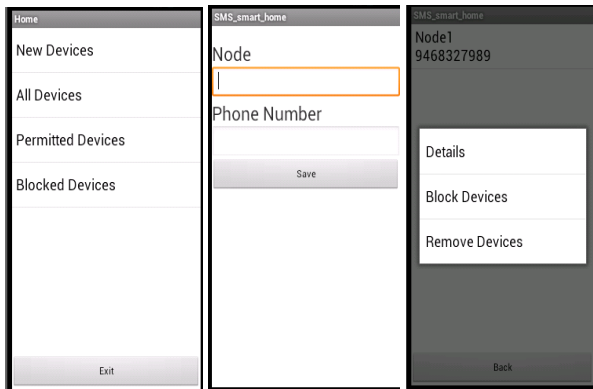
B. Control acknowledgement message

This message packet is basically confirmation or acknowledgement message generated by the destination node of the control message. This is for confirmation whether the message received is implemented or not. This is sent back to the main node for providing the latest status.

If not then it will send status "not ok" else if the message is implemented it will send "ok" as status in this message and this message is sent back to the source node that have generated the control message.

C. Configuration packet

These packets are the basically updates generated by the android nodes and these packets are transmitted to database server by Android node using GPRS medium. These messages consist of pin configurations, roboduino node name. This message is also used for blocking and unblocking the permitted devices and remove permanently also.

D. Configuration update packet

This type of access is like accessing the function and retrieving data from database server and updating the local database of android node by node itself.

E. Control packet

This packet involves the routine update carried out by roboduino node from database server. This involves retrieval of data from the webservice and used for implementing the instructions provided by the gprs node.

F. Control Acknowledgement packet

This packet involves the updates made by SMS/GPRS roboduino nodes. This involves the updation of the database on database server.

V. SECURITY

Security is kept in mind while designing this model. Physical addresses are used in this for communication which makes it more secure than earlier designs. This provides more security against unauthorized access to the network. Login option is also provided since there are a lot of devices of being capable of GPRS nodes. These devices must be secured by providing the login and password. Even the Android Node is provided with the login option so that unauthorized person cannot access these nodes and misuse them.

VI. ADVANTAGES

This design is having advantages over Bluetooth Based Smart Home System and other earlier automation technologies: (1) User friendly, (2) Wide Platform, (3) Less operational cost, (4) Less maintenance cost, (5) No increase in installation cost, (6) Temporary & permanent Blocking, (7) More Security, (8) More secure,(9) Embedded Technology,(10) More Android, (11) More performance

VII. CONCLUSION

In this paper we have introduced design and implementation of a low cost, flexible and wireless solution to the home automation systems till now by embedding two technologies in one package. The system is secured for since there is no information about query string to the users and login features are also provided. These devices can be blocked or permanently removed from network. This system can be used as for the controlling electrical appliances with no range limitations. This design is practical tested with six SMS Roboduino nodes and one android sms/gprs node. For future work it is recommended to have reducing the delay and power consumption, voice based control. This design is having advantages of unlimited access over earlier SMS based Smart Home Systems which was having limitation of limited number of SMS transmission.

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