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Framework of Distributed Automated System Controlling Via Mobile Device

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Abstract

A daily used technology, mobile device such as smartphone has grown its popularity among consumer market and its wide market makes it a candidate for industrial application. Currently, there are no devices based solutions for real time distributed control system via smartphone especially in industrial automation domain. This research has been done on creating framework of distributed controlling via mobile device.

Keywords- industrial; distributed; controlling; smartphone

In today's industrial market new technology brings many opportunities for system developers to successfully address ever-evolving challenges. The world as we know today is becoming more portable or in more specific terms, more mobile. A daily used technology, mobile device such as smartphone has grown its popularity among consumer market and its wide market makes it a candidate for Industrial Application. As adoption of advanced mobile devices such as smartphones has exploded in recent years, consumers have grown increasingly comfortable using phones for social networking, and engage in other types of transactions and interactions. All of those and other things are brought together in the idea of a tiny device that has replaced the need of physical objects including personal computer, notebook, networking system, camera, calculators, navigation units, radio and so on. Currently, there are no smartphone based solutions for real time distributed control system especially in industrial automation domain. Or in other words, smartphone hasn't been implemented yet in industrial automation and real time control system. Imagine how beneficial to monitor and control anything at anywhere by only using a single smartphone. Nobody will have troubles with getting a smartphone which widely used today, as smartphone now have become a typical daily used device and they will become more affordable and cheaper in the near future. The smartphone is more practical and convenient for networking interaction than a computer and it is a perfect candidate for automation control solution.

1. Target and Goal

Library that implement internet protocol were designed to provide interaction over client server paradigm. Software application of smartphone that used to control, manipulate and monitor the automated system was developed. All software libraries were then integrated over a system which allows access to automation control via smartphone over wireless internet network protocol. Imagine how beneficial to extend yet adapt mobile device into automation and user can monitor yet control anything at anywhere by only using a single smartphone. Through this approach, smartphone extendibility and adaption in different environment were proven successfully.

2. Fundamental

All this technique section covers the fundamental background concepts that will be used in designing smartphone related networked programs. Moving from the most general to the most specific, it discusses networks idea in general, protocol networks in particular, and the Internet. This section doesn't try to discuss how to wire a network or configure a system, but it's all about what need to know to write codes in high level language that communicate across the Internet.

2.1 High level language

An object oriented language based application was developed and embedded into mobile device or smartphone for better graphical interface which used to control, manipulate and monitor the automated system. The embedded application of smartphone consists of user interface that lets the user interact with the application to control an automated system and displays system status in real time.

2.2 Communication Protocols

The Transmission Control Protocol (TCP) is a protocol that provides delivery and ordering of bytes and is the most implemented and most important protocol in this research. TCP using a communications port by adding an extra later of abstraction. TCP uses Internet Protocol to send protocol segments that contain extra information which will make it able to order packets and resend them anytime they go astray. Communications port typically in the range between 0 to 65535 which could be used to distinguish one application or service from another. One host machine could have many applications connected over multiple ports and an application could connect to a Web server running and also to an e-mail server for new email checking. TCP uses a lower-level communications protocol which is Internet Protocol (IP), to establish the connection between machines. This connection provides an interface that allows transferring streams of bytes, and converts data into IP datagram packets. A common problem with datagrams is that they do not guarantee packets will arrive at their destination and thus TCP will overcome this problem by providing guarantee delivery of data bytes.

In this research, Internet Protocol (IP) is the protocol that is used to transmit data packets over the Internet. It is also the most widely used networking protocol in the world. Many organizations use IP and related protocols for their local area networks, as it can be applied equally well internally as externally. It will almost certainly support IP networking regardless any type of networking hardware is used. IP acts as a bridge between different types of networks, contribute to a worldwide network of computers and small sub networks. IP is a packet-switching network protocol so any information that exchanged between two hosts is in the form of IP packets, also known as IP datagrams. Every datagram is a discrete unit, regardless to any other previously sent packet and so there is no connection between any machines at this layer. Vice versa, a series of datagrams are sent and provided connection services by higher-level protocols at the transport layer.

Hypertext Transfer Protocol (HTTP) is the layer protocol designed within the library of the research. HTTP is the standard protocol for communication between client and server. It is an application-level protocol that uses the Transmission Control Protocol as a transport mechanism. HTTP connections use the TCP/IP protocol for data transfer and it is a protocol that runs on top of TCP/IP. TCP is responsible for making sure that a file sent from one network node to another ends up as a complete file at the destination, even though the file is split into chunks when it's sent. IP is the underlying protocol that moves/routes the chunks (packets) from one host to another on their way to the destination. HTTP, then, is another network protocol that has Web-specific features, but it depends on TCP/IP to get the complete request and response from one place to another. The structure of an HTTP conversation is a simple with only request and response sequence; an activity requests, and a server responds. HTTP specifies how a client and server establish a connection, how the client requesting from the server, how the server responds to that request, and finally, how the connection is closed. For each request from client to server, there is a sequence of four steps.

TABLE I.   HTTP PROTOCOL STEPS

Making the connection	The client establishes a TCP connection to the server on port 80, by default, but in this thesis, the port was changed to port 2000 instead of default port.
Making a request	The client sends message to server for command and action requesting.
The response	The server sends responses as directed.
Closing the connection	Either the client or the server or both close the connection. Thus, a separate network connection is used for each request. If the client reconnects, the server retains no memory of the previous connection or its results.

2.3 Client Server

In this research, a smartphone act as a client which initiating outgoing connections to remote host and a computer acts as a server which receive incoming connections. It's a straightforward client-server TCP/IP implementation where the client will initiate a connection to the server. Therefore, the client needs to receive and process the outgoing connection. The communications server will always waiting and listening for the connection requests from clients and will process multiple incoming connection requests.

2.4 Socket

In this distributed communication, a component or object called socket is created when the smartphone initiates a connection to the remote host which is the server. On a remote host, connection request is sent to a specific port. Socket that has created will enter a connected state and allow transferring of data between remote hosts once the remote host accepts a connection. In this paper, an Outgoing Connection refers to a locally created socket object that used to initiate connection and communicate with remote host. A socket is created and bound to a specific port address and instructed to listen for incoming connections. An additional socket object is created on smartphone to handle data transmission when a remote host requests on a connection to the specified port of smartphone was accepted.
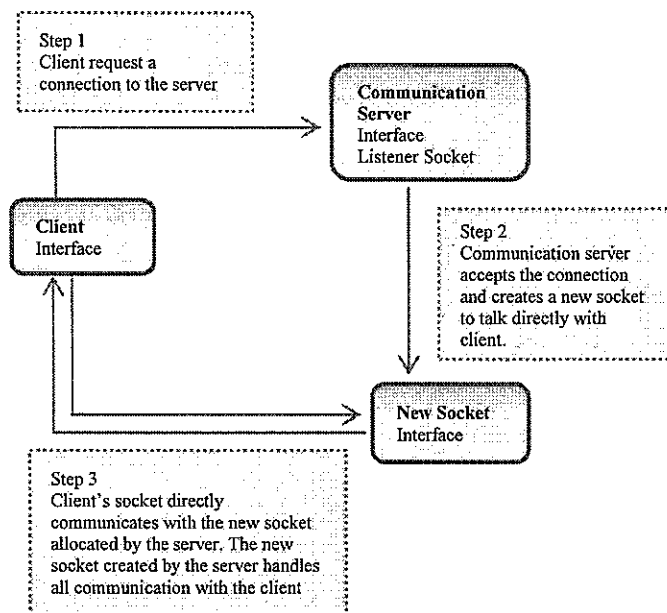
Figure 1. Communication Flow

3. Design and Implementation

There are totally three libraries that were designed to meet the requirement for distributed controlling via smartphone which is Front Component, Client Component, and Server Component. The entire three components were actually library software that have written using object-oriented high-level language which can suite in any type of platform. The three component concepts were all designed based on the techniques that have been discussed on the section before.

3.1 Front Component

Front Component is an object oriented high level language library program or software that provides job functions and user interface screen which users can interact in order to do something or any request. Front Component can be integrated into Smartphone or any mobile devices to interact with Client Component. In a word, a Front Component represents a single screen with a user interface which users can interact using Smartphone in order to do something or any request. It is a functional unit of an application, which may be invoked by another Front Component or application. An application may incorporate numbers of Front Component. One Front Component may be set as the default component which will be directly executed by the user.

3.2 Client Component

Client Component is designed to provide robust support of base HTTP protocol for client side. It is compiled and integrated into Smartphone or any mobile devices to interact with Front Component. Client Component is a client side HTTP transport library which used to transmit and receive messages over HTTP. It is simply a written library program that handles messaging between a client and server. This library may be used to send and receive streaming data whose length is not known in advance. It will not attempt to execute any other functionality

unrelated to the HTTP transport. It provides an efficient and feature-rich package by implementing client side HTTP standards and recommendations.

3.3 Server Component

A Server Component is a server-side library software program, written in high level language that handles messaging between client-server, controlling and giving command among connected automated system devices. It is a server side Java program that runs within web server software on the server side; it is compiled and integrated into Server Machine. Server Component receives and responds to requests from Activity/Client Component, across HyperText Transfer Protocol. It is a library that used to extend the capabilities of web server that host applications accessed via a request-response programming model. It is simply library software that runs on server that enhances server functionality, to do work of whatever client request and give command to all connected devices. Server Component can respond to client requests by dynamically constructing a response that is sent back to the client and send command to all connected automated system devices.

4. Conditioning

4.1 Event Listening

The port must alert whenever there are data to be read once it's opened. This is an event driven rather than a polling approach. A special function or method of code will run when the event is assigned. Because of polling requires constantly asking whenever data is available so this is an advantageous to polling approach. The method Event Listening is the event that is always checking for any serial events and it is crucial for the event to notify whenever data is received.

4.2 Data Manipulation

It is needed only to read data if it exists by test the condition in a correct algorithm. Else, this could be redundant because if the event never got triggered, it wouldn't be in this method. The read data method will returns an integer, but the real value in it actually is in byte so casting an integer to byte is needed here. This library has the ability of converting bytes to a string where a byte of array could be used as a parameter to initialize a string. Data that is sent to a specified device can be used for such things such as controlling motor speeds and direction. The write data method will cover with a using the output stream, that method was then called to write an integer value that need to be casted to byte value also.

4.3 Message Buffering

The main of the distributed communication and controlling is transmission and reception of messages. A message is a complete parcel of information when transferred. When it's unwrapped, it will contain the same information sent by sender. The secured buffer method is used for buffering any incoming and outgoing message data. Initial Bytes are waiting to be sent and incoming bytes that waiting to be processed are stored in array byte forms inside the same class. When data is received from a smartphone which is a remote client, data is queued in series byte of array and waiting to be processed. Bytes are dequeued from byte of array for transmission when data is ready to be sent. To enable multiple message sending by just using a single TCP/IP data packet, small byte portion are combined for transmission because it's inefficient to transmit small portion of data for multiple times

5. Summary

5.1 Paradigm

A User sends command or control Automated machine through smartphone through Front Component which embedded in the Smartphone. Both Front Component and Client Component which integrated in Smartphone's Operating System will interact within each other to send out request to a Server Machine. Client Component is needed to translate the message passed by the Front Component into network signal in order to be read by Web Server. The Client Component will open a TCP/IP connection to Server machine in order for sending request. Communication between server and automation then established to send out request which then receive by the Server Machine.
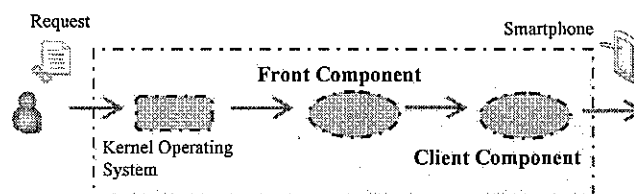

Figure 2. Client Side

After connection established, The Server Machine with Web Server installed are ready to receive any request from the Client Component. When Web Server gets request from Client Component, it hands the request signal to the Translator before it reach Server Component. When the request hands over by Web Server, the Translator then maps the request to the Server Component.
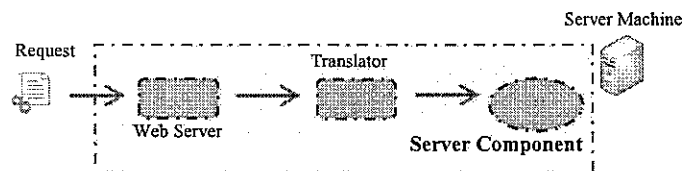

Figure 3. Server Side

The Server Component processes the request and produces two responses which is message response and control response. Message response is the network signal that sends back to the Web server to notify the Client Component while the control response is the command to control the automation devices. The result of the message response received by the client in message form while the control response received by the machine or automation in machine code binary form.
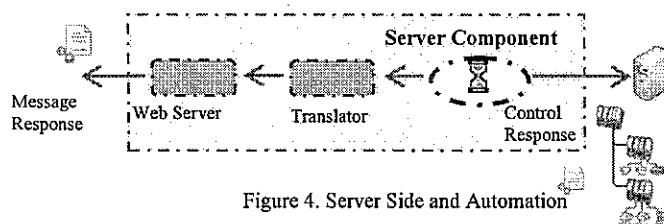

Figure 4. Server Side and Automation
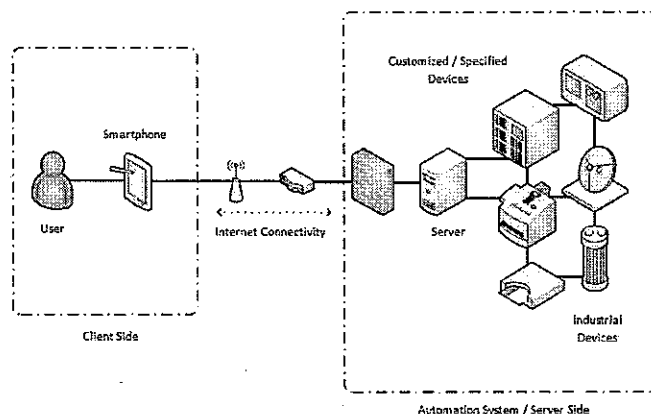
5.2 Graphical Illustration

Figure 5. System Overview

5.3 Conclusion

This research has produced several prototype systems to prove that this research and technology can represent a fundamentally new, simpler and more effective way of controlling peripherals and automation system in real time. Using smartphone or mobile devices in different environments requires a truly secure domain within different security settings and properties. Cryptography can indeed be implemented with efficient on a mobile device and smartphone. This path is a low-cost, high efficient yet more research on this path needed in future. Further development will lead to smartphone related based solution for the Enterprise Industrial Automation, Control System, as well as other application domain.

6. References

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