

A Technique for Transmission of Smart phones sensors data Using Zigbee Network

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Abstract

Smartphones sensor data is great value for scientific researches. Smartphone sensor is a Microchips build inside Smartphones devices. These sensors extract information from the around environment like heat and light. Transferring the sensor data from Smartphone to another Smartphone or from Smartphone to PC appears as a necessary need for scientific researches. This paper shows a technology for transferring Smartphone's sensor data using Zigbee wireless network.

KeyWords: Smartphones, sensors, Microchip, transferring, Zigbee.

1. INTRODUCTION

Zigbee network is a low energy wireless network in mesh standard used to connect devices, sensors, and other nodes to each other in small range. Zigbee network is a wireless personal area network (WPAN) were the Zigbee network connects devices in specific coverage area. Zigbee wireless network is a low power requirement network, low data rate wireless network, and small range wireless network. [1]

A Zigbee network works under IEEE 802.15.4 standard. Zigbee has several applications (e.g. Bluetooth, Wireless Local Area Network WLAN, infrared). [2] Zigbee network are used in many fields such as industry and small range application, Zigbee network has a set of disadvantages, small range, Complexity, low throughput, and small scale. [2]

Zigbee network can be used to transfer low power sensor data. Since the Smartphone's sensors are low power devices. Its possible to transfer the sensor data between Smartphone devices or from Smartphone to another device connected to Zigbee.

1- Zigbee architecture

Zigbee general structure contain a three basic devices, every Zigbee network should contain these devices in order to work. . As in figure bellow, these devices are:

- 1- Zigbee End Device (ZED): this includes the Smartphone's, home devices, or intelligent instruments.
- 2- Zigbee Router (ZR): this router connects the Zigbee Devices to the Zigbee network.
- 3- Zigbee Coordinator (ZC): each Zigbee network should contain at least on coordinator, coordinator is responsible of linking the Zigbee network with other network types using a wire communication medium. [3]

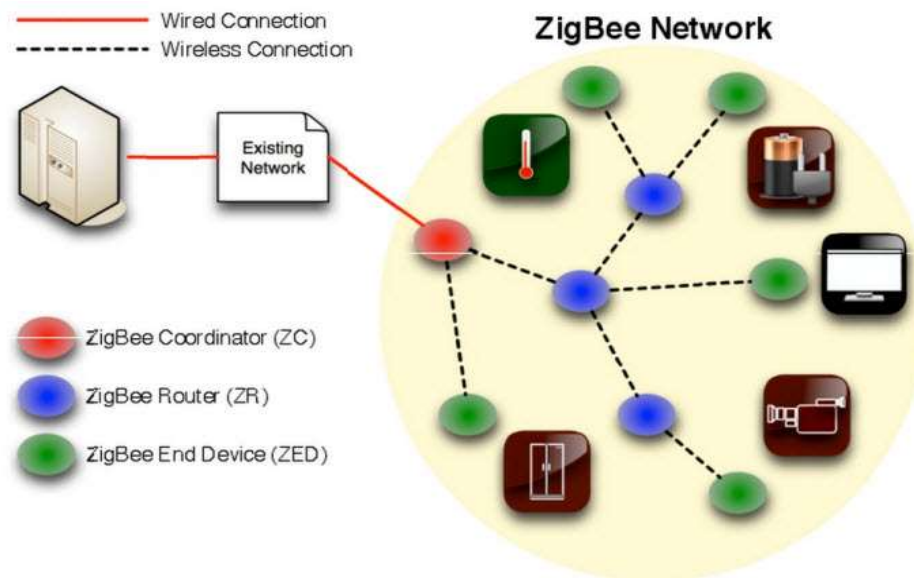


Figure 1: shows the Zigbee Architecture

The numbers of the Zigbee devices specified according to the Zigbee implementation and topology, such as Star, Tree, or mesh network, in each type of topology the number of devices, routers, and coordinators are changed.

2- Zigbee operations Mode

There are two types of operations Zigbee can perform. Beacon enabled and non-beacon network operation. In the Beacon enabled mode Zigbee network works over Battery power supply and Zigbee networks offers a maximum power saving. [4] A non-beacon mode is used when Zigbee network is plugged- in a main power source [5].

In beacon enabled mode, ZC sends beacons to the ZR were ZR in turn wakes attached ZED and transmits data. ZED searches for incoming messages. When messages received to ZED and finished transmitting between ZR and ZED both ZR and ZED goes on Sleep- Mode due to the power saving consumption. In non-beacon mode some of Zigbee basic devices doesn't sleep, ZC and ZR won't sleep because they will be ready for waking up any ZED due to the power supply status. Figure bellow shows how Zigbee works in both modes. [6]

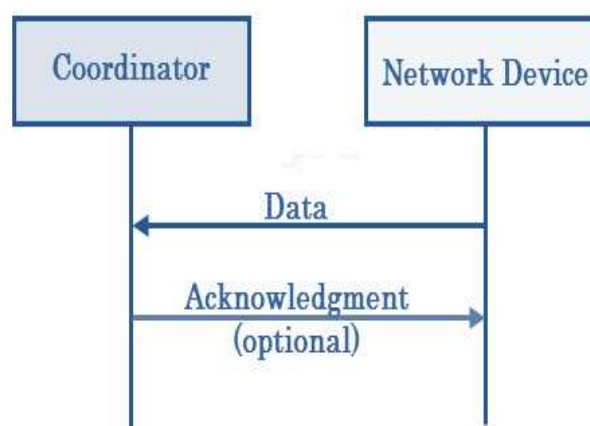


Figure 2: A- non-Beacon Mode

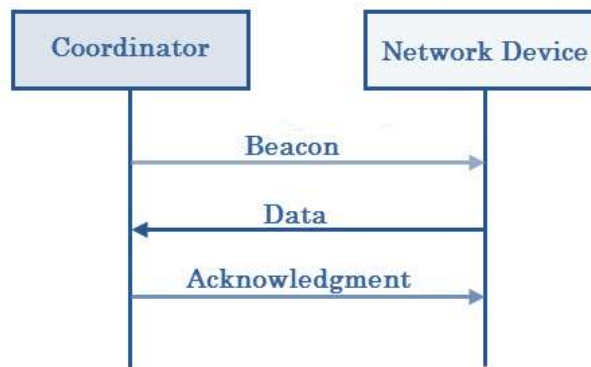


Figure 2: B- Beacon enabled mode

3- Zigbee Topology

Zigbee networks works with topologies in order to increase the range of communication. Zigbee works according to three basic topologies, Cluster Tree topology, mesh topology, and star topology. [7] Figure bellow shows the main topologies in Zigbee network

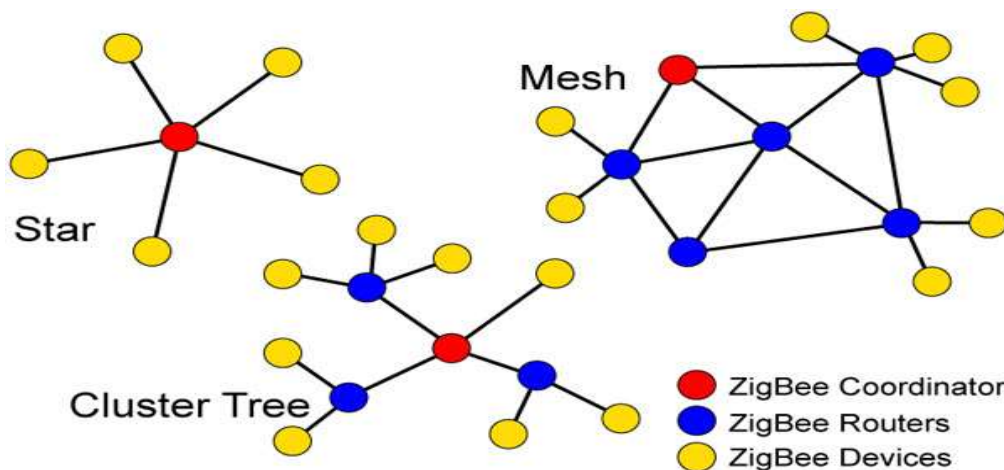


Figure 3: Zigbee Topologies

4- IEEE 802.15.4 protocol

Zigbee network runs over IEEE 802.15.4. any system runs over IEEE 802.15.4 consist of several components, these component can be either reduced-function device (RFD) or Full Function Device (FFD). More then one devices within Personal Operating Space POS communicating in the same channel over WPAN. Zigbee Networks falls under Low-Rate WPAN. [8]

Following table shows the main RFD and FFD in Zigbee network [9]

Table 1: RFD and FFD in Zigbee network)

Physical Device Type distinguish device capability and capacity	Logical Devices Types in Zigbee		
	Zigbee Coordinator	Zigbee Router	Zigbee End Devices
RFD	YES	YES	YES
FFD	NO	NO	YES

I- Smartphone's Sensors

Smartphone's sensor are integrated devices build inside Smartphone's. Smartphone's sensors designed to converts environmental characteristics into a measureable readings. Sensor data can be used for several applications. Many application used sensor data for several functionality (e.g. health care) [10]

Smartphone's sensors building using Micro- Electro-Mechanical-System (MEMS) technology. MEMS Technology scaling sensors into Micro-Chips build inside Smartphone's. MEMS takes advantages in Industrial and scientific applications.

1- Smartphone's Sensor Types

There are multiple types of Smartphone's sensors, [11] organized in the following table:

Table 2: Smartphone's sensor types

Smartphone Sensor	Description
Accelerometer Sensor	Sensing liner acceleration force in m/s^2
Pressure sensor	Measures the pressures applied to a device
Gyroscope sensor	Measures the degree of rotation of mechanical parts
Microphone sensor	Measures sound waves in dB
Light sensor	Measures the luminance of light
Magnetic sensor	Measures magnetic field at a specific position
Temperature sensor	Measures heat degree in celices

2- Smartphone's Sensor Applications

There are several application types can make use of Smartphone sensors [12], these applications are:

- A- Sport and Fitness: Airbags and Technical motion watch.
- B- Position Tracking: using GPS to determining current Position.
- C- Real-time alarming: Alarming from a certain danger when occur
- D- Temperature control: Monitoring heat of device or a room.
- E- Electronic Compass: used as a digital compass
- F- Vibration: used the Vibration control for attention tracking
- G-

II- Connecting using Zigbee

For connecting Smartphone's using Zigbee network there must be a getaway between the communication adapter in Smartphone's and the Zigbee network. Smartphone's provided with a Wi-Fi adapter or Bluetooth adapter to work with Networks. The getaway between the Wi-Fi or Bluetooth adapter and Zigbee network. This getaway acts as Interface between Smartphone's and Zigbee network. [13]



Figure 4: Zigbee adapter that enables Zigbee network

Zigbee network wont enabled unless its chip is plugged in with Smartphone. This chips is providing the Getaway between Smartphone device and other devices, as in above figure The Zigbee adapter plugged-in Smartphone's (via USB), Zigbee adapter connects directly to Smartphone so it can be attached physically with Smartphone devices, or if a PC is used the Zigbee adapter is plugged-in with the Laptop or PC in order to gain access to a Zigbee network. Zigbee adapter turning Smartphone devices or PC's into ZED and can connects directly to a Zigbee Router in Zigbee architecture. Figure bellow shows Zigbee connection adapter with Laptop and Smartphone's. [14]

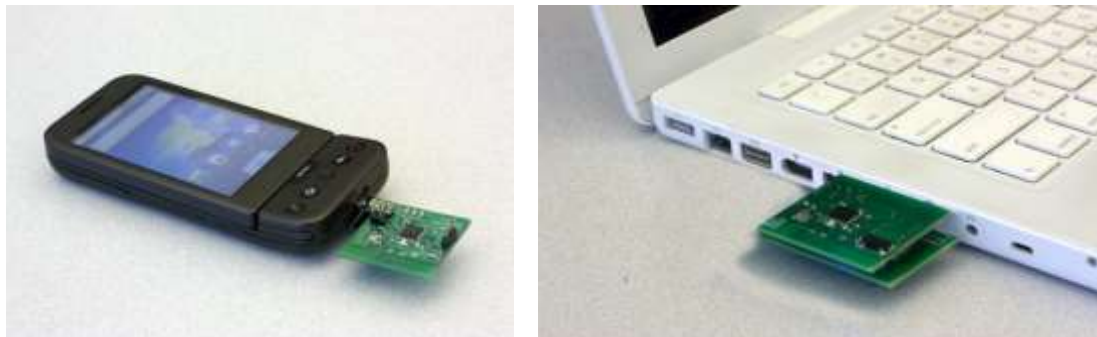


Figure 5: Zigbee adapter Plugged-in Smartphone's and Laptops

Zigbee router that connects ZED's is a special type of router designed to works and rout's over a Zigbee-based devices only. Connecting more than Smartphone devices with other ZED. ZED's can be many devices in home such as rooster or refrigerator or Garage door sensor. All these devices connecting together using ZR. [14] Figure bellows shows a prototype of Zigbee wireless router.



Figure 6. Zigbee wireless router

Connecting Smartphone devices with Zigbee network is performed by adding the Zigbee adaptor. If a Wi-Fi router is available it's possible to plugged-in a Zigbee adapter in Wi-Fi router to act as a router node for a Zigbee network. Zigbee developers Integrated a Chip can be plugged-in Wi-Fi router to enables Zigbee Network over Wi-Fi Router. Making Wi-Fi router acting as ZR. [15] Figure bellow shows how to plugged-in Zigbee adapter in Wi-Fi route.



Figure 7: Zigbee plugged-in Wi-Fi router)

III- Applications programming and development

The general structure of Zigbee network should be completed before start using the network. Transferring the Smartphone sensors data to other connected nodes it needs to be connected over Zigbee network for transferring the sensor data. Development of Smartphone's sensor application should be developed over a specific programming platform. Preparing the application platform and constructing Smartphone sensor application

1- Smartphone app design

The Smartphone application should contain all functionality required for sensor data display. The screen of the application should contain labels and commands required for application tasks. Such an application should be designed to work over a Zigbee environment, if a Smartphone device plugged-in with a Zigbee equipment that works with Wi-Fi conversion then the connection protocol can be a Wi-Fi based protocol.

2- Connection Method

Smartphone application methods organize application tasks were each task responsible for a specific job. Global variables are declared in a Global scope function these variables containing information's accessed from any place in application areas (e.g. IP address). A Connectivity function is using IP address and port number for establishing connection with the Wi-Fi network. Peer-to-peer connection is established between Smartphone and Wi-Fi router [16].

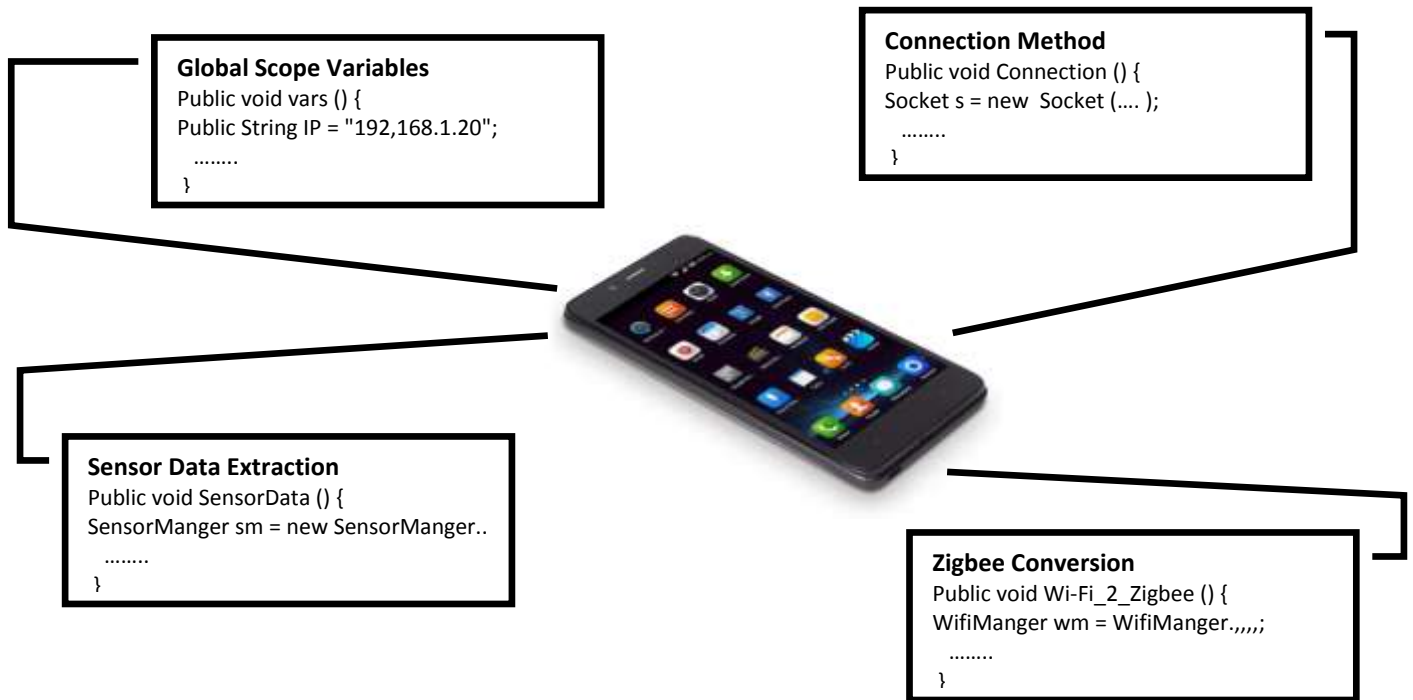
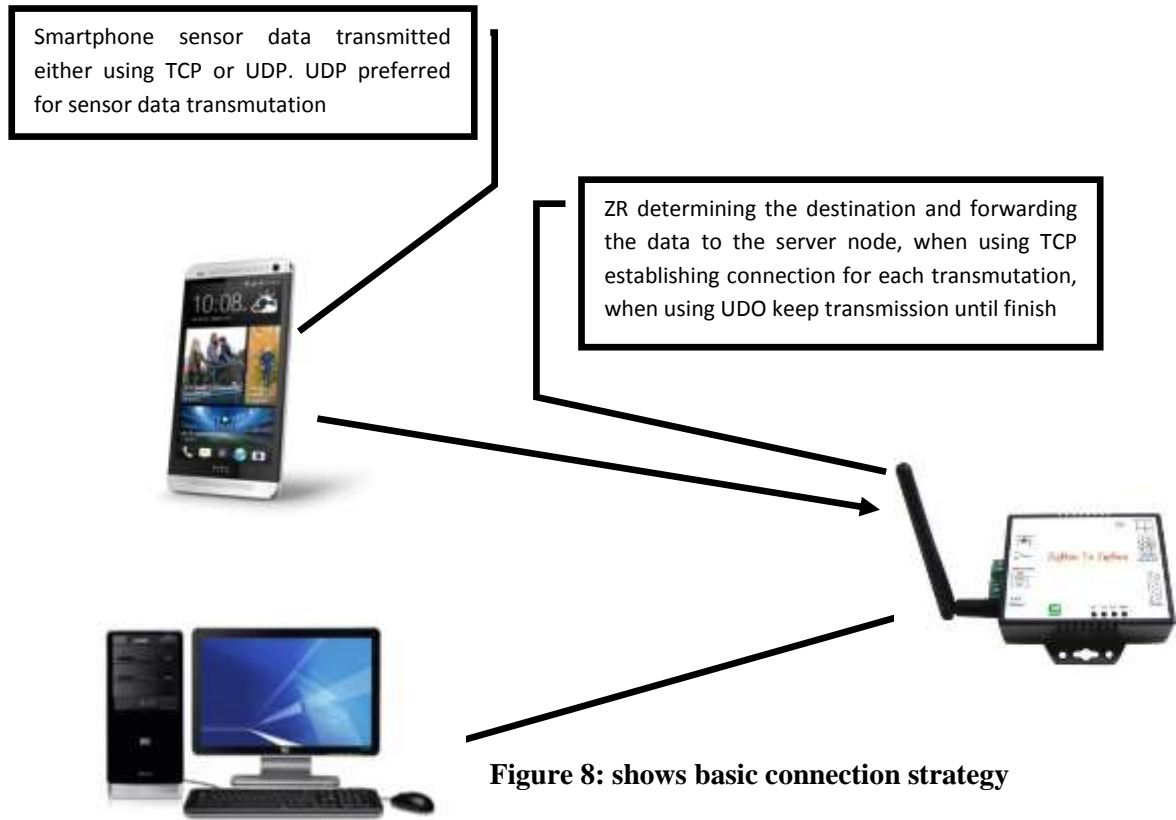
The connection method establishing connection with a wireless router through its Socket. A Socket is analogues to door were each connection node is connected to the network through their sockets [17]. There are 2 types of socket, a client socket and server socket. The client socket is for client data transfer and server socket is for receiving incoming packets from clients. Smartphone when using sensors and attempt to transfer data through sockets a client socket determines the destination through IP address were each node in the network has a unique IP address. Packet arrives from client socket to a server socket were the server socket receiving the data through its storage strategy. The storage unit in the server socket is Data Input Stream buffer, this buffer is designed to hold the data within server socket for later processing. [18]

Client socket push's the sensor data to the Data Output Stream were this buffer acts as storage unit for the client socket. Sensor data will gets through the ZR or Wi-Fi router with Zigbee plugged-in into specific Server node for processing. ZR determines destination of server node through the information contained in the sensor data packet. ZR sends Smartphone sensor packet into receiver socket to the Smartphone a server socket stores the incoming sensor packet to the Data Output Stream in Server machine for processing and evaluation [19].

A connection method finishing the data transmission through Zigbee network. Connection method simply closing the connection if using a Transfer Control Protocol (TCP). TCP establishing connection for each sensor data packet sending from client to server. TCP is reliable data transfer were data has no lose during transmission. A disadvantage in using TCP in such an application is that TCP needs a connection for each Sensor data packet, this will cause more waiting time for connection. [20]

User Datagram Protocol (UDP) is connectionless, unreliable data transfer protocol. UDP is compatible with applications required a speed transmission even if there is a loss In the data during transmission. Smartphone's sensor data varies continuously (each one second), it needs a protocol within a quick access and an open port protocol. UDP establishing the connection with the network without closing connection port. this is compatible to the sensor data processing were sensor data needs an open port protocol to transfer the continuous data without a closing at each packet sends from Smartphone to the server node. Smartphone sensor will continue data transmission until Smartphone sensor stopping data transmission. UDP then closing the connection between Smartphone and server node declared that all data has been transmitted and transmission using UDP is complete. [21]

Figures bellow shows the program application method with the basic connection strategy between Smartphone sensor application and server node application.



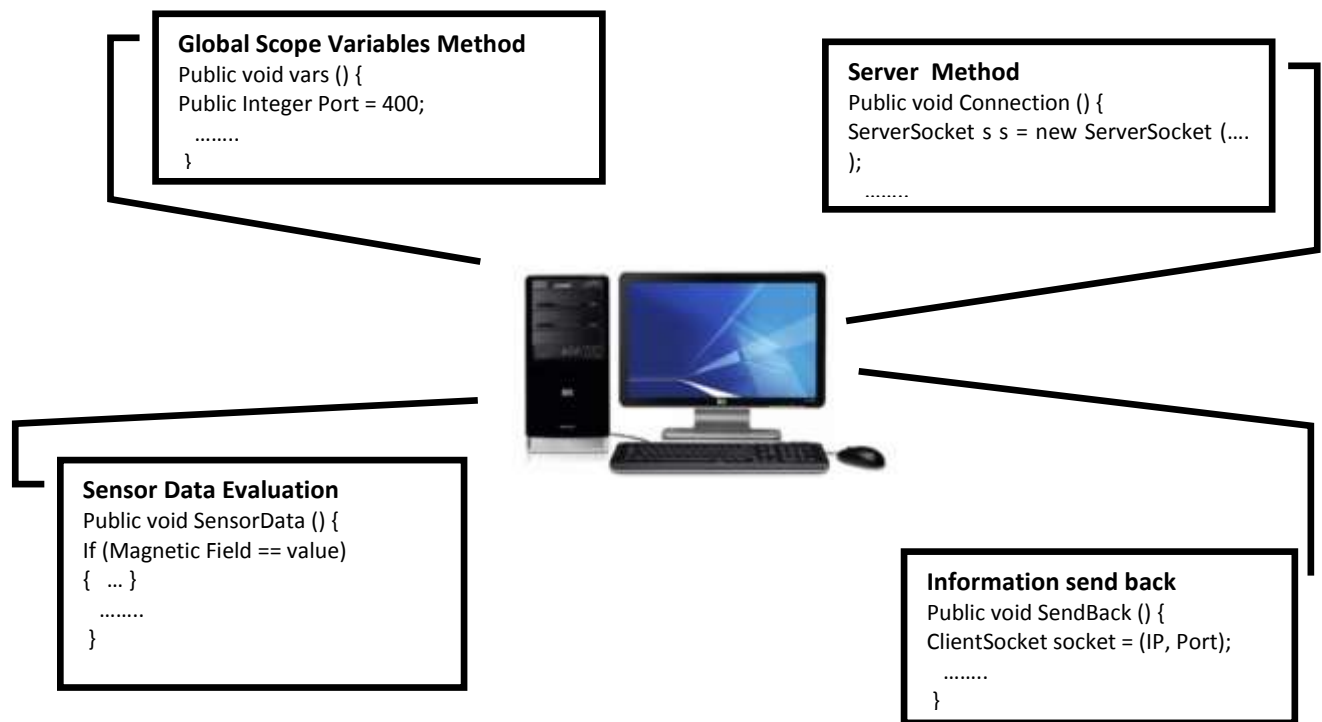


Figure 11: Basic Server Methods

IV- Conclusion

Smartphone's sensor data extracted from Smartphone sensors, sensors device sensing environment features and extracting data in numerical form. Smartphone sensor uses Zigbee network as a Personal Area Network for communication between Smartphone sensor and other connecting nodes such as alarm device. A Smartphone forwarded sensor data through Zigbee router to a specific node. Smartphone contain a Zigbee adapter converting the wireless network signal into a Become can be transferred through Zigbee network. An adapter can be used in Wi-Fi router converts Wi-Fi router into a Zigbee signal. Zigbee coordinator works with ZR to collecting information's and coordinate the data with other Network for extending Zigbee range. Server machine processing incoming sensor data for evaluation and decision making.

V- Application

Several types of application can use this technology for accomplishing certain task:

- 1- Scientific applications: using Gyroscope sensor and accelerator sensor in scientific research.
- 2- Security applications: Camera sensor can be used for security purposes.
- 3- Monitoring applications: Temperature sensor used for watching temperature degree.
- 4- Alarming Applications: using Pressure, Temperature, magnetic field sensors cooperated together for alarming from a certain threat when its happened.

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