USING WIRELESS BODY AREA NETWORKS FOR PATIENT MONITORING WITH THE HELP OF A MOBILE DEVICE

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF APPLIED SCIENCES

OF

NEAR EAST UNIVERSITY

By

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In Partial Fulfillment of the Requirements for

the Degree of Master of Science

in

Computer Information Systems

NICOSIA 2016

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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Date:

To my parents...

ACKNOWLEDGMENTS

This thesis would not have been possible without the help, support and patience of my supervisor Assoc. Prof. Dr. Nadire Cavus without their constant encouragement and guidance. She has helped me through all of the writing of my thesis. Without her consistent and illuminating instructions, this thesis could not have reached its present form.

And also many thanks to Prof. Dr. Dogan Ibrahim for helped me and support until I finished my thesis.

Above all, my unlimited thanks and heartfelt love would be dedicated to my dearest family for their great confidence in me. I'm greatly indebted to my wife who was indeed my inspiration and she led me to the treasures of knowledge. I would like to thank her for giving me support; encouragement and her endless love have sustained me throughout my life.

Also I would like to express my deepest gratitude to WAN Company for their kind support and encouragement during my study.

Eventually, there is a long list of friends that I would like to thank. I can't mention them all; nevertheless, I would like to thank them for their valuable help and support.

ABSTRACT

The new technology in communication systems proved for all researchers that it is rapidly increasing and is spreading fast all over the world. Nowadays, the increase of the new technology in the field of communications, especially in the use of Smartphone's in daily lives and the continuous use of its applications are increasing widely. The most attractive use of these applications is in the field of automatic control, using wireless sensors. Some of the health related applications have been developed to help the old people even when they are at their homes. The use of Android mobile phones to help and improve the health of the old people is an important field of study, and as a result of this help, old people become happier and also healthier. This thesis presents the development of a health monitoring system based on wireless sensors where the ECG and the blood pressure of a person are measured and the data is sent to an Android operating system compatible mobile phone equipped with the Bluetooth communications technology. Additionally, the collected data can be sent to any type of computer or device provided the computer is equipped with Bluetooth communications technology. With the help of this system the health of old patients can be monitored at a distance, for example at a doctor's surgery or at a hospital. The system developed in this thesis is composed of two types of hardware and supporting software systems. The system has been designed using the popular Eclipse Java software. Moreover, the developed system is completely wireless and is activated using Bluetooth. The developed system has been tested successfully, and the results obtainedcompared with the professional devices at the hospitals, thus giving highly satisfactory results.

Keywords: Withings; shimmer; wireless sensors; eclipse Java; ECG; blood pressure

OZET

İletişim sistemlerindeki yeni teknolojik gelişmeler bütün dünyada çok hızlı bir şekilde gelişmekte ve ayni zamanda yayılmaktadır. Halen yeni teknolojik gelişmeler, ve özellikle akıllı telefonların günümüzde olan yaygınlığı sayesinde bu konuda olan uygulamalar çok hızlı bir şekilde gelişmektedir. Bu alanda en ilginç ve çekici olan uygulamalar telsiz algılayıcılar konusunda olup bu uygulamalar özellikle yaşlı ve engelli insanlara yardım etmek ve onların hayatlarını evde oldukları zamanlarda bile kolaylaştırmak, ve onları mutlu etmek için yapılmaktadır. Bu tezde, ucuz fiyata mal olan ve telsiz algılayıcılar kullanan ve ayni zamanda hastaların veya yaşlı insanların EKG ve kan basınçlarını ölçüp Android işletim sistemi ile çalışan telefonlara göderen, ve ayrıca doktorlara mesaj gönderen bir sistem tasarımı yapılmıştır. Bu uygulama sayesinde yaşlı hastaların sağlıkları uzaktan kontrol edilebilmekte ve gereken tedavi çok daha erken bir zamanda yapılabilmektedir. Bu tezde sunulan sistemde kalp sinyallerini ölççen ve kan basıncını ölçen iki tane donanım ve bunları kontrol eden yazılımlar geliştirilmiştir. Geliştirilmiş olan sistem Eclipse ve Java yazılım tabanlı olup en son teknolojik donanımları kullanmaktadır. Sistem tamamıyle telsiz olup Bluetooth iletişim protokolü ile çalışmakta ve cep telefonuna veya Bluetooth ile uyumlu herhangibir bilgisayar sistemine bilgi göndermektedir. Geliştirilmiş olan sistem hastanelerde kullanılan profesyonel sistemler ile mukayese edilip doğruluğu tesbit edilmiştir.

Anahtar kelimeler: Withings; Shimmer; telsizalgılayıcılar; eclipse; EKB; kan basıncı

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BAN:	Body Area Network
CAN:	Car Area Network
CDPD:	Cellular Digital Packet Data
EEG:	Electroencephalography
FDMA:	Frequency Division Multiple Access
GSM :	Global System for Mobile Communication
HBC:	Human Body Communication
HME:	Hub Management Entity
LAN:	Local Area Network
MAC:	Media Access Control
MK:	Master Key
NB:	Narrow Band
NME:	Node Management Entity
OS:	Operating System
PD:	Personal Device
PHY:	Physical
PSDU:	Physical Layer Service Data Unit
QoS:	Quality of Service
SAP:	Service Access Point
TTA:	Telecommunications Technology Association

UWB:	Ultra – Wide Band
WiBro:	Wireless Broadband
WPAN:	Wireless Personal Area Network
WWAN:	Wireless Wide Area Network
BSN:	Body Sensor Network
CDMA:	Code Division Multiple Access
ECG:	Electrocardiogram
ESTI:	European Telecommunication Standards Institute
GPRS:	General Packet Radio Service
GTK:	Group Temporal Key
HCS:	Header Check Sequence
IEEE:	Institute of Electrical and Electronics Engineers
LTE:	Long-Term Evolution
MICS:	Medical Implant Communication Service
MSDU:	Media Access Control Service Data Unit
NIC:	Network Interface Card
OFDMA:	Orthogonal Frequency Division Multiple Access
PAN:	Personal Area Network
PDA:	Personal Digital Assistant
PLCP:	Physical Layer Convergence Protocol
PPDU:	Physical – layer Protocol Data Unit
PTK:	Pairwise Temporal Key

RF: Radio Frequency

SFD: Start Frame Delimiter

UMTS: Universal Mobile Telecommunications System

WAN: Wide Area Network

WLAN: Wireless Local Area Network

WSN: Wireless Sensor Network

WWAN: Wireless Wide Area Network

BSN: Body Sensor Network

BAN: Body Area Network

CAN: Car Area Network

CDPD: Cellular Digital Packet Data

EEG: Electroencephalography

FDMA: Frequency Division Multiple Access

GSM: Global System for Mobile Communication

HBC: Human Body Communication

HME: Hub Management Entity

LAN: Local Area Network

MAC: Media Access Control

MK: Master Key

NB: Narrow Band

VOIP: Voice over IP

WiFi:	Wireless Fidelity
WiMAX:	Worldwide Interoperability for Microwave Access
WLAN:	Wireless Local Area Network
SPOS:	Smart Phone Operating System
HID:	Human Interaction Devices
SMS:	Short Message Service
HACS:	Home appliance control system
AOS:	Android operating system
PC:	Personal computer

CHAPTER 1

INTRODUCTION

1.1 Wireless Sensor Network Systems

Wireless Sensor Network Systems (WSNs) convey independent sensor hubs to identify any natural developments, to the extent that they comprise micro-gadgets frameworks, and a low-control Digital Signal Processing (DSP).These WSNs might be mobile stations (MS) so as to be fit to join military units and identify straightforwardness with nature's domain and the same for mechanical systems or any detector system. These WSNs have wide uses in different situations, such as sound, vibration, weight, movement or poisons, monitoring for well-being and security, computerized medicinal services, smart building control, activity control, to the extent that they could be used by the military. These sensors can impart data either among themselves or simply to an outside base-station (BS). These WSNs are normally scattered in a sensor field, which is a region where the sensor hubs are sent. They work among themselves to procure astounding learning about nature. To cover a wider geological region area with more accuracy, it is intended to expand the amount of sensors as much as could be expected. Disregarding these sensors is not faultless as they are exorbitant macro sensor partners, yet they empower requisitions to systems. The primary basic issue in sensor systems is the restricted vitality on system hubs. When they are sent, the system can continue working while the battery force is satisfactory. This is a discriminating point to be considered as it is difficult to supplant the hub battery once sent to a distant territory. In this imparted remote system arranged by WSN, the individual hubs have restricted correspondence range. Both the information and control parcels need to be steered in multi-bounce modality. The information might be indicated between the hubs in the system keeping in mind the end goal to back diverse exercises from a sensor hub to another with the object of bringing about a nearby participation. This complex errand is achieved by planning and actualizing of steering plans to have the capacity to adequately and productively help the trade of data in WSNs. various hypothetical issues and viable restrictions must be considered. By and large, remote sensor data might be bolstered by a few means. The specific past post data is sent to the essential area instantly with respect to extra running; this recent post data is sent into a different hub simply before getting to the base segment. Each and every procedure offers their value regarding the provisions and also directing models. Through the outlook including loop topology, these directing norms might be arranged straight into normal topology and bunch topology. Various steering measures all through bunched WSNs are normally portrayed inside the ensuing bunches. Grouped WSNs are usually marked as heterogeneous and in addition homogeneous WSNs have great capacities for operations including sensor hubs. All through remote sensor systems with heterogeneous sensor supplies, this bunch brain offers better contraption analysis than standard sensor hubs, e.g. force, transforming capacity, memory, and as a rule they perform with all including data pressure setting (Mhatre et al., 2012).

The specific key capacity of any heterogeneous strategy would be to lessen the vitality usage of standard hubs by securing every one of them against sending information over a long separation from the fundamental area. The steering conventions for WSNs and correlation for their qualities and restrictions were carried out by Singh, et al. (2010).

Again off-based bunching in WSNs and the correlation done with even directing conventions and the coordinated multi-bounce system is a well-known progressive steering venture utilized all through grouped WSNs, on the grounds that it can without much of a stretch equal vitality utilization to develop this ring life compass (Wang et al., 2011).

It is practically comprised of several stages. In the setup, the sensed information is exchanged from hubs to group heads, and finally achieves the BS. The second area of the procedure which is longer relies on upon the round-based grouping calculation. It is well known that LEACH utilizes the code division multiple access – time division multiple access (CDMA-TDMA) half-breed correspondence plan to minimize the impedance between bunches, while TDMA spaces are relegated for every part to minimize media disputes. The filter is separated into rounds so as to dole out group heads at the start of each round to make and show time calendar to its parts, ignoring the issue created by the arbitrary head choice in each one round.

A plan which is focused around another standard to give the open door for sensor hub to settle on disseminated choice on whether choosing to be a bunch head or a non-head part, is a completely dispersed approach and proposed by Zhao et al. (2007).

The outlined Medium-dispute based Energy-proficient Distributed Clustering (MEDIC), with a specific end goal to supplant the bunch establishment that happens at the start of each round in LEACH is focused around the Duchauction to get higher time proficiency at every hub to number its neighbors and telecast their number. Recently, a couple of reports were centered on bringing down the vitality utilization of sensor hubs all through WSNs. This specific work intends to explore the relationship between the static and the element model to expand the life time by diminishing the utilization of vitality. A study to spare vitality throughout information transmission was carried out by Tarng et al. (2010).
This study states that the element steering strategy comprises two stages:

- Instatement state
- Working stage.

All in all, remote sensor data might be bolstered in a few ways. The specific past post data to the fundamental area instantly in regards to extra running; this last post data through sending into different hubs simply before getting to the base segment. Each and every procedure offers its value concerning the provisions and additionally directing norms. Through the point of view including loop topology, these directing benchmarks could be sorted straight into regular topology and group topology. Various steering benchmarks all around bunched WSNs are generally portrayed inside the ensuing WSNs. Bunched WSNs are normally named as heterogeneous and in addition homogeneous have great capacities for operations, including sensor hubs. All around remote sensor systems with heterogeneous sensor supplies, this group brain offers better device analysis than standard sensor hubs, e.g. force, handling capacity, memory, and by and large with all the perform including data clamping setting (Mhatre et al., 2012).

The advantages and disadvantages of these body area network sensors are:

Advantages

1. It avoids a lot of wiring
2. It can accommodate new devices at any time
3. It is flexible to go through physical partitions
4. It can be accessed through a centralized monitor

Disadvantages

1. It is very easy for hackers to hack it as users cannot control propagation of waves
2. Comparatively low speed of communication
3. Gets distracted by various elements like Bluetooth
4. Still costly at large

The biggest benefit of this research is to give the ability to old people, patients, and any other ill persons to be in direct communication with doctors in hospitals by the use of these sensors with the use of a mobile system.

In this research, the combination of the mobile system with the wireless body area network sensors enhances healthcare of the patients, not only for games and other useless applications of the mobile system.

This study is done according to the advantages of the wireless body area network sensors with the use of an Android mobile application to help old people and give them the ability to stay in their homes and live their lives normally between their families while they are under continuous control by doctors in hospitals if anything suddenly happens to their health to send alarm signals to the server in hospital through the global positioning system (GPS).

1.2 The Problem of the Study

In this thesis, the problems facing the researchers were that they did not build a system depending on GPRS to carry the transmitted signal from the wireless body area network sensors to cover a larger geographical area with constant and continuous signal for the purpose of monitoring the patients from their homes as an Android application. The researchers took into consideration the propagation loss inside urban and suburban media in their research; they just studied the case of connecting the sensor nodes to the body and mentioned the effectiveness of the transmitted signals of the following:

1. Clothes
2. Movements
3. Distance
4. High buildings
5. Traffic
6. Weather conditions.

1.3 Motivation

In WSNs and their substance as they have dispersed supervision towards one sensor's centre in order to perceive any regular advancement; to the degree that they involve micro-fitting schemas and a low-control DSP, these WSNs could be mobile station MS remembering the deciding objective to be fit to join and find straightforwardness with the earth in the same way as mechanical frameworks or any sensor framework. These WSNs have wide demands in distinctive districts. These demands cane be, sound, vibration, weight, development or defilements, surveillance for well-being and security, robotized medicinal administration, building control, and movement control, to the degree in a trustworthy environment in military procurements. The particular key limit of any heterogeneous technique would be to reduce the imperative utilization of standard centre points by guaranteeing each one of them against sending data over a long partition of the key fragment. The guiding assemblies for WSNs and relationship for their qualities and limitations was done by Singh, et al. (2010).

Again off-based grouping in WSNs and the examination done with actual guide meetings and the facilitated multi-bounce method. It is well-known that different leveled controlling wanders used all around gathered WSNs, in light of the fact that it can without much of a stretch balance imperativeness usage to create this ring life compass (Wang, et al., 2011).

For all intents and purposes, it involves a couple of stages. In the set-up phase, the sensed data is traded from centre points to gathering heads, finally accomplishing the BS. In the second range of the approach which is longer, depends on upon the round-based grouping estimation. It is overall understood that LEACH uses the CDMA-TDMA cream correspondence plan to minimize the impediment between gatherings. Channel is disengaged into rounds with a particular deciding objective to consign bundle heads at the beginning of every round to set aside a few minutes datebook to its parts. Rejecting the issue brought on by the self-assertive head decision in every round, an arrangement which is centered around an alternate model to give the open entryway for the sensor centre to settle on passed on decision on whether deciding to be a gathering head or a non-head part, this arrangement is a totally coursed approach and was proposed by Zhao et al. (2007). This proposed model achieves better execution in terms of lifetime and importance. Where the Medium-discussion based Energy-profitable Distributed Clustering (MEDIC) is used, with a particular deciding objective to supplant the gathering station that happen at the beginning of every one round in LEACH, this delineated MEDIC is centered on the Duchauction to get higher time viability as every centre point to number its neighbors and broadcasts their numbers.

As of late, several reports were based on cutting down the essential usage of sensor centers all around WSNs. This particular work aims to investigate the examination between the static and the component model to extend the lifetime by lessening the use of imperativeness, extending this time of WSNs by using gathering blending and what are more eager guiding portions. A study to extra essentialness all around data transmission was completed by Tarng, et al. (2010). This study stated that the component controlling system contains two stages, 1. All around these two states and 2. extra imperativeness usage data gathering and sleep mode is used. This study depends on after dividing nature's turf into more humble extents with a particular finished objective to scatter the sensor centers, and each extent has five sensor centre points spread in a chosen position by pseudo-discretionary generator.

Regularly, these gathering-based directing sections try to help the time of WSNs. For that understanding, apportioning imperativeness will include incredible vitality inside a wide area – have a go at sensing air. A static batching assembly outlines these sensor centers straight into a few genuine groupings including undefined measuring. Consistently, this gathering pioneer of the key section will expend extra essentialness by sending information concerning distinctive groupings. A vague sensor framework WSN is undeniably an independent framework with no pre-established or bound together association. WSNs are important for a collection of procurements where, normally, the lead objective is to screen a particular phenomenon. Remote sensor frameworks offer different purposes of investigation when contemplating expected wired or remote frameworks. Particularly, WSNs give more redundancy considering that the breakdown of any number of sensors has less effect on the complete system execution. WSNs may be sent quickly at sensible time and are thus fit for use in adaptable stages. Obviously, they've got open unlimited willingness to emergency and military orders.

The field of software engineering is continually advancing to process bigger information sets and store ever larger amounts of network. At same time, progress in scaling down take into account expanded portability and availability. Body Area Networks (BAN) aim for regular join in the middle of network and scaling down. A BAN is characterized formally as an arrangement of gadgets in close vicinity to an individual's body that coordinate for the profit of the client. Disregard neighborhood– these will be body zone systems.

Figure 1.1, below, portrays the perfect position for BAN in the force vs information rate range.

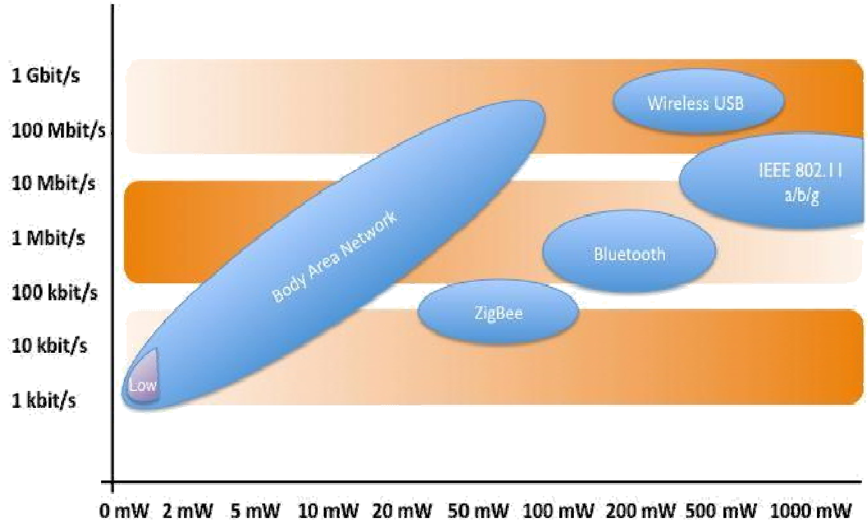

Figure 1.1: Data Rate vs Power (Otto et al., 2006)

As shown in Figure 1.1, the varying stage for the BAN devices in terms of the bandwidth and the consumption of used power is greater than the other devices. The draft specifications for the BANs are tabulated in Table 1.1.

Table 1.1: IEEE BAN Summary

Distance	2m standard, 5m special use
Network density	2-4 nets/m^2
Network size	Max: 100 device/network
Power consumption	~1mW
Startup time	<100us
Latency	10ms

The proposed system has more advantages for the patients as:

- The proposed system is going to enable patients to remain in their house and be under continuous control by the doctors. This will give hospitals enough room for new patients instead of filling their beds with old patients and for long periods just for control.
- The proposed system depends on the GPS system providing a continuous signal and over long distances. This point makes the proposed system an original work.

- The proposed system has multi-connections for the internet, it has the ability to be connected through the access point inside the house or through the mobile internet to be available outside the house, which enables the patient to live his normal live between his family and (s)he visit to his/her relatives or neighbors, and this point makes the proposed system original.

1.4 The Aim of the Study

A handmade system with a consideration of a very limited WBAN consisting of only five sensors that are directly and wirelessly connected to a personal mobile working with an Android system, where these sensors otherwise use transceivers with large antennae that are not adapted for use on a body, and where the protocols developed for WBANs can span from communication between the sensors on the body to communication from a body node to a data centre connected to the internet. Thus communication in WBAN is an extra body communication as shown in Figure 1.2.

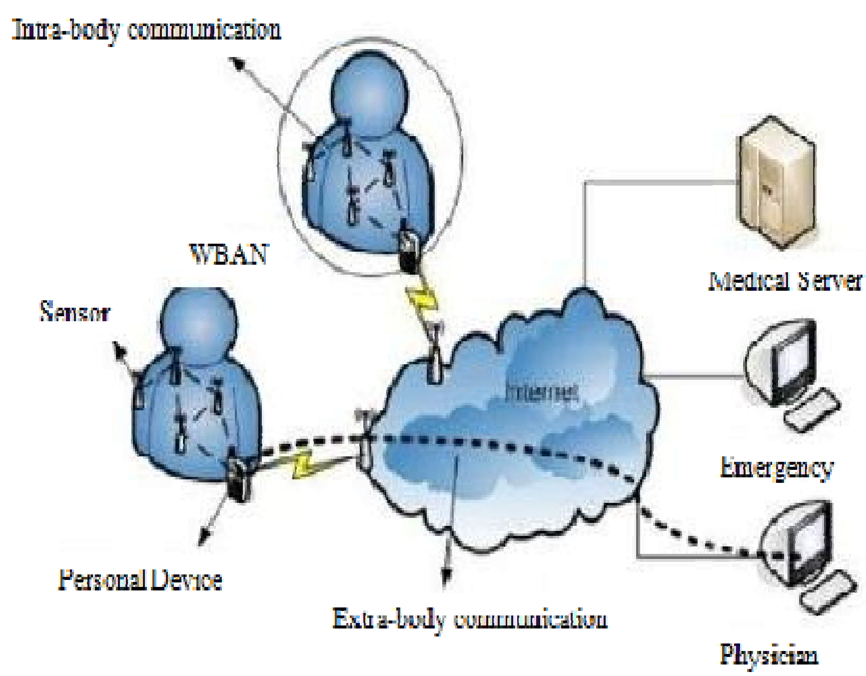

Figure 1.2: Extra body communication

1.5 Limitations of the Study

This study has the following limitations:

1- Survey problem areas in WBANs;

2- This study is limited by the period that begins from March till June 2015 depending on the models mentioned in this study;

3- Introduces the selection of the hardware parts and the specifications of each part. Moreover, the features are discussed in the results chapter;

4- Required software for the connection and recognition of the proposed system with the computers in the hospitals and the Android system;

5- Optimize the target as old people and servers in hospitals for the aim of the continuous control;

6- This study is limited to Middle East countries.

1.6 Overview of the Thesis

This thesis consists of six chapters and references:

Chapter One: presents a brief description of the new technology to give the ability for these old people to use their Smartphone's and computers and be able to be in continuous connection with doctors in hospitals as described, and a literature review of the study.

Chapter Two: presents an overview of different research on WBANs and the use of the new technology.

Chapter Three: consists of two parts: the first presents an overview of different communication methods and introduces the main topic of old people and their continuous connections with the servers in the hospitals. It gives a broad introduction of the research area; the second part provides more detail about old people and the use of the computers for their active communication with their doctors in hospitals.

Chapter Four: discusses the hardware parts, specifications, software used, and the operations process for each part.

Chapter Five: chapter describes the proposed Withings hardware scheme for blood pressure and simulation results.

Chapter Six: chapter presents the ECG hardware and the obtained simulation results.

Chapter Seven: draws conclusion from the results achieved in the last chapter. It also presents ideas that might profit the reader to undertake future research work in the region.

CHAPTER 2

RELATED RESEARCH

2.1 Related Research

Health awareness is changing, and health awareness needs change. The populace is maturing, the increment is perpetual and heart sickness and simply the expansion in population size will overpower the current doctors' facility-driven social insurance. There is a developing enthusiasm by people to screen their own particular physiology. For game exercises, as well as to control their own particular maladies, they are transforming from detached human services recipients to proactive social insurance takers. The focus is moving from clinic-focused medicine to patient-driven medical services. Nonstop, ordinary, wearable health monitors are part of this change. In this setting, sensors that screen the heart, pulse, development, cerebrum action, dopamine levels, and actuators that pump insulin, pump the heart, convey pills to particular organs, fortify the mind, are required as pervasive parts in and on the body. They will tend to an individual's need to monitor health and encourage one's own social insurance. These sensors around a human body act in a composed manner to make a Body Area Network (WBAN). By and large, and in our perspective, a focal, more influential part will become the facilitator of this system. These systems mean to expand the ability to screen the human body and respond to issues uncovered by such monitoring. One key point of this framework is their all-encompassing perspective of the entire system. That is, the focal segment can have an understanding of all the observed indicators and collate them to better assess and respond to issues. There are a few physiological relationships known by the therapeutic field. Connecting pulse and a cross-sectional range of veins to compute blood speed, evaluate oxygen conveyance from cardiovascular yield and oxygen immersion, are such illustrations. This information ought to be accessible in a WBAN and to be used as a single system.

Brandao (2012) contended that this multi-parameter relationship of the heterogeneous data is not being taken care of by BANs. The current perspective depends solely on the requisition that is utilizing the system and its understanding of the parameters. This implies that each provision will manage the BAN's heterogeneous assets overseeing them specifically without taking account of different requisitions, their needs and information, latest advances in hardware building remote sensor in, on or around the human body. Body Range Networks (BAN, is additionally called

Body Sensor Networks) reutilized within therapeutic requisitions as well as having non-restorative provisions territories, for example, amusement, military. The fundamental characteristics of BAN can be audited and the prerequisites for BAN base can be secured by giving a sample of a current requisition. Also, a proposed cross-breed strategy to enhance existing BAN foundation is called Intelligent Body Sensor Networks (IBSN). Likewise the new IEEE 802.15.6 is presented as standard and points out the similarities and contrasts with existing models. As of late remote body territory system (WBAN) draws more considerations on account of its delivery, particularly in observation of well-being. As the sensor hubs in WBAN are battery-fuelled, vitality productivity is the top concern in the medium access control (MAC) convention outline.

Tsouri et al. (2012) proposed directing convention and assessed utilizing an equipment trial set-up involving numerous hubs and a right to gain an entrance point, where the set-up is utilized to evaluate system architectures, including an on-body access point and an off-body access point with shifting number of reception apparatuses. Additionally, real-time trials are led in indoor situations to evaluate execution picks up. Also, the set-up is utilized to record channel reducing information which is then prepared in distant machine recreations giving knowledge on the impact of convention parameters on execution.

Crosby et al. (2012) introduced an exhaustive review consisting of stand-alone areas concentrating on essential parts of WBANs, as well as inspecting the accompanying: checking and sensing, force productive conventions, framework architectures, steering and security, and finished up by examining some open exploration issues, their potential results and future patterns.

Yuan et al. (2013) proposed an Enhanced MAC (EMAC) convention which coordinates hand-off with element force control component to spare vitality utilization. On one hand, the convention chooses a handing-off hub for the hub which may be vitality deficient to drag out its lifetime and after that the system topology is changed from one-jump to multi-bounce. As needs be, the super edge structure is altered. Then again, for further vitality sparing, element force control calculation is performed at whatever point sensor hubs have information parcels to transmit. Worldwide directing conventions in remote body range systems are acknowledged. Worldwide steering is enlarged with a novel connection expense capacity intended to adjust vitality utilization over the system. The effect is a significant build in system lifetime at the cost of a minimal expansion in vitality for every bit. System upkeep requirements are decreased too, since adjusting vitality utilization implies batteries need to be changed less regularly.

Dinkar et al. (2013) defined and surveyed the body area network as a wireless network of bio-medical sensors that are attached to a human body, where the aim of WBAN is to facilitate continuous recording and monitoring of a person's health condition and transfer it over a long-distance communication network. Also, the sensing system is to be worn by the individual for a long duration.

Bourouis et al. (2014) proposed a monitoring system using the WBASN and applications on Smartphone's based on the use of cloud computing depending on the neural networks to determine the status of the patients.

Altini et al. (2014) introduced a BAN door to Android cell telephones for versatile well-being applications, where the proposed methodology is in light of a Secure Digital Input Output (SDIO) interface, which takes into consideration long haul observing subsequent to the cellular telephone equipment be extended so as to work with ultra-low-power radios. The product structural planning actualized on the cell telephone empowers diverse gimmicks; information can be shown, further prepared or sent to a remote server misusing the WLAN or 3G systems. In addition, the framework permits the arrangement of edges on the deliberate parameters and to consequently send alarms, for example, SMS messages and messages in light of these qualities.

Navale et al. (2014) proposed a system where the sensors will sense the body temperature and heart rate of patient and this information is changed to Android advanced cell by means of Bluetooth. The gadget even permits the patient to move uninhibitedly and can be observed continuously. The Android telephone will contain an application which will identify the heart beat as indicated by the received information separately and if any irregularities are discovered in regards to the heart beat message, it will be sent to the specialist, relatives and healing centers. The SMS contains the patient's circumstance and location by means of GPS to give important medicinal consideration.

Nandkishor et al. (2014) proposed a BAN combined with an Android-based Smartphone to offer a large functionality in telemedical infrastructure so different medical parameters can be analyzed, stored and visualized using the graphical user interface of an Android Smartphone designed for the end user, where the Bluetooth-based sensor nodes acquire physiological parameters of patients, then perform signal processing and data analysis and send the results to the coordinator node. The data is transferred to an Android-based Smartphone via Bluetooth. The system will continuously monitor the physiological parameters of the patient and if any variation occurs, then it sends alert messages to the medical professional. The alert is of two types: SMS alert and email alert. Using this alert system the emergency situation can be handled effectively and the patient will get the medical care as soon as possible.

Kahtan et al. (2016) last decade statistics of medical records, death rates due to hypertensive heart disease, shows that the blood pressure is a crucial risk factor for atherosclerosis and ischemic heart diseases; thus, preventive measures should be taken against high blood pressure which provide the ability to track, trace and save patient's life at appropriate time is an essential need for mankind.

Mendrela et al. (2016) the wireless sensor that communicates in mesh, collects and transmits some threshold parameter. This increases the efficiency and reliability of this field to a considerable level. Due to the limited resources in medical equipment and its staff, there is a need of a dynamic updating system. It is not at all easy to supervise a large number of patients at each and every instant.

Appendix B shows a comparison of author's work with other similar work done by other researchers in this field.

CHAPTER 3
THEORETICAL FRAMEWORK

3.1 Wireless Body Area Network

Latest advancements in remote sensor system innovation open an entryway for an alternative system called wireless body area network (WBAN). It is a developing innovation that may enhance human services conveyance, sickness monitoring, symptomatic observation, and related medicinal systems (Altini et al., 2014). Additionally it can be used for wellness checking, game preparation, slumber examination, step counting, feeling recognition, media players, headsets, amusement (Wang et al., 2013). It gives very solid and low power remote correspondence for restorative gadgets, particularly those embedded in or worn on the human body. It guarantees customized supportable administration to the patient. Every WBAN comprises one portal hub and numerous sensor hubs for essential body parameters, for example, temperature, weight, EEG, ECG, insulin and so forth are gathered by the physiological sensors and after that given to the passage hubs which transmit to focal transforming unit (Pal et al., 2012). The WBAN system is demonstrated in Figure 3.1.

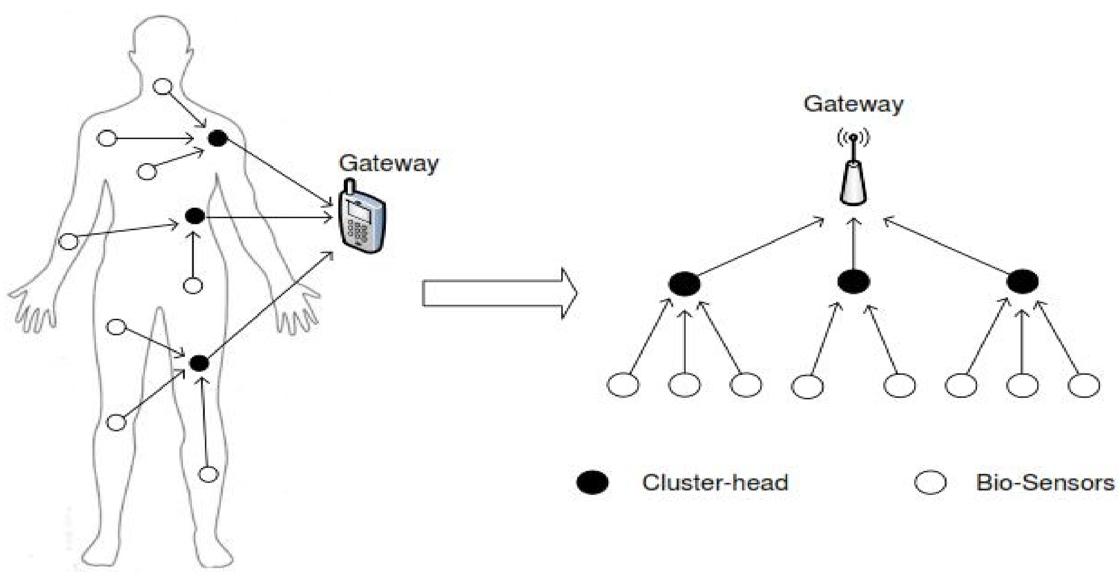

Figure 3.1: Nodes deployment (Pal et al., 2012)

The body sensors convey data to the door hub by means of Bluetooth, Zigbee or IEEE 802.15.6. The passage hub sends data to the preparing focus through Wi-Fi or for substantial separation it uses cell correspondence. MICS band can be used for correspondence. It is a recurrence band somewhere around 402 and 405 MHz in correspondence with therapeutic inserts (Kaur et al., 2011).

Since the embedded sensor hubs are battery controlled, vitality proficiency of sensor hubs seems, by all accounts, to be a real test as mentioned in Kaur et al. (2011). Additionally, information parcels carrying discriminating data about the patients must be legitimately conveyed as soon as possible. In a busy WBAN environment like healing centers, shopping centers and so forth, every WBAN transporter is more prone to be near others, and they will interfere with one another if they use the same groups. The impedance diminishes the signal to obstruction in addition to clamor degree signal to noise ratio (SINR) and in this way causes throughput debasement and more parcel problems, which could likewise expend the influence of sensor hubs all the more rapidly. Since social association of WBAN transporters can happen anywhere at any time, the system must be clever enough to stay away from impedance when it enters the correspondence scope of other WBAN bearers (Jung et al., 2008).

3.2 General Healthcare Systems

The general interconnection of independent and remote sensor gadgets has conceived an expansive class of energizing new applications in some parts of our lives, where health awareness is constantly a stand-out among the most essential and quickly developing ones. The rise of low-power, single-chip radios has permitted the outline of small, wearable, genuinely organized therapeutic sensors, as explained in Jung et al. (2008). Medicinal readings from sensors on the body are sent to servers at the healing facility or restorative centers where the information can be examined by experts. These frameworks diminish the tremendous expenses related to ambulant patients in healing centers as checking can happen progressively even at home and over a drawn-out period. Figure 3.2 demonstrates the general review of a medical services framework. The WBAN contains a few sensors that measure restorative information, for example, ECG, body development, temperature and so on (Cherry et al., 2011). This is possible either straightforwardly or by means of a few middle of the road jumps. The individual server base station is unique for every WBAN and thus for each patient and goes about as a passage between the WBAN and the outside system. As it has more preparing force than ordinary sensors, it can prepare the medicinal information and produce cautions if fundamental (Crosby et al., 2012). Every sensor should just send its recorded information to the special passage it is interfaced with and these needs to be authorized by particular security instruments. The outer system can be any system giving an association between the base station and the restorative server (Altini et al., 2014). As a rule, the correspondence between the outside system and the base station will be remote. The therapeutic server safely stores, forms and deals with the tremendous amount of medicinal bio-information originating from the patients. This information can then be watched and examined by medicinal staff (Devi et al., 2014).

The contribution of our work is to develop a lightweight protocol to secure communication links between sensor nodes using biometrics data. Because of the sensitive nature of the information imparted over the system, security is the overbearing segment in these sorts of systems. What makes securing these systems more troublesome than other sorts of systems is that remote sensor hubs typically have constrained assets, while traditional security components cause high usage for CPU, memory, transfer speed, and vitality utilization (Dinkar et al., 2013; Devi et al., 2014) .

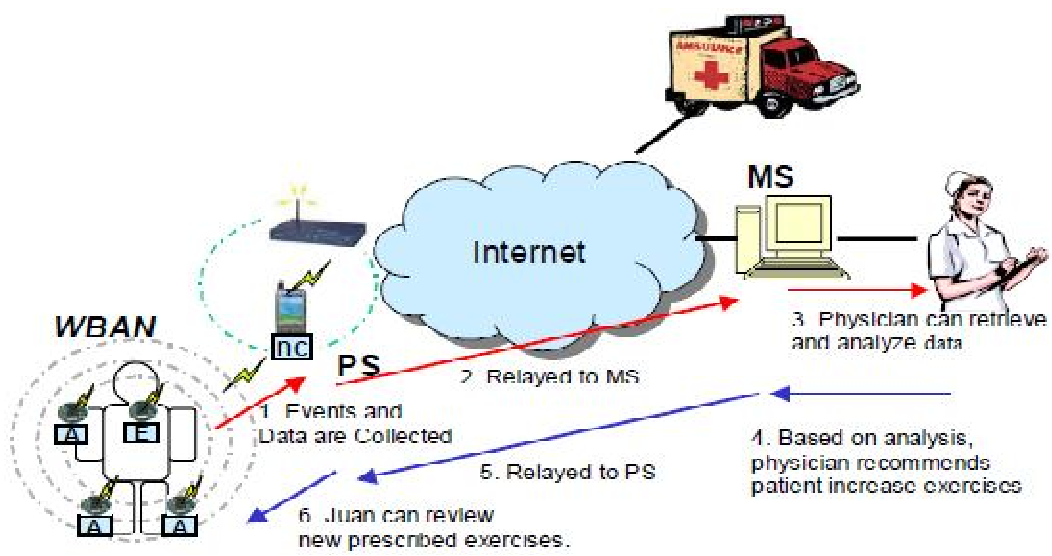

Figure 3.2: General healthcare system (Dinkaret al., 2013)

3.3 Outdoor Path Loss Propagation

The outside way base station is focused around ITU-R P.1411-6 which stands for propagation data and prediction methods for the planning of short-range outdoor radio-communication systems and radio local area networks in the frequency range 300 MHz to 100 GHz. Proliferation information and expectation routines for the arrangement of short-range open air radio correspondence frameworks and radio neighborhood in the recurrence run 300 MHz to 100 GHz. It gives a suggestion for engendering over ways of less than 1 km, which is influenced fundamentally by structures and trees (Chandra, 2014). The impact of structures is prevalent, since most short-way radio connections are found in urban and suburban territories. The versatile terminal is well on the way to being held by a passer-by or placed in a vehicle. The sort of proliferation component that rules depends likewise on the height of the base station reception apparatus with respect to the encompassing structures. Table 3.1 runs down the ordinary cell types important for outside short-way proliferation (Bose et al., 2007).

Table 3.1: Cell type definition (Nandkishor et al., 2014)

Cell type	Cell radius	Typical position of base station antenna
Micro-cell	0.05 to 1 km	Outdoor; mounted above average roof-top level, heights of some surrounding buildings may be above base station antenna height
Dense urbanmicro-cell	0.05 to 0.5 km	Outdoor; mounted below average roof-top level
Pico-cell	Up to 50 m	Indoor or outdoor (mounted below roof-top level)

3.3.1 Propagation situations

The comparing cell is a micro-cell. Proliferation from this BS is predominantly over the tree tops. In these cell types, engendering is predominantly inside road ravines. For versatile to-portable connections, both closures of the connection can be thought to be beneath top level, and the models identifying with BS2 may be used as depicted in Figure 3.3 (Iskandar et al., 2006; Japertas et al., 2012).

3.3.2 Line-of-Sight paths

The paths BS1-MS2 and BS2-MS4 illustrated in Figure 3.3 are examples of LoS situations. The same models can be applied for both types of LoS path.

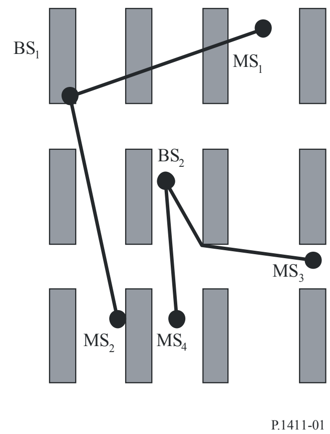

Figure 3.3: Urban area, typical propagation (Iskandar et al., 2006)

3.4 Path Loss In Free Space

Path loss (PL) defines the amount of strength of the signal lost during propagation from transmitter to receiver. Free space is dependent on frequency and distance. Equation 3.1 is used for the path loss calculations (Bose et al., 2007).

$$PL = 32.45 + 20\log_{10}(d) + 20\log_{10}(f) \quad (3.1)$$

Where, Frequency$f$ in MHz, distance between transmitter and receiver, and d in metres.

3.4.1 Okumura Model

The model was built by the assembled data in Tokyo in Japan. In Europe, the towns are medium compared with Tokyo. This work considers European urban regions with ordinary building structures of only 15-20 m. Furthermore, Okumura gives variables for suburban and nation or open extents. By using Okumura's model the user hasthe ability to track path mishaps in urban, suburban and countryside up to 3 GHz (Altini et al., 2014; Arya et al., 2014; Asare, 2014; Chandra, 2014; Devi et al., 2014; Kaur et al. 2011; Khan et al., 2014).

$$PL = L_f + A_{mn}(f,d) - G(h_{te}) - G(h_{re}) - G_{area} \quad (3.2)$$

Where, path loss PL, A_{mn} attenuation mdeia, $G(h_{te})$ height of base station, $H(h_{re})$ height of mobile antenna, G_{area} enviornment gain.

$$G(h_{te}) = \begin{cases} 20\log_{10}\frac{h_{re}}{200} & 1000 > h_{re} > 10 \\ 10\log_{10}\frac{h_{re}}{3}h_{re} & \leq 3 \\ 20\log_{10}\frac{h_{re}}{3} & 10 > h_{re} > 3 \end{cases} \quad (3.3)$$

3.4.2 COST 231 HataModel

This model gives simple and straightforward techniques to ascertain street problems. In spite of the fact that our working wavelength (4 GHz) is well beyond its estimation extent, its effortlessness and adjustment variables still allow it to anticipate problems in this higher wavelengthrange. The fundamental way problem mathematical statement due to this COST-231 Hata Model could be communicated is in Equation 3.4 (Altini et al., 2014).

$$PL = 6.3 + 33.9\log_{10}(f) - 13.82\log_{10}(h_b) - ah_m + (44.9 - 6.55\log_{10}(h_b))\log_{10} d + c_m \quad (3.4)$$

Where, distance d, and h_b height of transmitter antenna, and c_m has two values 0dB for suburban and 3dB for urban, while ah_m is defined as

Urban area: $$ah_m = 3.2(\log_{10} 11.75h_r))^2 - 4.79 \quad (3.5)$$

Suburban area: $$ah_m = (1.11\log_{10} f - 0.7)h_r - (1.5\log_{10} f - 0.8)(3.6)$$

3.4.3 Stanford University Interim (SUI) Model

IEEE 802.16 Broadband Wireless Access working with the proposed models with the waveband lower than 11 GHz holding the channel model brought to life by Stanford University. This model is recognized as an expansion of the Hata model with wavelength greater than 1900 MHz, while the revision parameters made this model suitable for 3.5 GHz band. In the USA, this model is known as Multipoint Microwave Distribution System (MMDS) for wavebands running between 2.5 GHz to 2.7 GHz, and communicated as in mathematical Equation3.7 (Altini et al., 2014).

$$PL = A + 10\gamma \log_{10}\left(\frac{d}{d_0}\right) + X_f + X_h + S \qquad (3.7)$$

Where, $d_0 = 100m$, X_f is the correction frequency above 2GHz, X_h is the height of the corrected receiving antenna, S is the correction of the shadowing, and is the path loss exponent.

$$A = 20\log_{10}\left(\frac{4\pi d_0}{\lambda}\right) \qquad (3.8)$$

And the path loss exponent γ is defined in equation (3.9)

$$\gamma = a - bh_b + \left(\frac{c}{h_b}\right) \qquad (3.9)$$

Where, h_b is the height of base station antenna and varies between 10 to 80m, $\gamma = 2$ for free space in urban area, $3 < \gamma < 5$ for urban NLOS, and $\gamma > 5$ for indoor.

$$X_f = 6\log_{10}\left(\frac{f}{2000}\right) \qquad (3.10)$$

$$X_h = \begin{cases} -10.8 \log_{10}\left(\frac{h_r}{2000}\right) & for\ type\ A, and\ B \\ -20 \log_{10}\left(\frac{h_r}{2000}\right) & for\ type\ C \end{cases} \quad (3.11)$$

where, f is the working recurrence in Mhz, and h_r is the beneficiary recieving antennaheightinmetres. For the above figures this model is broadly utilised for the way problems are forecast for each of the three sorts of landscape in rustic, urban and suburban situations (Chandra, 2014; Devi et al., 2014 ;Kaur et al., 2011).

3.4.4 Hata-Okumura Extended Model or ECC-33 Model

A champion around the most extensively used accurate models is the Hata-Okumura model, which is based upon the Okumura model. The main Okumura model does not give any data more astounding than 3 GHz. Considering previous data of the Okumura model, an extrapolated framework is joined with expectation of the model for higher repeats more dynamite than 3 GHz. The reasonable proposed expansion model of Hata-Okumura model with report is suggested as ECC-33 mode (Devi et al., 2014).

$$PL = A_{fs} + A_{bm} - G_b - G_r \quad (3.12)$$

3.4.5 COST 231Walfish-Ikegami (W-I) Model

The COST 231 further made this model. This is as a result of the additional parameters introduced which depicted the various circumstances. It distinguishes a unique scenario with different proposed parameters.

$$PL_{Los} = 42.6 + 26 \log(d) + 20 \log(f) \quad (3.13)$$

$$PL_{NLOS} = \begin{cases} L_{FSL} + L_{rts} + L_{msd} & for\ Urban\ and\ Suburban \\ L_{FSL} & if\ \ L_{rts} + L_{msd} > 0 \end{cases} \quad (3.14)$$

3.4.6 Ericsson Model

To anticipate problems, the system designers have used a product given by the Ericsson organisation called the Ericsson model. This model additionally remains on the adjusted Okumura-Hata model to permit space for changing in parameters as stated by the earth (Mhatre et al. 2012).

$$PL = a_0 + a_1 \log_{10}(d) + a_2 \log_{10}(h_b) + a_3 \log_{10}(d) - 3.2(\log_{10}(11.75h_r)^2) + g(f) \quad (3.15)$$

Where the default values of a_0, a_1, a_2, and a_3 are given in Table 3.2 .

Table 3.2: Ericssonmodel parameter values (Mittal et al., 2014)

Environment	a_0	a_1	a_2	a_3
Urban	36.2	30.2	12	0.1
Suburban	43.2	68.93	12	0.1
Rural	45.95	100.6	12	0.1

The most critical part of any radio signal is the way field quality shifts as a function of separation and area. This property is normally caught in the idea of way problems. Path loss has a tendency to increment directly with the logarithm of the transporter recurrence (Mhatre et al., 2012). This is otherwise called vast scale blurring, which represents the weakening of the signal level. Different manifestations of blurring are: the small-scale blurring which causes signal contortion, dissemination and are moderately harsh to the bearer recurrence; however, impacts can rely on upon the administration transmission capacity. Multipath could emerge from diffraction, disseminating and impression of related protests, for example, building and autos in the physical situations. The current way misfortune models can be arranged into: hypothetical and experimental models (Mittal et al., 2014). Hypothetical models anticipate transmission problems by numerical examination of the geometry of the landscape between the transmitter and the recipient and the refractivity of the troposphere (Nadeem et al., 2013). Observational models include ecological ward misfortune variables to the free-space misfortune to figures the net way misfortune in the relating environment. This system means that estimates are made, thus considered more precise in perspective of its natural similarity. Path-loss models are needed for effective wireless design

(Nandkishor et al., 2014). These models help through re-enactment to foresee sign level and scope. Way misfortune alongside the transmitter influence and the addition at each one end of the radio way, the investigator/architect can decide how much influence is to be had from specific transmitter. In this work, we consider just the observational models which utilize estimation information to model a way misfortune mathematical statement. The point of the work is to make a near examination of existing proliferation models for utilization in GSM and wireless body area network (WBAN) Communication Systems in Urban Area (Navale et al., 2014).

CHAPTER 4

PROPOSED SYSTEM DESCRIPTION

4.1 Scheme

A large number of searchers have been doing research on recovering the way adversity spreads and perceiving the transmitted signs from the pack pioneers of the remote sensor frameworks (WSNs) (Crosby et al., 2012) and also in the field of remote body range frameworks (WBAN), where Wireless Body Area Sensors are utilized to screen human well-being with restricted note-worthiness assets (Cao et al., 2009). Contrasting critical planning courses of action are utilized to push information from body sensors to healing server (Ederer, 2012). It is essential that notable patient information is dependably recognized to accommodate data for further examination. In Khan et al. (2009) the makers passed on eight sensors on the patients' body as shown in Figure 4.1, with the parameters organized in Table 4.1.

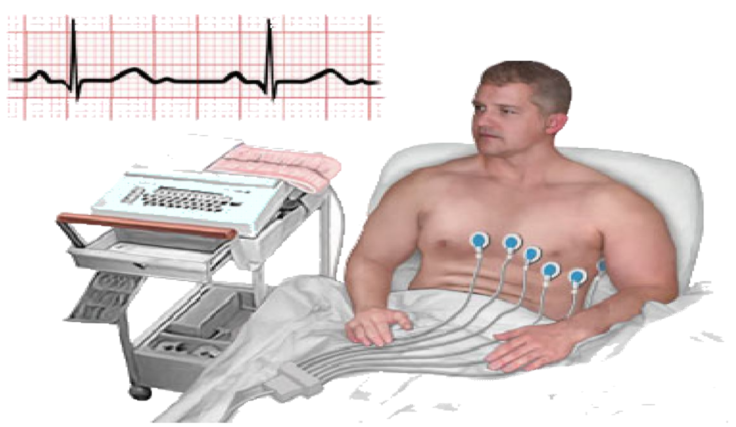

Figure 4.1: Network model for WBANs (Dinker et al., 2013)

Table 4.1: Radio Parameters (Cao et al., 2009)

Parameter	Value
ETX	16.7 micro
ERX	36.1 micro
Emp	1.97 micro
Frequency	2.4
d_o	0.1
Receiver antenna height	3m
Speed	299792458
Lambda	.125
Transmitter Antenna height	30m
Nodes	8
human body path loss exponent	3.38

In this section, the COST-231 hata model for enrolling the way mishap extension model in urban compass is clarified for the purpose of reviewing energy parameters and utilization. This model gives crucial and direct approach to find the road failures (Ekka, 2012). Regardless of the way that our work goes (4GHz) it is well past its estimation degree, its straightforwardness and closeness variables still permitted to expect the course calamities in this higher repeat range. The significant way failures test illumination by virtue of this COST-231 Hata Model could be given as in Equation 4.1 (Nossire et al., 2014).

PL= 46.3 + 33.9log10 (f) – 13.82log10 (hb) – ahm + (44.9-6.55log10 (hb)) log10 (d) + cm,

(4.1)

Where, distance d, and h_b height of transmitter antenna, and c_m has two values 0dB for suburban and 3dB for urban, while a_{hm} is defined in Equation 4.2as

Urban area: ahm = 3.2(log10 11.75hr))2 – 4.79 (4.2)

In this stage, the gathering head transmits the signal packages to the base station informing the territory regarding the body, so that with COST-231 hata model for urban extents to fuse the high structures, development and atmosphere, which applies the best conditions to the signal to be transmitted to the required building, for instance, mending focus with the base setback, where the study was associated with the particular models to consider the spread disaster for each model and in assorted cases (Ederer, 2012; Singh, 2012).

4.2 Simulated Models

4.2.1 Urban Area

The balanced work goes over at 4 GHz; empty between transmitter gathering apparatus and beneficiary enduring wire is five storeys high(3m every x 5 = 15 m), transmitter radio wire stature is 30 m in urban and provincial compass and 20 m in rural zone. It saw three orchestrated getting wire heights for beneficiary i.e. the lion's share of the model gives two particular conditions i.e. the mistreated Free Space Model (FSM) as a sort of point of view model in our whole examination. In the work, variables were set as showed up in Table 4.2, and as imparted by the variables, the conclusions for various heights are shown in Figures 4.2, 4.3, and 4.4 (Bose et al., 2007).

Table 4.2: Variables taken into consideration (Alim et al., 2010)

Distance in metres between the roof and the first floor	15m
Frequency in MHz	4000
Transmitter antenna heights	30m
Receiver antenna heights	3/6/10 m
Distance between buildings	50m
Street width	25m
Height of roof	15m
Transmitter height	30m
Urban environment the parameter	a=3.6, b=0.005, c=20 in m

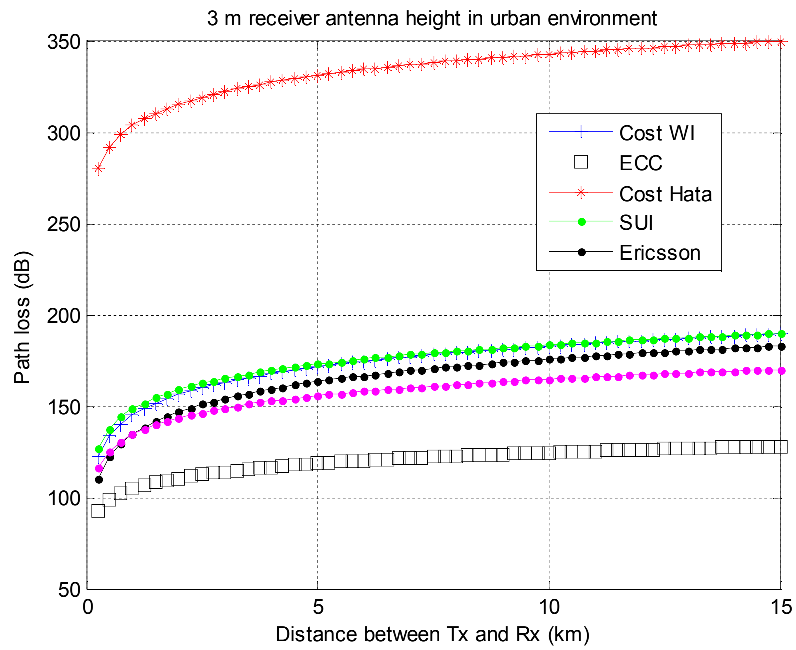

Figure 4.2: Obtained results for 3m antenna height (Nossire et al., 2014)

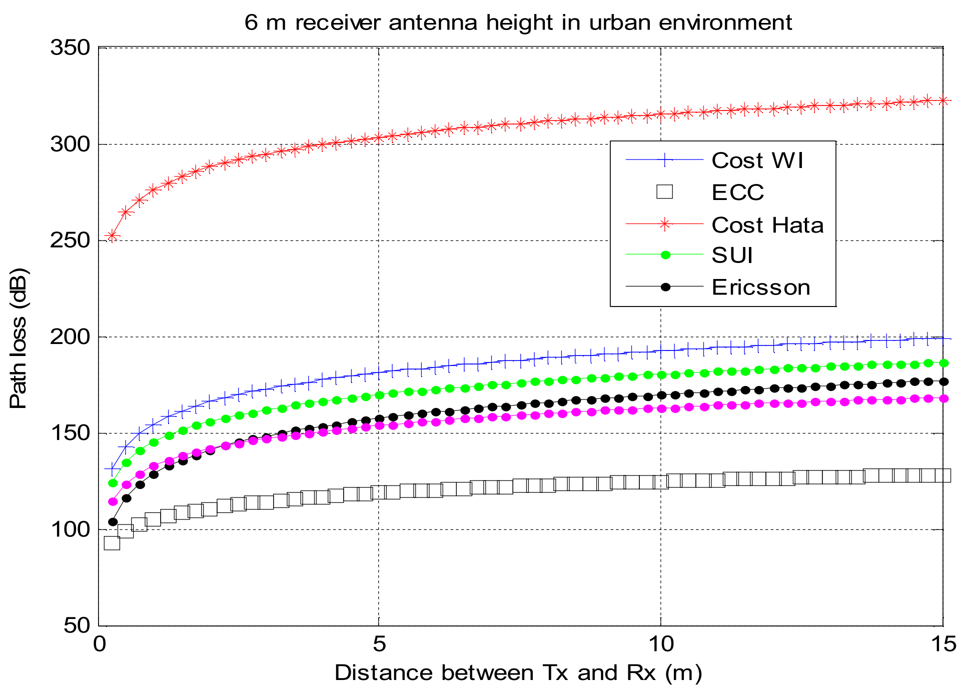

Figure 4.3: Obtained results for 6m antenna height (Ekka, 2012)

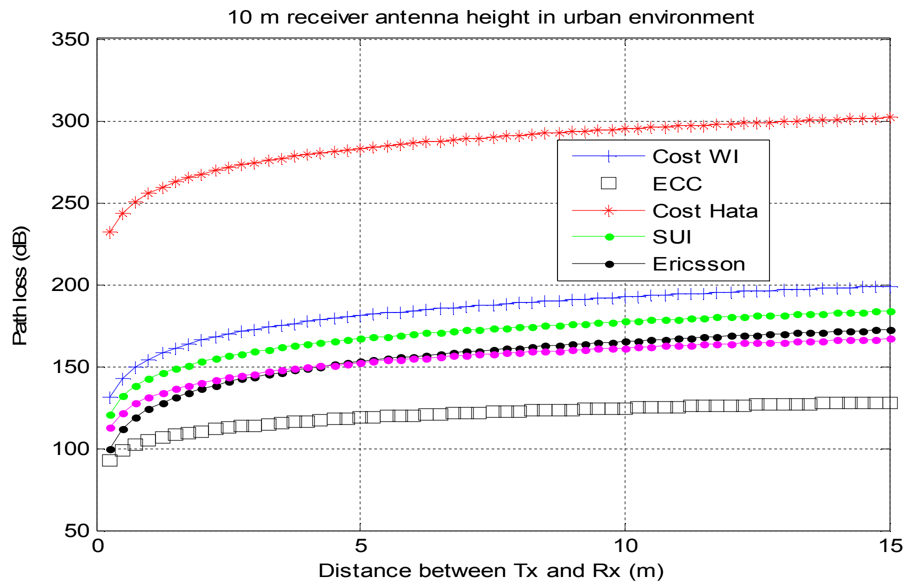

Figure 4.4: Obtained results for 10m antenna height (Ekka, 2012)

The collected outcomes for urban environment are indicated in Table 4.3.

Table 4.3: Urban Environment (Nossire et al., 2014)

Height in m	Free Space	Cost-231 WI	ECC-33	SUI	Ericsson	Cost-Hata
3	128.0130	199.0542	349.8965	182.9498	170.0844	189.7338
6	128.0130	199.0542	322.2264	176.9292	168.1578	186.4631
10	128.0130	199.0542	301.8344	172.4922	166.7379	183.6815

4.2.2 Path Loss in Rural Area

The variables were set as shownin Table 4.2 above. The ECC model is avoided for unavailability reasons in nation areas, and the outcomes for grouped heightsare displayed in Figures 4.5, 4.6, and 4.7.

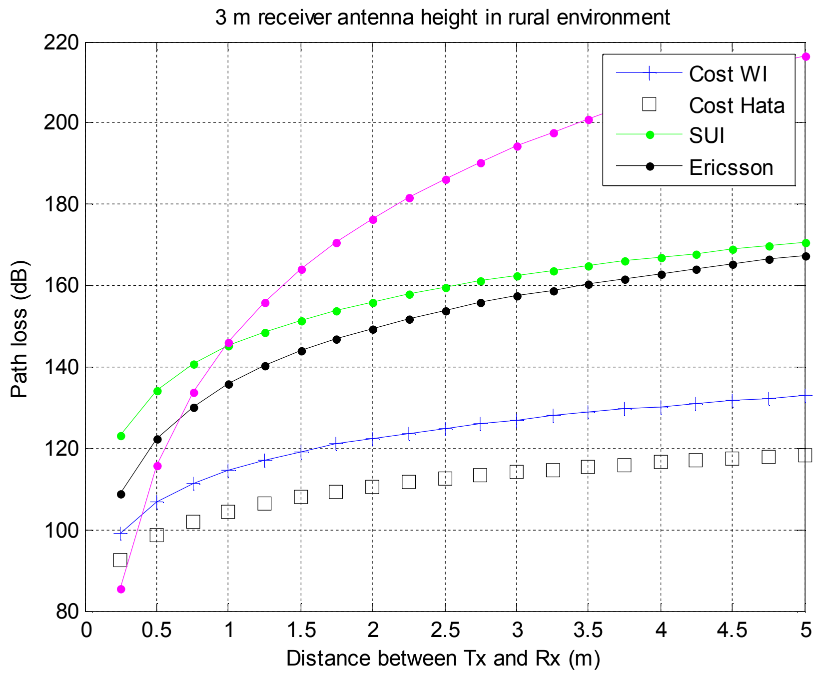

Figure 4.5: Obtained results for 3m antenna height (Alim et al., 2010)

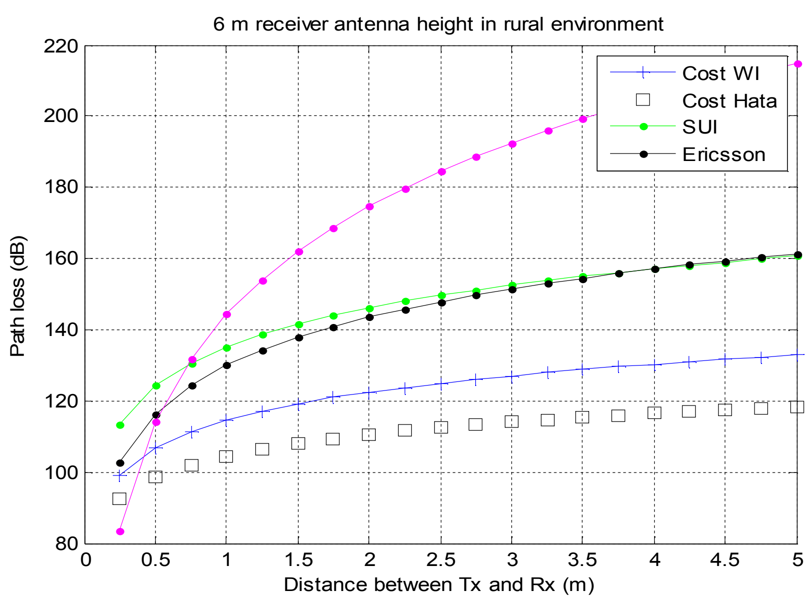

Figure 4.6: Obtained results for 6m antenna height (Nossire et al., 2014)

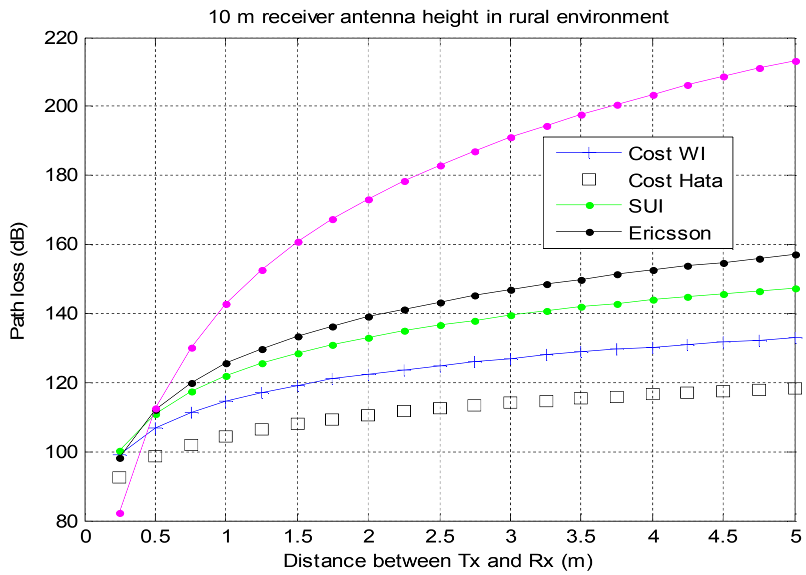

Figure 4.7: Obtained results for 10m antenna height (Nossire et al., 2014)

The collected outcomes for rural environment are indicated in Table 4.4.

Table 4.4: Rural Environment (Ekka, 2012)

Height in m	Free Space	Cost-231	ECC-33	SUI	Ericsson	Cost-Hata
3	118.4706	132.8144	NON	167.4210	216.6631	170.5651
6	118.4706	132.8144	NON	161.4004	214.7365	160.6703
10	118.4706	132.8144	NON	156.9634	213.3167	147.4771

As exhibited in the above figures, the base way misfortune spread is the COST-231 hata model for the rustic zones. At long last, this gives us the lion's share to choose COST-231 hata model for our proposed model to utilize for the WBANs for more precise and stronger data.

CHAPTER 5
BLOOD PRESSURE MODEL

5.1 Introduction

Blood Pressure (BP) can be defined as the weight of blood in veins. BP happens when heart pumps blood around the body as part of circulatory system, largely by contracting and relaxing (Altini et al., 2014).It is a measure of how commandingly the heart is pumping blood around the body (Arya et al., 2014; Abderrahim et al., 2014).

Every estimation of pulse will give two numbers, for instance 120/80 mmHg. The primary (higher) number is known as the systolic BP and the second (lower) number is the diastolic pulse. So the 120 means systolic BP and 80 is the diastolic pulse. The BP is measured in millimeters of mercury (mmHg) (Asare, 2014).

The most widely recognized method for observing the BP is to use the stethoscope as a part of excellent route by the greater part of the specialists in a restorative environment. As of late, a considerable amount of medicinal equipment has ventured into the high innovation world. The best and most useful procedure to measure the BP, is the one to help the patient to get his pressure automatically and over a continuous period; the heart is important for all patients (Bourouis et al., 2014).

In this thesis, the proposed method is the system's direct and continuous measurement of BP wirelessly and transmitting the results directly to the hospital server for continuous and direct check-ups by the doctors and the nurses. BP has an average for healthy people and this average is 115/75 mmHg, which can be considered as day time and the night time and it should be between 120/80 mmHg and 105/65 mmHg. This pressure can be considered as normal pressure, while for people with hypertension, the pressure can be considered to be between 130/80 mmHg and 135/85 mmHg in day time, and 120/75 mmHg in night time. As shown from the numbers mentioned above, the night time average is almost 10% lower than the day time average. This high pressure is not only for the people with hypertension, but it may happen depending on the emotions, exercise, speaking and the use of the cigarettes and caffeine drinks. In real life, there are more and more reasons that affect BP in patients and cause a fault in the reading (Chandra, 2014).One of these reasons is called the white coat effect, and this reason is discovered and can cause the patients to have overtreatment for their cases. Researchers and doctors discovered that the readings of the patients BP in private clinics and hospitals are higher than readings taken in the houses of patients. Even this affects patients with hypertension and may respond completely differently to the antihypertensive medicines and get more side effects for their cases (Devi et al., 2014). In theory, the white coat effect patients, it is discovered that they are dependent on the ambulatory blood pressure monitoring (ABPM) and have more tension than others. In this case, the BP is higher than for other patients and they tend towards hypertension while they are normal BP owners. In these cases, the importance of accurate reading for the BP, especially for the old people and pregnant ladies, who may have higher than normal BP, and these people have what are called pregnancy-induced hypertension and aged-induced hypertension, these cases affect the reading of the BP. In this case, the doctors are going to check whether the drugs taken to lower BP are safe or not, by taking careful consideration of the risk (Dinkar et al., 2013; Devi et al., 2014).

5.2 Methods of Measuring Blood Pressure

Generally, there are two methods for measuring blood pressure:

1. The classic method which uses the stethoscope manually by hand pump.
2. An automatic method with an electronic system using new technology.

While the difference between the two types is so simple and can be considered as a disadvantage of the first method as a complicated one if compared with the second, where the classic method is dependent on the cuff to fill the air, this method may make the patient feel uncomfortable and may be his arteries will close. This gives the doctors to use the stethoscope in order to listen to the sound of the Korotkoff in order to slowly release the air available in the cuff. This systolic BP is considered as the first Korotkoff sound which is obtained when the pressure of the cuff is exactly the same as the pressure obtained by the heart of the patient. This sound becomes quieter and almost vanishes when the air in the cuff is released by the doctor or nurse, this process is done because of cuff stops limiting the blood flow and allows the smooth flow of the blood. This process is the diastolic BP. In the automatic or new technological system, the patient has to wear the cuff on his hand in the level of his heart and just to press the ON/OFF button, the accuracy of his BP will be displayed in the monitor of the system by deflating the sensors in the device to detect the pulse (Chandra, 2014; Bourouis et al., 2014).

5.2.1 Monitoring Blood Pressure

In previous research, it was noticed that measurements of BP in patients' houses are more accurate than measurements taken in private clinics and hospitals, so it is recommended to take BP readings at home. For this reason, especially for pregnancy and elderly patients, it is recommended to take BP readings in their homes and this is approved by the hypertension practice guidelines for BP monitoring (HBPM) and accepted as a fact that it is a valuable tool in the daily life. These readings are preferable to be taken between three and seven days before visiting the doctor, while the duplicated measurements must be taken in the morning before the time of taking the drug if treated or in the evening before eating. While HBPM can help in improving the compliance in the long period of treatment, in this case where hypertension controls and conditions in the strict blood pressure it is considered to be mandatory. This process is considered to be very important for doctors in order to determine the daily BP for patients for the exact treatment to decrease the intake of drugs which may lead to bad side-effects. The process of daily and continuous check-ups can help doctors to improve the situation of the patients (Khan et al., 2014; Ling et al., 2015; Kaur et al., 2011; Mittal et al., 2014).

For BP devices, there are so many types. In this thesis some devices are going to be mentioned such as ambulatory and self-measurements, where the ambulatory BP measurement is the measurement taken every 20-30 minutes daily. In this case the patient can undergo his normal activities, such as sleeping as mentioned above; this measurement can be taken for some special cases, such as pregnant women and elderly people. The results are given to the doctors for continuous check-ups for analysis; this method is used to get accurate results, while self-measurements taken at home, are considered to be more comfortable so that they are taken by anyone at home, even by the patients themselves. Nowadays, the new technology and the new companies are producing new digital machines which are easier for patients to use, so that these devices are easy to setup and take BP readings. These devices are using the oscillo-metric method to display the BP result. The process in these devices needs just to be the upper arm and the position in the same level of the hearts. The patient simply has to press the START button for the cuff to inflate and deflate automatically (Mhatre et al., 2012).

5.2.2 Sensor Blood Pressure Reading

In this method, the devices use the latest technology to measure the BP using the built-in sensors. These devices use a different type of sensor called Micro-electromechanical system (MEMS). This type of sensor is very small in size and consumes low power. Moreover, it is made using the techniques of micro-fabrication. Finally, it is very light in weight. The devices that use these sensors to measure BP, especially in the oscillo-meter methods, use the electronic pressure sensors even with a numerical readout of the BP. In the operation of this type of device, the cuff is inflated and released by an electrically operated pump and a valve; this can be fitted on the wrist (Yuan et al., 2013).

5.2.3 Bluetooth Analysis

In this thesis, the proposed model is a different type depending on wireless communication. This new technology can be considered as the common method used in laptops and mobile phones, where Bluetooth is used as a wireless technology in order to expand the range of the device and its services. Moreover, Bluetooth uses the unlicensed transmission in the range of 2.4 GHz to 2.485 GHz. This new technology is mostly used in the personal area network (PAN) technology where the PAN can be defined as the technology for personal use to communicate with each other (Wang et al., 2011).

5.2.4 XBee Technology

XBee technology is considered to be the high level communication protocol. This technology is based on the control and sensor network dependent on the IEEE 802.15.4. This technology is created by the ZigBee technology, and works in the low data rate to reduce energy consumption. This technology is a transceiver that has the ability to transmit and receive the data wirelessly and it is so widely used because of its low cost, which is the reason to be used in wireless control and the control of sensors network. This technology is mostly used for the creation of the point-to-point connection or the star topology connection. The ZigBee devices have three types (Pal et al., 2012):

1. ZigBee Coordinator
2. ZigBee Router
3. ZigBee end Device

5.2.5 WiFi Technology

Nowadays, WiFi technology has become dominant for wireless local area networks (WLANs). This technology has improved in order to work as the wireless Ethernet. WiFi is considered to be the open-standard technology, the reason of giving the wireless connectivity the stuff to be connected with the local area networks (LANs). This technology also works in the unlicensed radio spectrum. The advantages of WiFi are also that it can be considered as open access in order to allow the public to connect to and use it. Moreover, it has a range of communication of 50 to 150 meters. The encryptions of this technology are

1. Wireless Encryption Protocol (WEP) based on IEEE 802.11
2. Wireless Application Protocol (WAP) based on IEEE 802.11i

These encryptions are so simple and easy to be hacked, so for this reason it is not recommended to be used in the PANs (Tsouri, 2014).

In Table 5.1 is a comparison between these above mentioned technologies

Table 5.1: Comparison of XBee, Bluetooth and WiFi (Leng et al., 2015)

	XBee	**Bluetooth**	**WiFi**
Data rate	20, 40 and 250 Kbit/sec.	1 Mbits/sec	11 and 54 Mbits/sec.
Range	10-100 metres	10 metres	50-100 metres
Frequency band	868/915 MHz, 2.4 GHz	2.4 GHz	2.4 GHz, 5 GHz
Power consumption	Very low	Medium	High
Number of cell nodes	More than 65000	8	2007

5.3 Withings Wireless Blood Pressure Monitor

BP Monitoring Made Simple Slip on the sleeve, turn on the Wireless BP Monitor and the Health Mate application will naturally dispatch. Position arm correctly and you're prepared to take your pulse. The application stores all readings, adjusts with Withings Health Cloud, and shows a straightforward diagram. Picture details can be seen on your iPhone, iPod touch, or Android gadget, and in addition, on your online dashboard (Tarng et al., 2010). The information is constantly moved down. The application gives a moment shading criticism in view of the National Health Institute benchmarks for a brisk and straightforward handling of estimations. Offer estimations with a specialist with a couple of simple taps on cell phones and improve bolster battling hypertension. Furthermore, estimations naturally get synchronized with more than 100 awesome applications and administrations. Estimation Cuff oscillo-metric strategy Pressure Accuracy: 3 mmHg or 2% of perusing Heart Rate Accuracy: 5% of perusing Cuff boundary: 22 to 42 cm (9 to 17 in) Automatic swelling and Controlled discharge Connectivity Bluetooth Smart Ready Compatibility/Requirements Phone 3GS, 4, 4S, 5, 5c, or 5s, iPod touch fourth gen or more up to date, all iPad variants (aside from the first iPad – App not iPad improved), iOS 6.0 or higher Android cell phone or tablet with Bluetooth network, running Android 4.0 or higher. Figure 5.1 shows the proposed system.

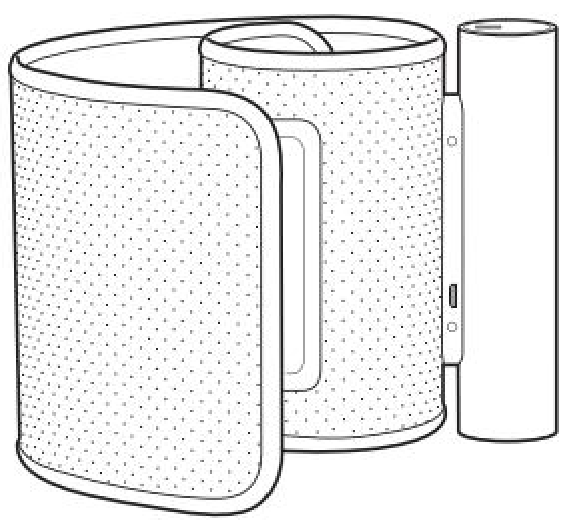

Figure 5.1: Wireless blood pressure using Android system

In Figure 5.2, the used Android mobile.

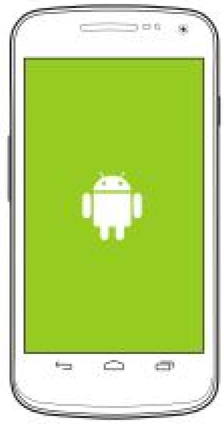

Figure 5.2: Used Android System

The proposed system is so easy to setup with any Android system, so that the BP pulses can be easily transmitted through the WiFi to the hospital or private clinics for continuous check-ups.

The proposed system has the following specifications:

1. Using Bluetooth or WiFi;
2. Just one push button;
3. Direct save the reading into Dropbox;
4. Easy to use for more than one or two times in the day, it automatically starts;
5. Easy to be transmitted everywhere, even outside the country;
6. Its software is readily available in the Google store and is free.

The operating instructions for the proposed model are shown below To start download the operating system from the Google store as shown in Figure 5.3.

Figure 5.3: Installing software from the Google store

Opening the Bluetooth in the Android system in order to pair the proposed model with the smart phone as shown in Figure 5.4.

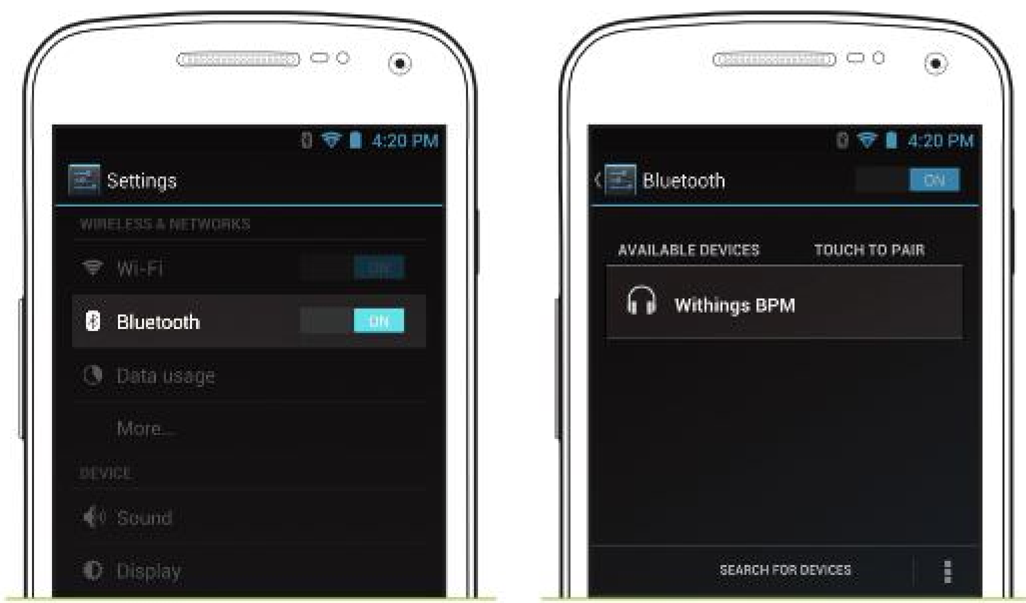

Figure 5.4: Pairing the proposed model with the mobile

Figure 5.5 shows the most suitable position for the cuff to be on the wrist.

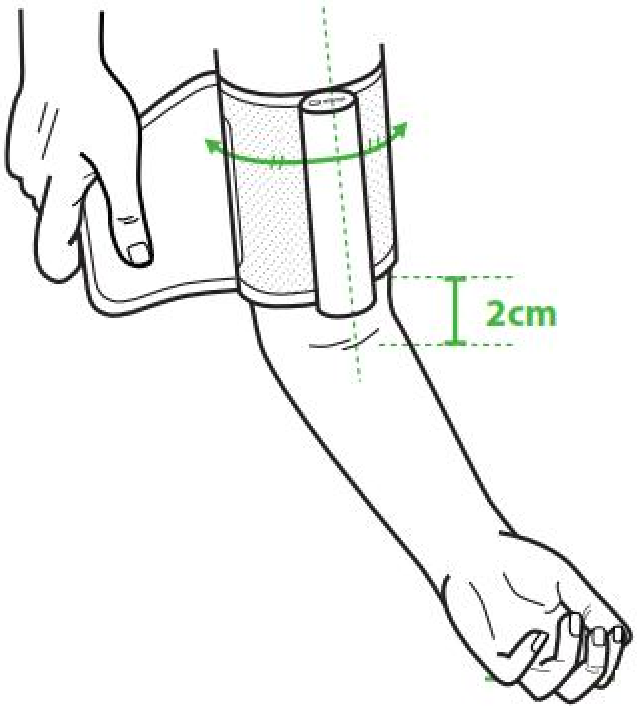

Figure 5.5: The suitable position of the proposed system on the wrist

Figure 5.6 shows the connection options by Bluetooth or by USB cable to the mobile or computer.

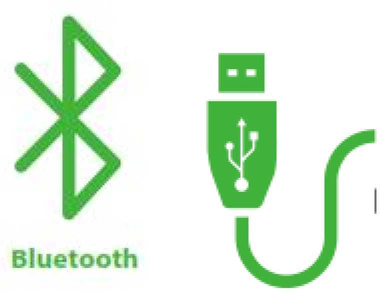

Figure 5.6: Connection process

To start the operation, Figure 5.7 shows the position of the start button on the proposed model.

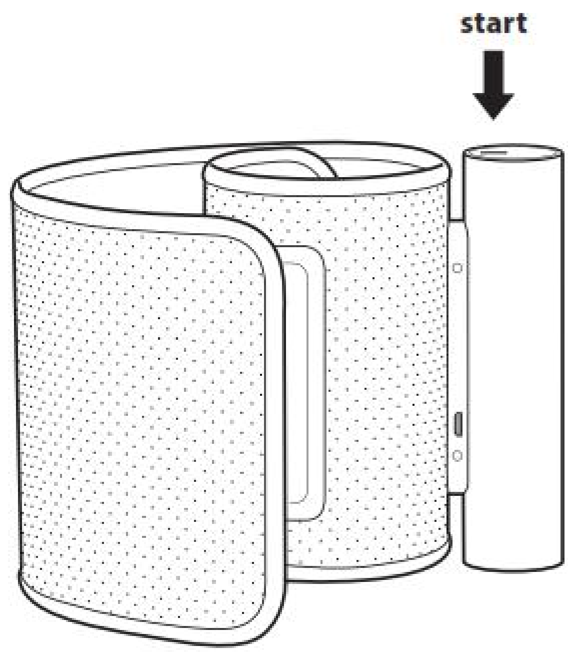

Figure 5.7: The start button

Figure 5.8 shows the start operation in the Android system.

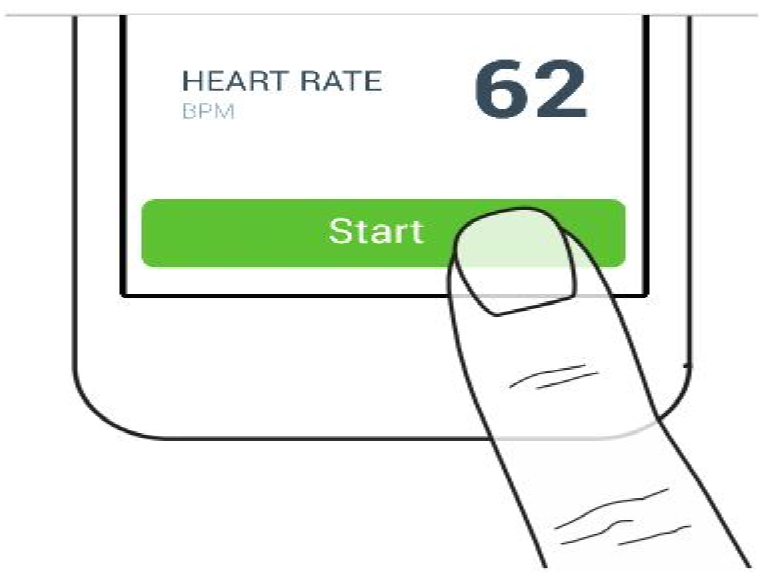

Figure 5.8: The start in the Android operating system

5.4 Simulation Results

The proposed model consists of the apparatus so that everything is automatically calculated and saved in the iCloud driver so that the data is ready to be transmitted to any place, such as the hospitals, for continuous check-ups. The run is done for the proposed system and the results are shown in Figure 5.9.

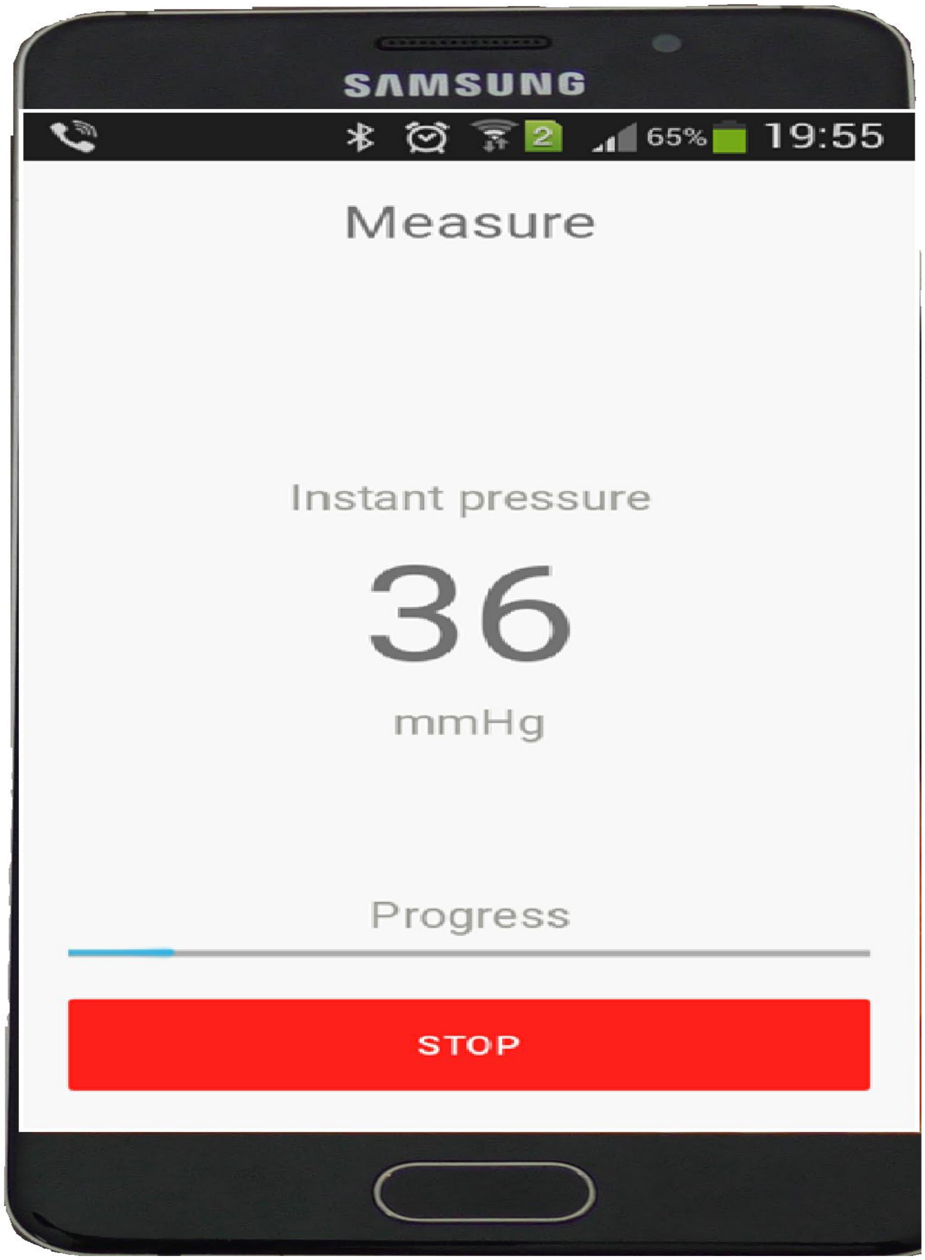

Figure 5.9: The measure Process

Figure 5.10 shows the continuing measurement process.

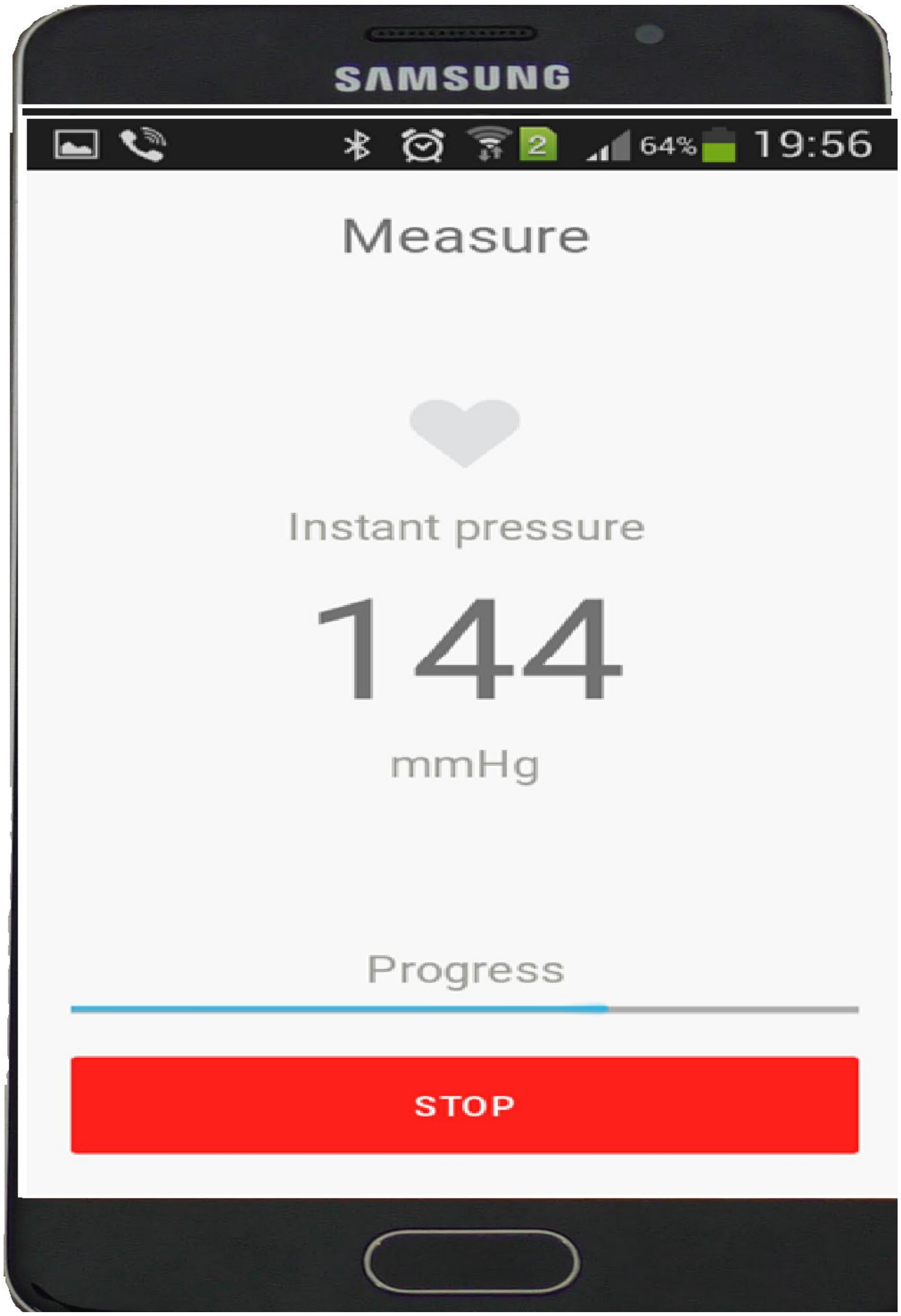

Figure 5.10: Continuing the measurement process

While Figure 5.11 shows the results obtained by the proposed system for three persons separately,

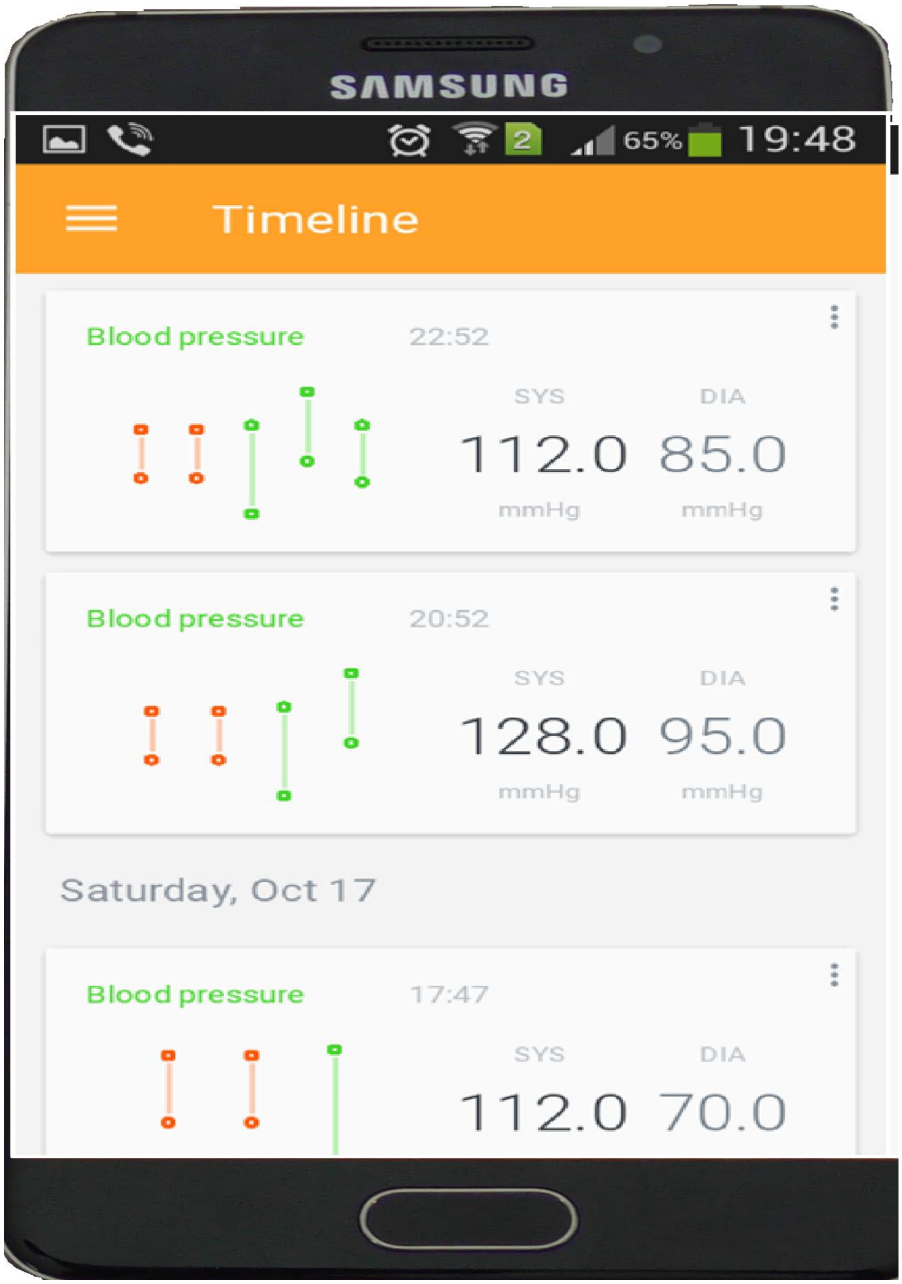

Figure 5.11: The readings for three persons separately

The proposed system has the ability to save the patient's profile, with an alarm to keep the patient in touch and in continuous check-ups. The process of building a profile for one patient and in the profile selected to get the reading two times daily is shown in Figure 5.12.

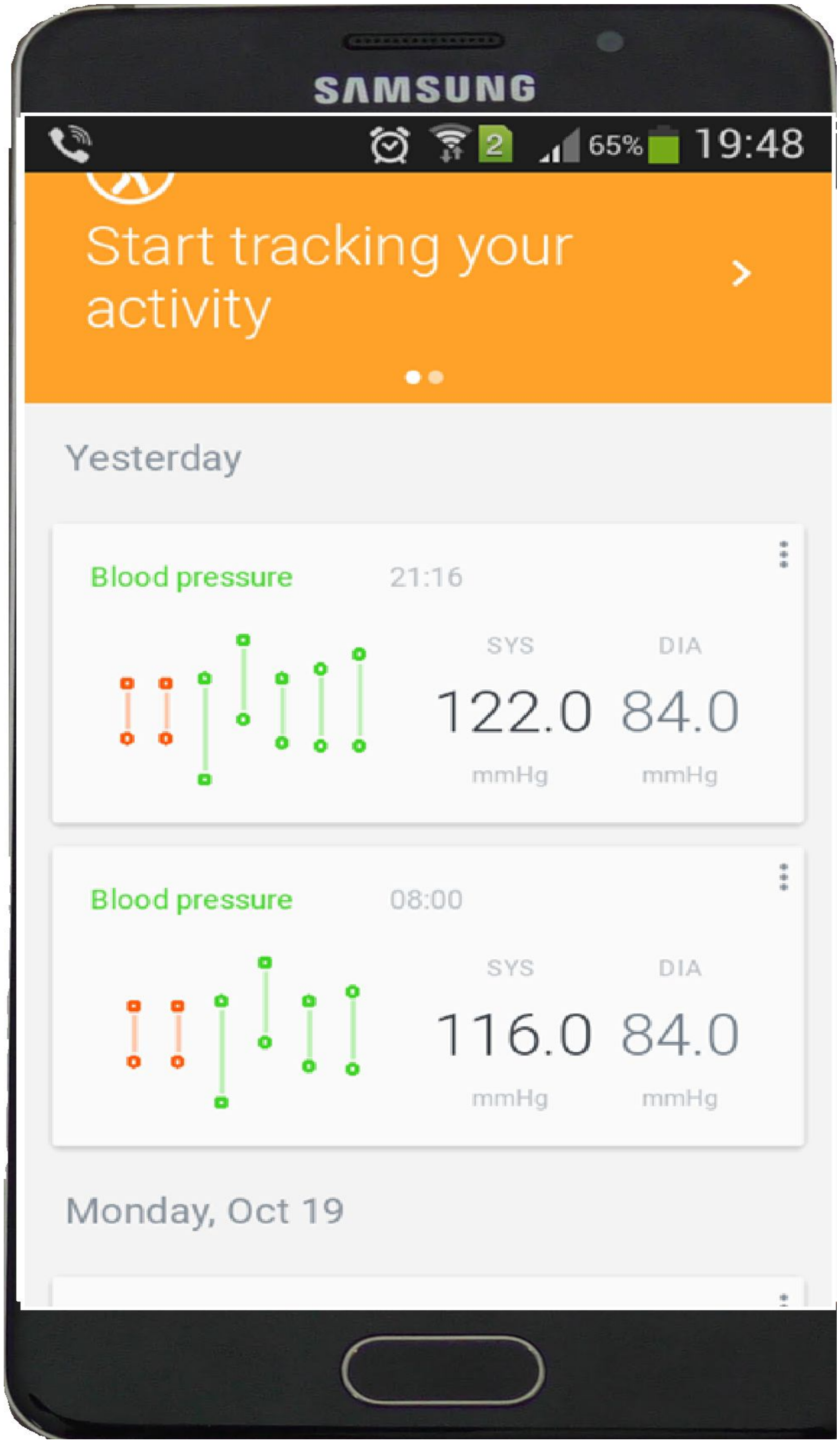

Figure 5.12: The reading taken two times daily

When these results have been taken, the database is saved in the iCloud drive, ready for the transmission process to any hospital – not just inside the country, but anywhere in the world.

CHAPTER 6
ELECTROCARDIOGRAM MODEL

6.1 Introduction

Electrocardiogram (ECG) is a simple tool that is used to explore the electrical as well as muscular activity of the heart. This method allows the cardiologists to diagnose and interpret heart defects (Parak et al., 2010).As the cardiac cycle consists of two main stages, systole and diastole, the ECG can measure the rate and rhythm of the beats coming from the heart (Saritha et al., 2008). Where the well-known type of ECG causes some problems as: skin irritations refers to their direct connections to the body of the patients, heavy as a weight to the patients especially for the patients they did not get used for using like this type of electrodes and finally, constant signal delivery. Researchers have found a new tool for replacing the electrodes, which is used in routine ECG taking. For obtaining 12 signals that is normally detected through electrodes, the scientists have carefully calculated these required numbers by dividing them as: arm and leg, while the rest which is 6 electrodes have to be placed on the chest and recording each signal, printing out these signals is called the electrocardiogram (Castells et al., 2007).

The new technology as the proposed model which is improved by Shimmer reduced the number of electrodes to three electrodes and they are placed on the hands, one on the left chest, but this measures only the rate and rhythm of the heart (Parak et al., 2010).

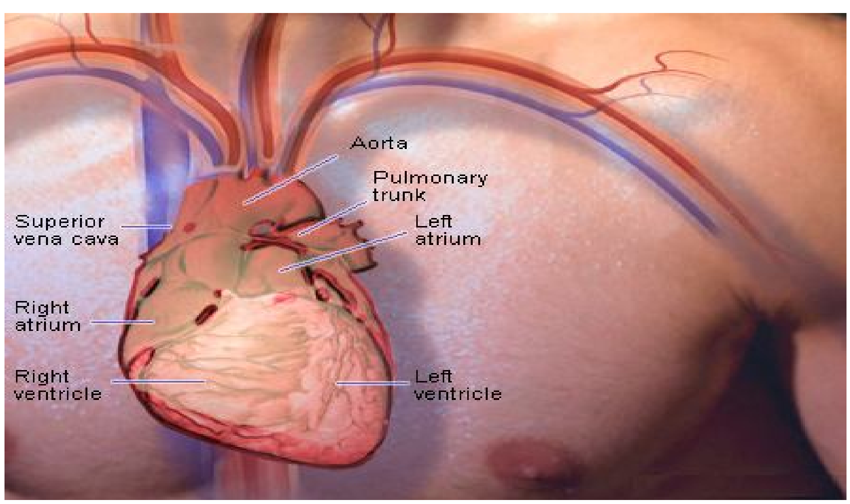

Figure 6.1: Basic Anatomy of the heart (Jones and Bartlett Publisher, 2008)

While the heart includes four chambers as:

1. Right and Left Atrium and
2. Right and Left Ventricle.

The right part of the heart is for collecting blood from all the body to pump it to the lungs, but the left part is for receiving the blood from the lungs to pump it to the whole body which is considered the opposite operation of the right side. The blood flows inside the body as:

1. The left side of the heart which is taking the blood fully of Oxygen to the veins,
2. The blood flows into the left to the aorta to be distributed to the whole body in order to support the body with the required Oxygen and the nutrients for the metabolism process,
3. In this case, the returned back blood to the heart is mixed with Oxygen and carbon dioxide which is considered as the waste of metabolism. This is entering the right part of the right atrium through the vena cava to be pumped to the right part of the heart, and
4. The blood is pumped through the pulmonary artery to the lungs by the right ventricles in order to cancel the carbon dioxide and replace the Oxygen.

This process is shown in Figure 6.2.

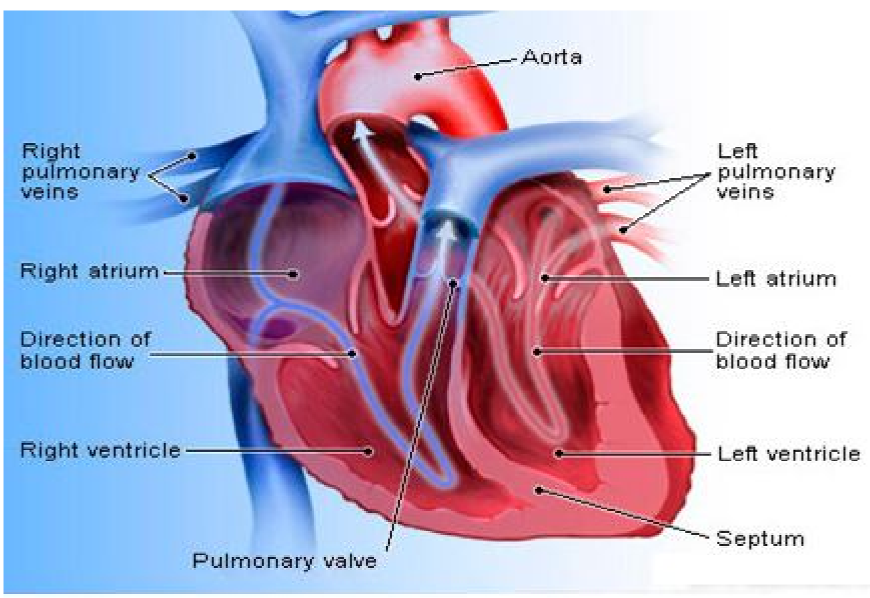

Figure 6.2: Blood Flow Process (University of Toledo, 2011)

The basic principle of heart to operate is the need for the Oxygen and nutrients, these requirements are supplied by the arteries. This process is required to supply the whole body by a rich Oxygenated blood. While electrically, the heart can be subdivided to two parts: upper and lower chambers. As known, the electrical signal is produced from the upper part to cause the atria in order to work and squeeze the blood through the ventricles. In this process, a small delay is happening to give the chance for these ventricles to be filled of blood to be pushed to the body including the lungs (Cherry et al., 2011).

6.2 Heart Function and ECG

In this section, the heart generates electrical impulses, where these impulses are detected by the electrodes places on the chest. When there will be multiple leads, then there will be many views of the heart to support the doctors in order to easily learn about the heart rate and rhythm and the blood flow even. Moreover, the proposed model has five leads for more accurate reading. In the following paragraph, the definitions of the rate and rhythm are explained in details.

a. Rate which is the explanation of the beats of the heart. In the normal mode, the *sinoatrial node* (SA) node can generate electric pulse in the range of 50-100 times in one minute. While, Bradycardia which is equal to slow plus cardia and equals to heart is used to describe the rate of the heart when it is less than 50 beats in one minute. Finally, the Tachycardia which is equal to the fast plus the cardia and equals to the heart, also describes the beats of the heart when they are faster than 100 in one minutes.
b. Rhythm is a reference for the beats of the heart, which is normally beating in the sinus rhythm including each generated pulse by the SA to result a ventricular contraction. These rhythms are separated to two types, some are normal variants and some are dangerous. In the sudden death, the electrical rhythms do not generate any heartbeat. To show rhythm strip, must be 12 leads of ECG used as shown in Figure 6.3.

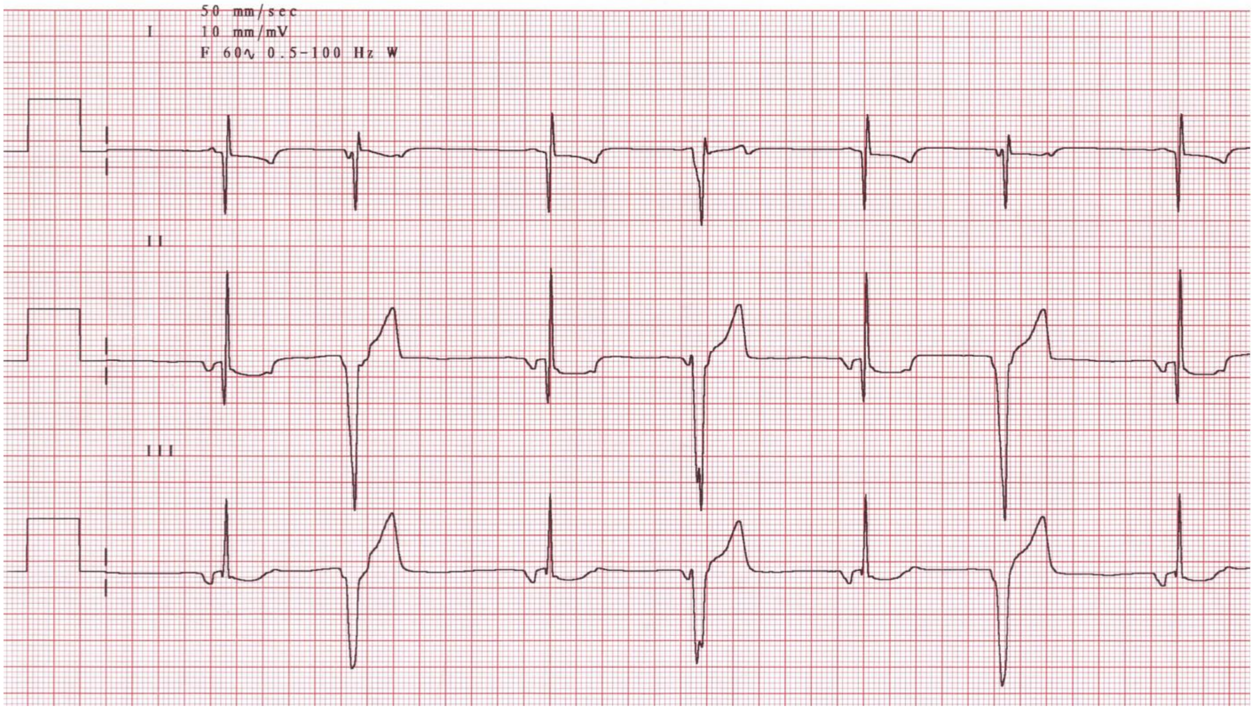

Figure 6.3: Heart Rhythm ECG (University of Toledo, 2011)

In this system, there are also delays in the electrical signal and this delay includes the SA node, also atria signal, AV node and called the ventricles. These signals are two types, one is normal variant of the heartbeat rhythm and the second is dangerous for life threatening. These signals are as (University of Toledo, 2011) :

- AV block in the first degree
- AV block in the second degree and in type 1
- AV block in the second degree and in type 2
- AV block in the third degree which is for heart block
- Branch block which is in the Right bundle and
- The branch block in the left bundle.

In the heartbeat case, there is a special case called Wolfe-Parkinson-white (WPW) for the un-normal cases as the short circuit in the pathways for the rate and rhythms. This un-normal case is in the pathway in the AV node and causes the tachycardia.

The main aim of the ECG is to track the information about the heart that it is conducting the electricity in the appropriate form or not. From this signal, the doctors can detect whether the heart muscles are working in right way to flow the blood to the parts of the heart or there is a decrease in the flow. If there is any presence of the acute blockage, this means there is a heart attack can be happen. These are helpful for the doctors to determine the health of the heart for the patients, and this is the first step for the doctors to do when a patient comes and complains about pain in his chest.

6.2.1 During the ECG

The ECG is a machine to scan the electricity pulses generated from the heartbeats; this scan does not hurt the patient, these pulses recorded by this machine called ECG. This machine has patches; some are connected to each leg, some to the limbs and some to the shoulders. Some machines have another six patches to be placed on the chest starting from the right bone of the breast, these patches are giving a shape of semi-circle because of this are called chest leads and they are connected to the ECG to record the scan of the heartbeats and print them on special papers. In the new technology, the new ECG machines have the ability to display video to help the doctors and nurses to decide the quality of the pulse. These machines have the ability to be connected to the computer with a computer program to help detecting the heartbeat signals.

In some situations, the doctors would like to check the heartbeats in different angels, for this they place the ECG machine props on the chest walls or even in the back; this gives them different scans for the signals of the heartbeats.

6.2.2 ECG Interpretation

The idea of the ECG is explained in the above sections, and this requires a high level education and experiences for the users to get the heartbeat scans and to understand the signals well. Moreover, the heartbeats scans, need well discussions with the doctors to give right decisions even the heartbeat scans are appearing to be normal. In this situation the assessment of the ECG scan has the following:

- The rate and its determinations
- The rhythm and its determination

- The electrical conduction and its evaluation, as happens with the heart muscles and how to conduct the electricity which will be different in the normal case.

The ECG machines record the heartbeats in 12 leads as mentioned which are (I, II, AVR, AVL, AVF) and the chest leads as (V1 till V6). The PR interval is the time taken for the electricity to travel between the SA till the AV nodes. While QRS is to measure the electrical time taken through the ventricles, finally, the QT is the measurement of the ventricles in order to recover the beat and the preparation of the next beat. The P-QRS-T, is the wave sequence which shows the simple strips and where the M equal to 1.0 millivolts as shown in Figure 6.4.

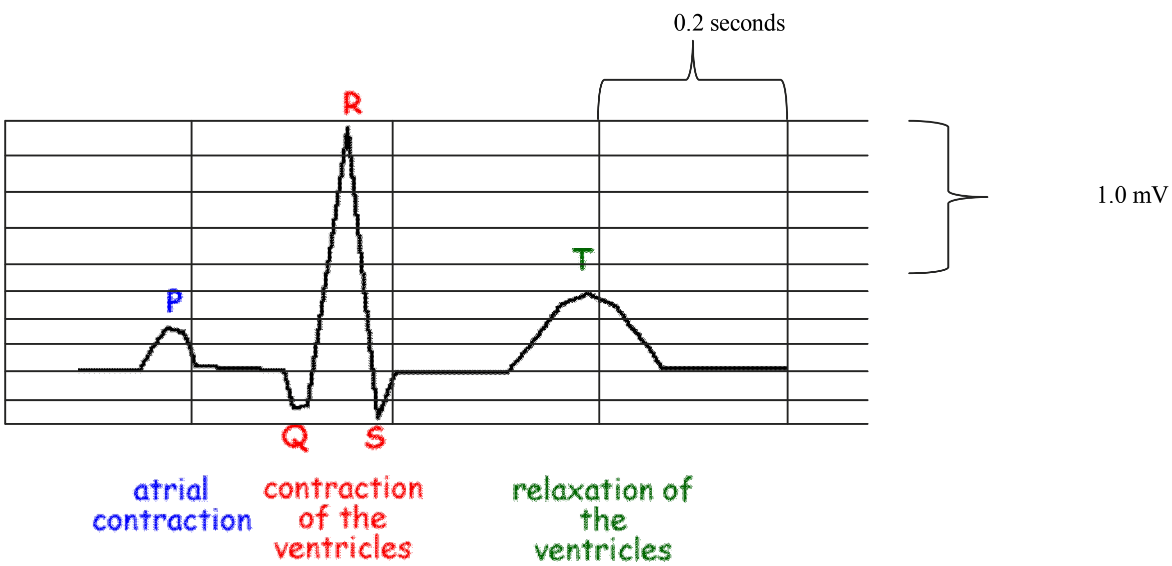

Figure 6.4: The P-QRS-T Signal (University of Toledo, 2011)

As shown in Figure 6.4, the wave explained as P corresponds the contraction of the atrial signal, and the QRS corresponds the contraction of the ventricles signal, if compared with the P signal, the QRS is larger than the P signal due to the difference in the muscles in the atria and ventricles as shown in Figure 6.5. While the T signal is the repolarization of the ventricles and its relation signal and it is masked by the QRS signal.

Figure 6.5: ECG signal

Figure 6.6 shows a 30 BPM signal with a sample frequency 102.4 Hz, and showing the R-wave height.

Figure 6.6: ECG Signal at 102.4 Hz Frequency

This contraction of the cardiac muscle is shown in the middle of the right atrium and called sinus node as shown in Figure 6.7.

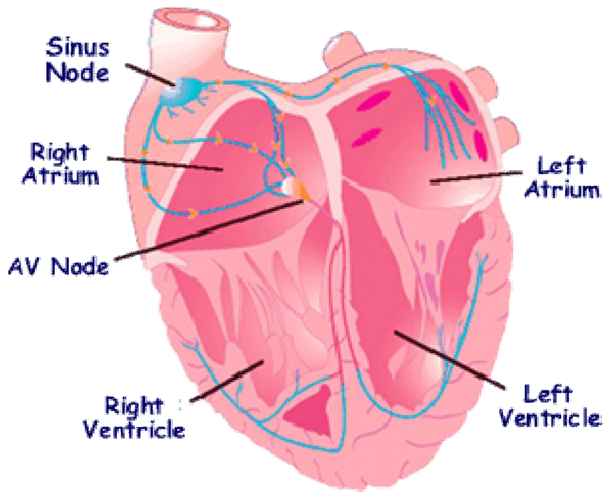

Figure 6.7: Sinus Node (American Medical Association, 2015)

As much as the time in the datasheet for the heartbeat is important and showing the heartbeats are normal or not as shown in Table 6.1.

Table 6.1: Timing for normal heartbeats (American Medical Association, 2015)

ECG Segment	P	PQ	QRS
Normal range	≤ 0.12	0.12-.022	≤ 0.10 sec

The replacements of the leads are shown in Figure 6.8.

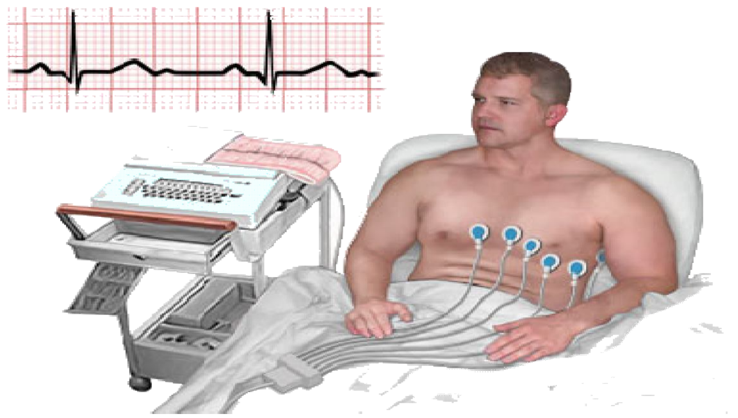

Figure 6.8: Replacement of Leads to scan the heartbeats (American Medical Association, 2015)

6.3 Proposed Model

In this section, the used units in the proposed system are discussed briefly.

6.3.1 Main Unit

The proposed system has so many advantages as a new and improved technology so that it has the ability to work using the Android mobile system and the computer system. The proposed system main function is the amplifier unit as shown in Figure 6.9.

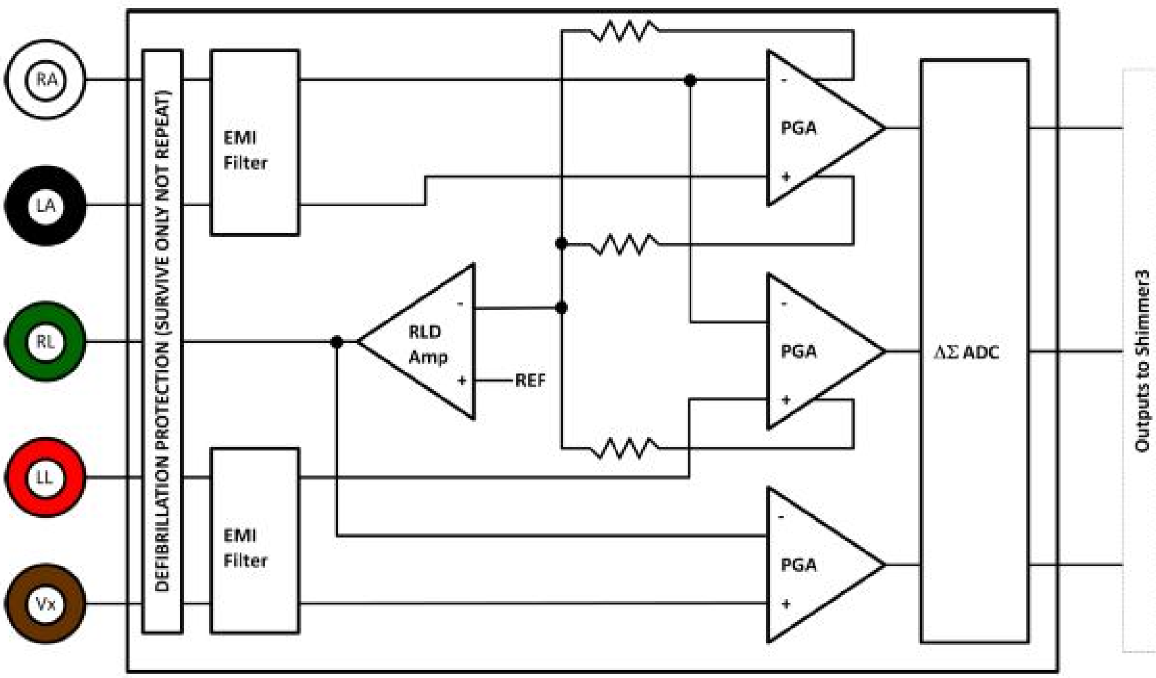

Figure 6.9: The Amplifier Unit

Where, the main unit has different colors and different connections and they are as: the white color and is connected to the RA, the black input is connected to the LA, green to the RL, the red one is connected to the LL and the brown one is connected to the Vx. As shown in Figure 6.9, the main unit consists of different types of filters as:

- EMI filter in order to reduce the electromagnetic waves and this filter is with a -3dB bandwidth which is approximately a frequency of almost 3MHz.
- Right-Leg Amplifier while this amplifier has the counteracts common mode type of amplifiers for the interferences as the interference produced by the main power or the lights inside the room.
- Programmable Gain Amplifier, this amplifier is used to increase or maximize the signal, where the gain of this amplifier can be set by the software available with the proposed system.
- Analog-Digital Converter, this is used to convert the signal from analog to digital as much as the computers and the mobiles are digital systems for ease interface. Moreover,

these readings are ready to be transmitted to the SD cards or to be transmitted through the Bluetooth system.

6.3.2 Electrode Positioning

In the proposed system, the inputs for the ECG unit are placed in their places in order to measure the signal in the following places:

A. For the Bipolar Amplifier
   - LA is placed on the Left Arm,
   - RA is placed on the Right Arm,
   - LL is placed on the Left Leg and
   - RL is placed on the Right Leg.

B. For the Unipolar Amplifier
   - The Vx which is V1 till V6 are placed on the chest.

The connection of the proposed system is shown in Figure 6.10

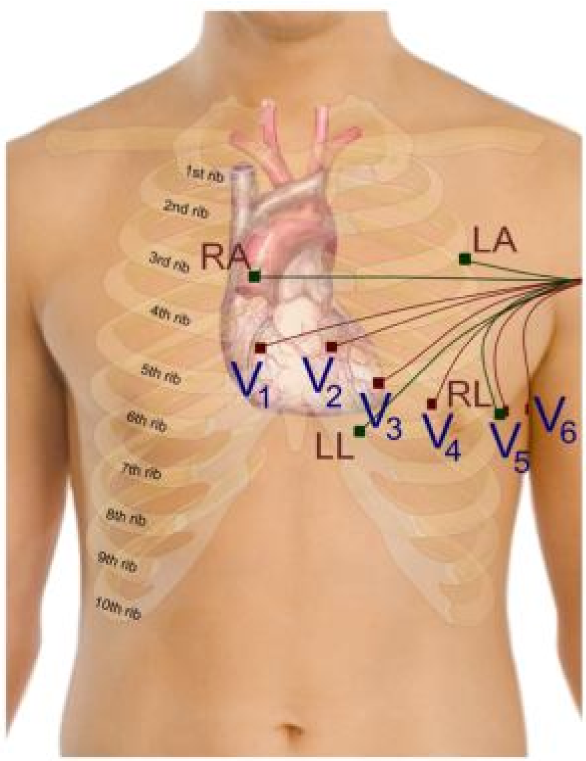

Figure 6.10: The Electrodes connections (Shimmer, 2015)

6.3.3 Proposed System Platform

This section explains the proposed system overview especially the main unit. The main unit has a detailed connection and aims of this unit to support and work as a ECG unit, as much as has the ability to be connected with the Android system using Bluetooth. The main unit is shown in details in Figure 6.11. While the main unit has functions and are tabulated in Table 6.2.

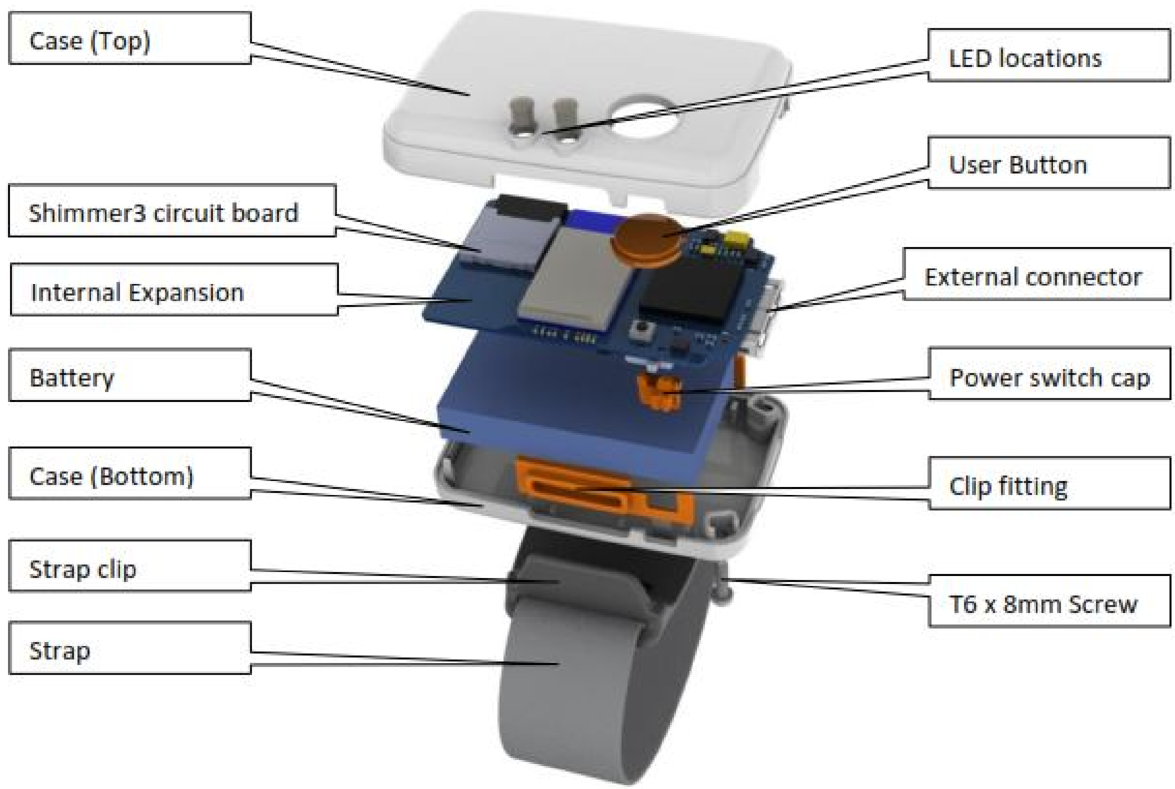

Figure 6.11: The main Unit Platform (Shimmer, 2015)

Table 6.2 explains the main operations of the main unit for the ECG:

Table 6.2: Main Functions of the Main unit (Shimmer, 2015)

Feature	Purpose	Capability
I/O (Input/Output)	Capturing the data transmitted from the patient	*Integrated* • 3 Axis as accelerometer for the low noise array. • 3 Axis for the wide range accelerometer array. • 3 Axis for the sensor of the angular rate. • 3 Axis of the Magnetic sensor. • Relative pressure sensor. • Temperature Sensor. • 5 colored sensors. • Software defined button. *Expansion* • 7 leads for the Analog signal • UART, SPI and 12C for the supporting bus • 18 position for the charging process, programming and data access • Keyed 16-signal in the size of micro for the connection of the analog leads • FFC header for the purpose of the radio channel • JTAG for the external connection.

The proposed hardware has a multipurpose system to support the following functions:

- Charge purpose,
- SD card access and
- The programming purpose.

While it has several iteration of design as shimmer v3 which is considered as the best and the system is shown in Figure 6.12.

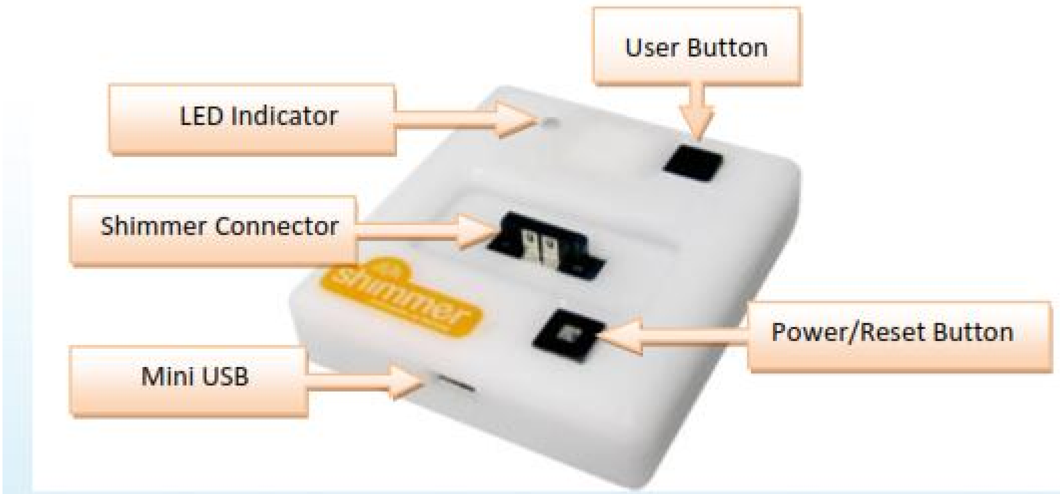

Figure 6.12: Shimmer V3, the proposed system (Shimmer, 2015)

The proposed system has the ability to support Java for Android which allows the user to use the Android system for the transmission of the database directly. Moreover, giving the ability for the user to configure, stream, display and log the data on the Android devices. This gives the patients to reduce the time instead of going to the hospital and taking turn to see their doctors. Also the proposed system is easy to use as shown in Figures 6.13, 6.14 and 6.15.

Figure 6.13: Connection of the proposed system

Figure 6.14: Connection shape

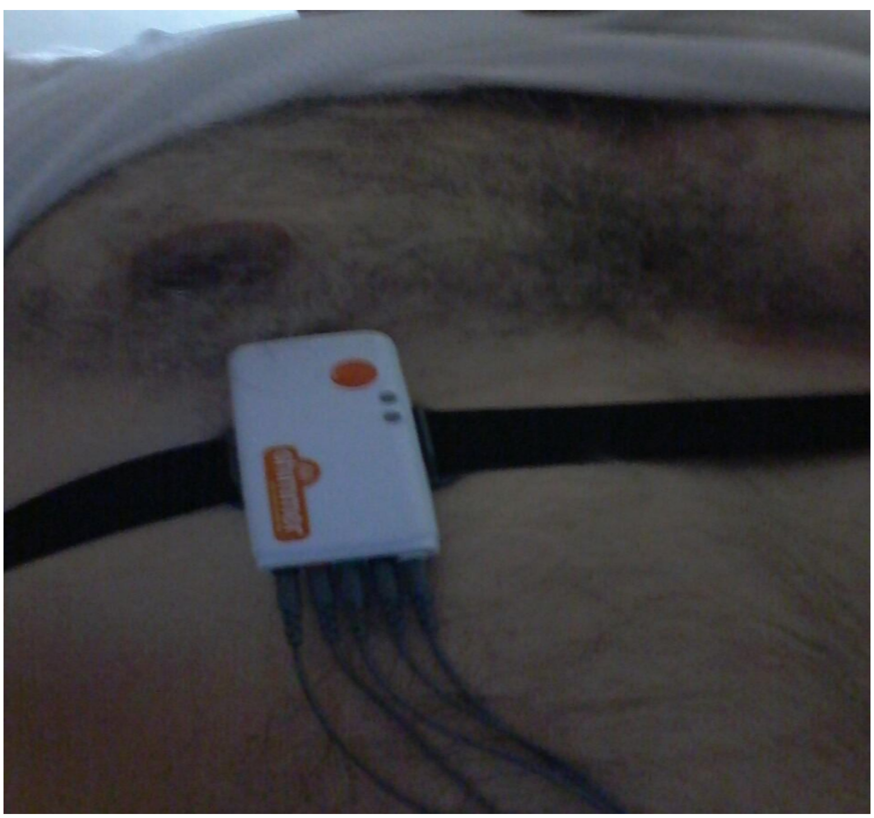

Figure 6.15: The connection type of the proposed system

The proposed system has the ability to scan the ECG and so many functions as an example of the result obtained by the proposed system for the ECG signal is shown in Figures 6.16 and 6.17, while the obtained results as an Excel sheet are attached in Appendix A.

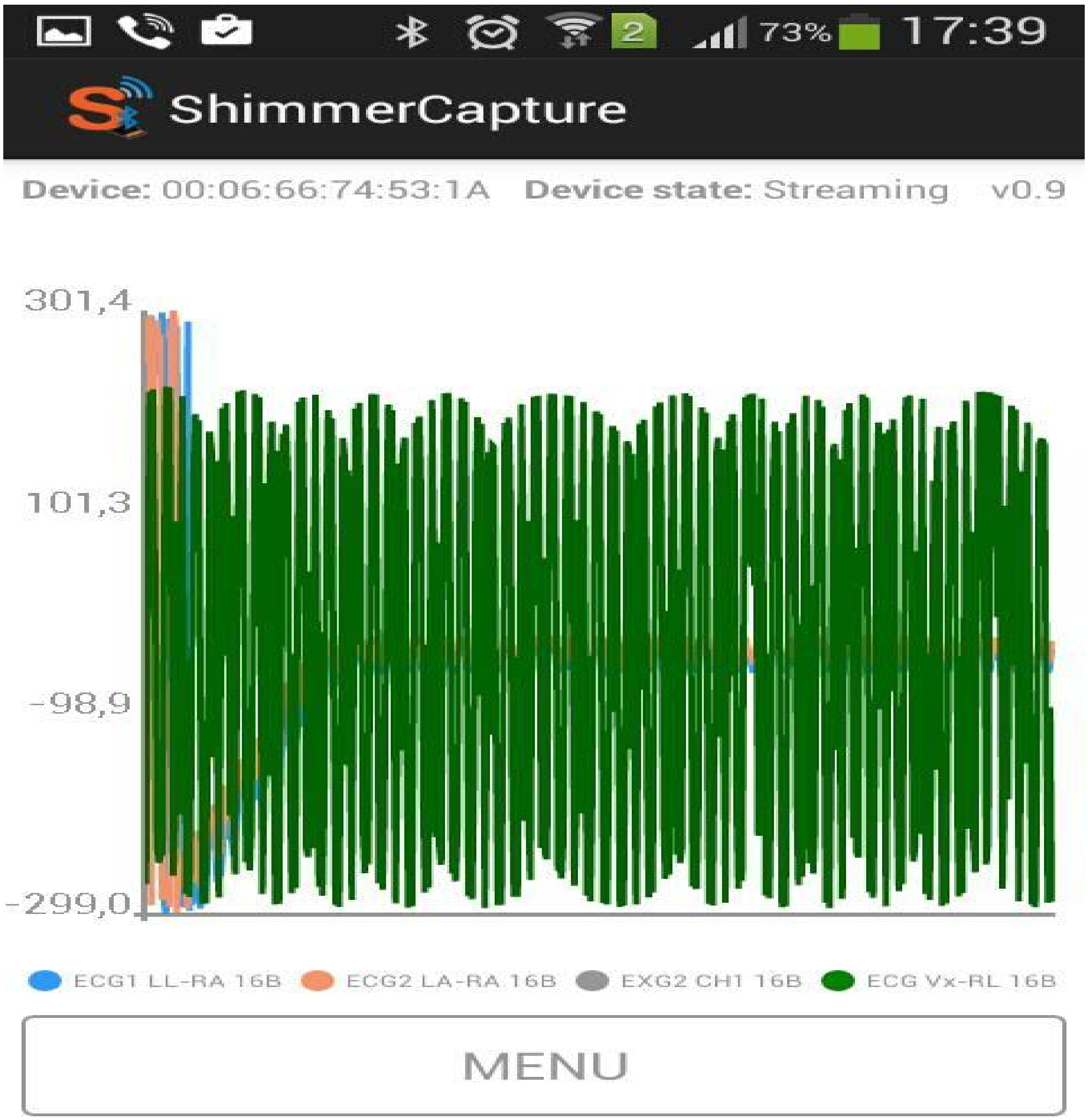

Figure 6.16: One example of the obtained result for the ECG scan

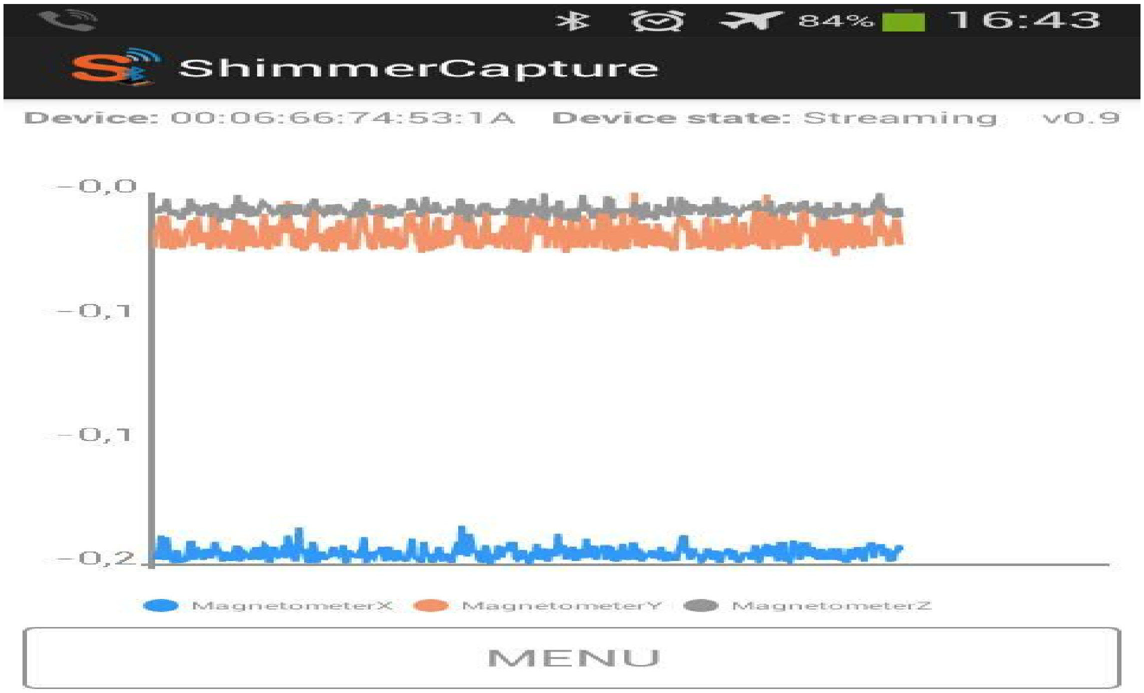

Figure 6.17: An Example of the obtained scan for the ECG

For the external ADC and the obtained results are shown in Figure 6.18.

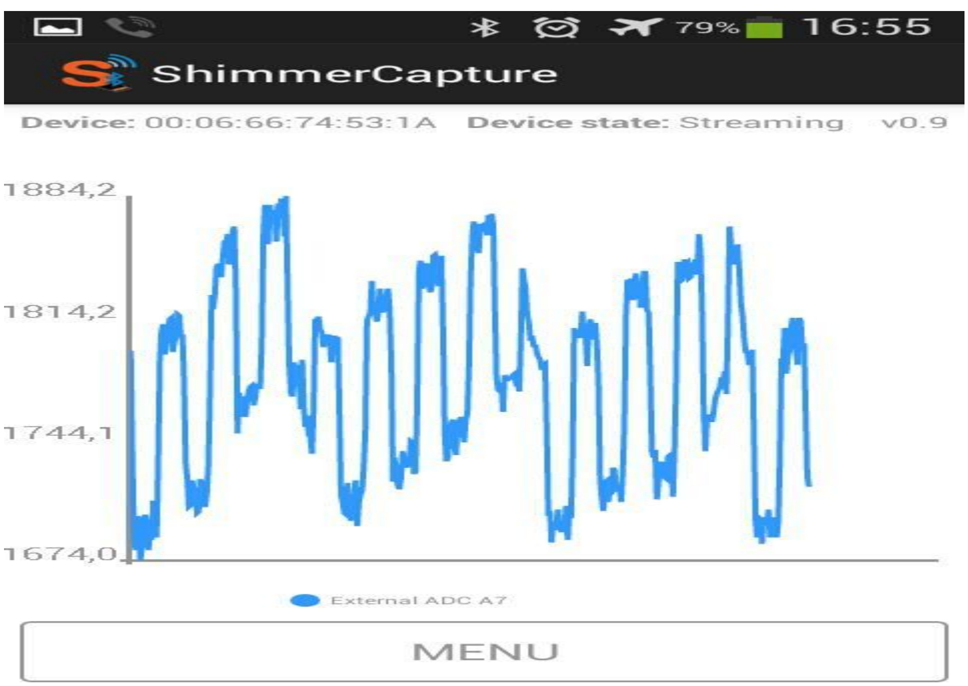

Figure 6.18: External ADC A7 obtained signal

ECG LL-RA, ECG LA-RA, EXG2 CH1 and ECG Vx-RL signals are obtained and shown in Figure 6.19.

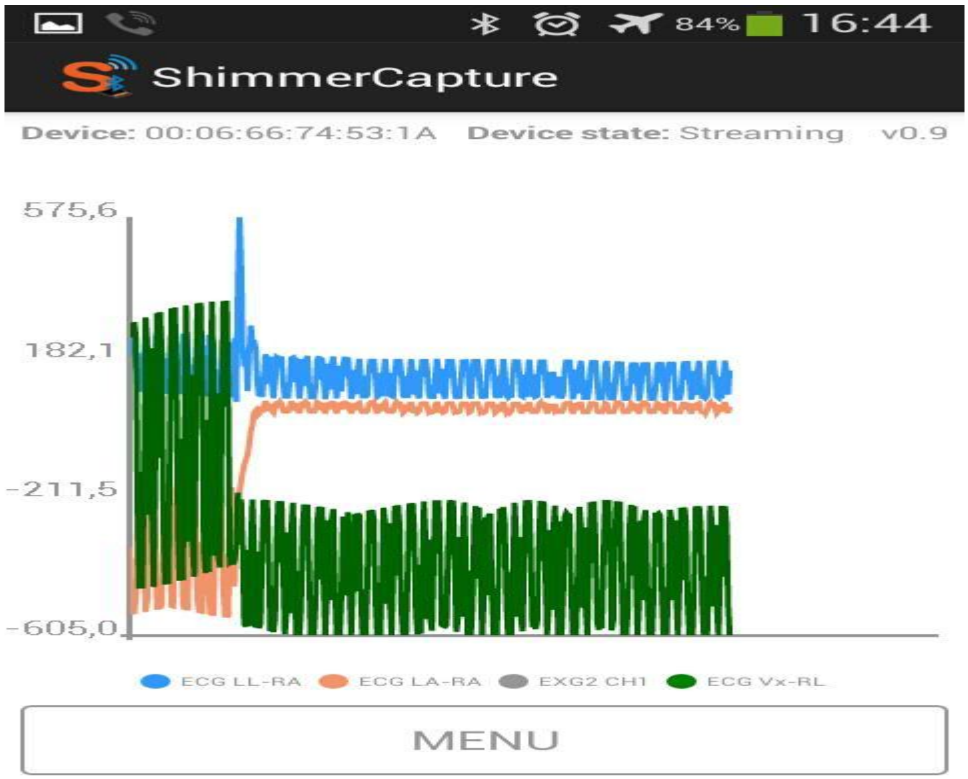

Figure 6.19: ECG LL-RA, ECG LA-RA,EXG2-CH1 and ECG Vx-RL signals

From the mentioned above simulation results of the proposed system, it is shown that the proposed system is flexible for all types of use, by Android, UNIX and Windows can be used easily. The requirements for easy use are:

- Sign in for the Shimmer scan, shimmer plot, and shimmer capture
- Assign an email in the hospital and this can be done by the doctors for each patient
- The patient has to hold the sensors and the proposed system for continuous tracking of the signal transmitted by heartbeat to be saved in the Android system.

CHAPTER 7

CONCLUSION and RECOMMENDATIONS

7.1 Conclusion

To develop a system suitable for elderly patients depending on the new technology developed by android system is not that easy, especially to be not available inside this new technology. The new technology is spreading so fast. In this thesis, a new technology is proposed and improved using the android system to combine both ready software as Shimmer Capture and Withings. The proposed improvement software takes the results obtained by the Shimmer Capture and the Withings software to transmit them to a server available at a hospital for the doctors to monitor continuous check-up. The improved software using Android Eclipse is written to give the patient the authentication as a first step of the operation, then to combine the results obtained by the Withings and Shimmer to send them as an email to the server at the hospital. The desired advantages of the proposed model – to help patients, especially elderly people, even in their houses to be under continuous control at hospitals – is discussed in detail, as are the experimental results obtained, proving that the proposed system is helpful for patients. Finally, the results showed that there is no need to stay in hospital for check-ups and continuous control.

7.2 Recommendations

The discoveries of this study were that continuous control of the health of elderly patients using an Android system can be more than simply a gathering of data for older people. It is additionally utilized as a spot where medical caretakers can question, illuminate data and improve their learning. Generally speaking, each one sort of old people in their homes had specific qualities and limits; in any case, no author was assessed as being more powerful or less cost. Attaining the different objectives of continuous control at home for the older people presents analysts and clinicians with a challenge. It is important to investigate more innovative methods to control the sensors adjusted on the bodies of the older people for automated control, so that a critical part of nursing practice does not get delegated. According to this study and the obtained results, the recommendations are the following:

1. Increase the range of the reception of Bluetooth by using WiFi for a widerarea;
2. Improve the written program to include more points for health control;
3. Improve the capacity of the improved software and its library;
4. Use the static IP address (dedicated IP address) in order to control the sensors from any place in the world.

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APPENDIX A:
MAIN ACTIVITY

```
package com.example.test;
import java.io.BufferedReader;
import java.io.ByteArrayOutputStream;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.util.ArrayList;
import org.apache.http.HttpEntity;
import org.apache.http.HttpResponse;
import org.apache.http.client.HttpClient;
import org.apache.http.client.entity.UrlEncodedFormEntity;
import org.apache.http.client.methods.HttpPost;
import org.apache.http.impl.client.DefaultHttpClient;
import org.apache.http.params.HttpConnectionParams;
import org.apache.http.params.HttpParams;
import org.json.JSONArray;
import org.json.JSONObject;
import android.app.Activity;
import android.app.ProgressDialog;
import android.content.Intent;
import android.os.AsyncTask;
import android.os.Bundle;
import android.speech.RecognizerIntent;
import android.util.Log;
import android.view.Menu;
import android.view.MenuItem;
import android.view.View;
```

```
importandroid.view.View.OnClickListener;
importandroid.widget.Button;
importandroid.widget.ImageButton;
importandroid.widget.TextView;
importandroid.widget.Toast;

publicclassMainActivityextends Activity {

	private String Link = "http://192.168.1.100:8080/ledservice.";
	private String lednum ="";
	privateImageButton l1 , l2 ,l3 ,l4 ,l5 ,l6 ,s;
	privateProgressDialogpd ;
	private String l1s="off" , l2s="off",l3s="off",l4s="off" ,l5s="off",l6s="off";
	protectedstaticfinalintREQUEST_OK = 1;
	InputStream is = null;


	@Override
	protectedvoidonCreate(Bundle savedInstanceState) {
		super.onCreate(savedInstanceState);
		setContentView(R.layout.activity_main);

		pd = newProgressDialog(MainActivity.this);

		l1 = (ImageButton) findViewById(R.id.button1);
		l2 = (ImageButton) findViewById(R.id.button2);
		l3= (ImageButton) findViewById(R.id.button3);
		l4= (ImageButton) findViewById(R.id.button4);
		l5= (ImageButton) findViewById(R.id.button5);
		l6= (ImageButton) findViewById(R.id.button6);
//		l1.setOnClickListener(this);
//		l2.setOnClickListener(this);
//		l3.setOnClickListener(this);
```

```
//			l4.setOnClickListener(this);
//			l5.setOnClickListener(this);
//			l6.setOnClickListener(this);
			s = (ImageButton) findViewById(R.id.button10);
//			s.setOnClickListener(this);
			s.setVisibility(View.INVISIBLE);
			 Intent i = new Intent(RecognizerIntent.ACTION_RECOGNIZE_PASS);
i.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, "en-US");
try {
startActivityForResult(i, REQUEST_OK);
	} catch (Exception e) {
	 Toast.makeText(this, "Error initializing pass to text engine.",
Toast.LENGTH_LONG).show();
	}
	  }


	privateclassviewAskextendsAsyncTask<Void, Void, Void> {

		protected Void doInBackground(Void[] paramArrayOfVoid) {

			try
			{
			DefaultHttpClienthttpClient = newDefaultHttpClient();
			HttpPosthttpPost = newHttpPost(Link+lednum);
			HttpParamshttpParameters = httpPost.getParams();
			inttimeoutConnection = 10000;
			HttpConnectionParams.setConnectionTimeout(httpParameters,
					timeoutConnection);
			inttimeoutSocket = 10000;
			HttpConnectionParams
					.setSoTimeout(httpParameters, timeoutSocket);
			HttpResponsehttpResponse = httpClient.execute(httpPost);
```

```
HttpEntityhttpEntity = httpResponse.getEntity();
                        is = httpEntity.getContent();
                                returnnull;
                        } catch (Exception localException) {
                                while (true)
                                        localException.printStackTrace();
                        }
                }

                protectedvoidonPostExecute(Void paramVoid) {
                        pd.dismiss();
                         Intent i = new In-
tent(RecognizerIntent.ACTION_RECOGNIZE_PASS);
        i.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, "en-US");
        try {
        startActivityForResult(i, REQUEST_OK);
              } catch (Exception e) {
              }

                        super.onPostExecute(paramVoid);
                }

                protectedvoidonPreExecute() {
                        super.onPreExecute();
                        pd.show();
                }
        }


        @Override
protectedvoidonActivityResult(intrequestCode, intresultCode, Intent data) {
super.onActivityResult(requestCode, resultCode, data);
```

```
if (requestCode==REQUEST_OK&&resultCode==RESULT_OK) {
        ArrayList<String>thingsYouSaid = data.getStringArrayListExtra(RecognizerIntent.EXTRA_RESULTS);
//      ((TextView)findViewById(R.id.text1));
        Log.e("YOU SAID", thingsYouSaid.get(0));
        if (things.get(0).equals("1"))
        {
                ll1();


        }
        elseif (things.get(0).equals("2"))
        {
                ll2();
        }
        elseif (things.get(0).equals("3"))
        {
                ll2();
        }
        elseif (things.get(0).equals("4"))
        {
                ll1();
        }
                {
                }
        else
        {
                Intent i = new Intent(RecognizerIntent.ACTION_RECOGNIZE_PASS);
        i.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, "en-US");
        try {
        startActivityForResult(i, REQUEST_OK);
              } catch (Exception e) {
```

```
Toast.makeText(this, "Error initializing pass engine.", Toast.LENGTH_LONG).show();
                }
            }
        }
    }

        publicvoid ll1 ()
        {
                viewAsk as = newviewAsk();
                lednum="";
                lednum="?LED2=2";
                if (l1s.equals("off"))
                {

        l1.setImageDrawable(getResources().getDrawable(R.drawable.on));
                        l1s="on";
                }
                else
                {

        l1.setImageDrawable(getResources().getDrawable(R.drawable.off));
                        l1s="off";
                }
                as.execute();
        }
        publicvoid ll2 ()
        {
                viewAsk as = newviewAsk();
                lednum="";
                lednum="?LED3=3";
                if (l2s.equals("off"))
                {
```

```
l2.setImageDrawable(getResources().getDrawable(R.drawable.on));
                  l2s="on";
         }
         else
         {

l2.setImageDrawable(getResources().getDrawable(R.drawable.off));
                  l2s="off";
         }
         as.execute();
}
publicvoid ll3 ()
{
         viewAsk as = newviewAsk();
         lednum="";
         lednum="?LED4=4";
         if (l3s.equals("off"))
         {

l3.setImageDrawable(getResources().getDrawable(R.drawable.on));
                  l3s="on";
         }
         else
         {

l3.setImageDrawable(getResources().getDrawable(R.drawable.off));
                  l3s="off";
         }
         as.execute();
}
publicvoid ll4 ()
{
```

```
viewAsk as = newviewAsk();
            lednum="";
            lednum="?LED5=5";
            if (l4s.equals("off"))
            {

        l4.setImageDrawable(getResources().getDrawable(R.drawable.on));
                  l4s="on";
            }
            else
            {

        l4.setImageDrawable(getResources().getDrawable(R.drawable.off));
                  l4s="off";
            }
            as.execute();
        }
        publicvoid ll5 ()
        {
            viewAsk as = newviewAsk();
            lednum="";
            lednum="?LED6=6";
            if (l5s.equals("off"))
            {

        l5.setImageDrawable(getResources().getDrawable(R.drawable.on));
                  l5s="on";
            }
            else
            {

        l5.setImageDrawable(getResources().getDrawable(R.drawable.off));
```

```
l5s="off";
                }
                as.execute();
        }
        publicvoid ll6 ()
        {
                viewAsk as = newviewAsk();
                lednum="";
                lednum="?LED7=7";
                if (l6s.equals("off"))
                {

        l6.setImageDrawable(getResources().getDrawable(R.drawable.on));
                        l6s="on";
                }
                else
                {

        l6.setImageDrawable(getResources().getDrawable(R.drawable.off));
                        l6s="off";
                }
                as.execute();
        }




//      @Override
//      public void onClick(View v) {
//              if (v == l1)
//              {
//                      viewAsk as = new viewAsk();
//                      lednum="";
```

```
//                  lednum="?LED2=2";
//                  if (l1s.equals("off"))
//                  {
//
        l1.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                          l1s="on";
//                  }
//                  else
//                  {
//
        l1.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                          l1s="off";
//                  }
//                  as.execute();
//          }
//          else if (v == l2)
//          {
//                  viewAsk as = new viewAsk();
//                  lednum="";
//                  lednum="?LED3=3";
//                  if (l2s.equals("off"))
//                  {
//
        l2.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                          l2s="on";
//                  }
//                  else
//                  {
//
        l2.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                          l2s="off";
//                  }
```

```
//                          as.execute();
//                  }
//                  else if (v == l3)
//                  {
//                          viewAsk as = new viewAsk();
//                          lednum="";
//                          lednum="?LED4=4";
//                          if (l3s.equals("off"))
//                          {
//
        l3.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                                  l3s="on";
//                          }
//                          else
//                          {
//
        l3.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                                  l3s="off";
//                          }
//                          as.execute();
//                  }
//                  else if (v == l4)
//                  {
//                          viewAsk as = new viewAsk();
//                          lednum="";
//                          lednum="?LED5=5";
//                          if (l4s.equals("off"))
//                          {
//
        l4.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                                  l4s="on";
//                          }
```

```
//                  else
//                  {
//
        l4.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                          l4s="off";
//                  }
//                  as.execute();
//          }
//          else if (v == l5)
//          {
//                  viewAsk as = new viewAsk();
//                  lednum="";
//                  lednum="?LED6=6";
//                  if (l5s.equals("off"))
//                  {
//
        l5.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                          l5s="on";
//                  }
//                  else
//                  {
//
        l5.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                          l5s="off";
//                  }
//                  as.execute();
//          }
//          else if (v == l6)
//          {
//                  viewAsk as = new viewAsk();
//                  lednum="";
//                  lednum="?LED7=7";
```

```
//                              if (l6s.equals("off"))
//                              {
//
          l6.setImageDrawable(getResources().getDrawable(R.drawable.on));
//                                        l6s="on";
//                              }
//                              else
//                              {
//
          l6.setImageDrawable(getResources().getDrawable(R.drawable.off));
//                                        l6s="off";
//                              }
//                              as.execute();
//                    }
//                     if (v == s)
//                    {
//                               Intent             i             =             new             In-
tent(RecognizerIntent.ACTION_RECOGNIZE_PASS);
//        i.putExtra(RecognizerIntent.EXTRA_LANGUAGE_MODEL, "en-US");
//                try {
//        startActivityForResult(i, REQUEST_OK);
//          } catch (Exception e) {
//                  Toast.makeText(this,    "Error    initializing    pass    to    text    engine.",
Toast.LENGTH_LONG).show();
//                }
//                  }
//
//        }

}
```

APPENDIX B:
COMPARISON TABLE FOR ORIGINALITY

No.	Author	Title	Proposed	No. of Sensors	Software	Hardware
1.	Arya et al. (2014)	A Review Wireless Body Area Networks for Health Care	Present various innovations and discuss promising new trends of wireless body area networks for ubiquitous health monitoring applications	2	---------	---------
2.	Asare,(2014)	Body Area Network Standardization, Analysis and Application	Analysis of frame processing of Media Access Control specified by IEEE 802.15.6 and the physical layer is discussed. Finally, the current and future applications of BAN are summarized, providing a comprehensive review of BAN.	4	TinyOS	-----------
3.	Chandra, (2014)	Antennas, Wave Propagation, and Localization in	Presented research work done for antennas and communica-	11	3D-CAD	-----------

		Wireless Body Area Networks	tion channels for various applications in the wireless body area network. Phantoms have been used for the investigation. The investigated applications are binaural hearing aids, sensors placed around the body, wireless capsule endoscopy, and in-mouth devices.			
4.	Devi et al. (2014)	Wireless Body Area Sensor System for Monitoring Physical Activities Using GUI	Concluded that Life-saving applications and thorough studies and tests should be conducted before WBANs can be widely applied to humans, particularly to address the challenges related to robust techniques for detection and Classification to increase the accuracy and hence the confidence of applying such techniques without physician intervention	4	GUI MATLAB	ZigBee, GBRS
5.	Rafatkhah et		Proposed	10	MATLAB	----------

	al. (2014)	A Novel Multi-hop Routing Protocol for Wireless Body Sensor Networks	routing protocol uses fixed deployment of wireless sensors (nodes) in home and mobility support for sensor nodes on human body. The sensor nodes on human body select the best routing by receiving Home-Signal to minimize energy consumption. Also direct link is used for emergency and real-time data while Multi-hop link is used for normal data transfer. M is thermal-aware which ability Recognition the link Hot-spot and Replacement the links.			
6.	Rahman et al.(2014)	Developing Forensic Readiness Secure Network Architecture for Wireless Body Area Network (WBAN)	Proposed a practical approach to assessing WBAN security impact is designed in order to identify, evaluate, and	4	Internet website	-----------

			develop a Secure Network Architecture complete with the Forensic Readiness capability to secure WBAN implementation.			
7.	Salem et al. (2014)	Online Anomaly Detection in Wireless Body Area Networks for Reliable Healthcare Monitoring	Proposed a model is to reduce false alarms resulting from unreliable measurements and to reduce unnecessary healthcare intervention.	5	Haar Wavelet Transform MATLAB	------------
8.	Proposed Model	USING WIRELESS BODY AREA NET-NETWORKS FOR PATIENT MONITORING WITH THE HELP OF A MOBILE DEVICE	a solid, power effective and high throughput directing convention for Wireless Body Area Networks (WBANs) composed of 2 sensors are proposed and connected wirelessly with a personal mobile system to transmit the signal from the patient to the hospital's server in the purpose of transmitting in a wide geographical	2	Android Operating System, Java program gramming	1. ZigBee, 2. GPRS, 3. 2 WBANs 4. HPZB01 HopeRF use Ember ZigBee chip developed a low-cost, high-performance, based on the IEEE 802.15.4-2003 standard ZigBee network protocol 2.4GHZ ISM band transceiver module.HPZB 01 Maximum

			area and stability for continuous monitoring with the use of the GPRS system.			transmitting power up to +8dBm. 5. HP02S pressure sensor module. 6. HP03 Series (HP03M High Precision pressure sensor module). 7. RFM83 ASK receiver module