Development of Mobile Approach Based Cost-Effective Remote Patient Health Monitoring System using IoT

[1]R Chandrasekhar Reddy, [2]Santhosh.B.Panjagal, [3]Dr.G.N.Kodanda Ramaiah,

[1]P.G Scholar, [2]Associate Professor, [3]Professor & HOD
[1]Department of Electronics & Communication Engineering,
[1]Kuppam Engineering College, Kuppam, Chittoor (Dist), A.P, INDIA

Abstract: Now a day's remote health monitoring of patient is receiving wide spread importance with ease in connecting sensors with internet of things (IoT). Remote patient health monitoring concept is a boon for the middle class patients who cannot able afford for medical expenses with long term observation in the hospital care units. This paper presents remote health monitoring system using IoT, to reduce the manual check-up and manual entry of patient health conditions into the database for doctors observation.

In this proposed system the health data like Blood pressure (BP), Heart Rate, Body temperature and fall detection status are measured, analyzed displayed on LCD and also uploaded to IoT using Wi-Fi technology. The user-friendly Smartphone application is developed to monitor the patient data remotely by doctors, care takers, nurses and even family members. If any of the health parameters like BP and Heart Rate goes abnormal, the system and mobile application will notify both care takers and doctors through buzzer and voice announcements, so that the doctors can suggest for further medical assistance. Hence the remote health monitoring system will revolutionize the health care systems.

Keywords: e-Health Monitoring, Cloud IoT, e-Health Sensor (BP, Heart Rate), Smartphone application, ESP8266

I. INTRODUCTION

As the population growth increases, the demand for affordable health care services needs to be implemented, coz traditional diagnosis services have become insufficient. With the rapid increasing of the elderly population coupled with a longer life span, e-health is targeted to provide low cost and everyday household usage. So, researchers design a system as portable device. Researcher designed different health monitoring system based on requirement [1]. Different platform like microcontrollers are used to design the system based on this performance. Different biomedical sensors like blood pressure, pulse rate, temperature sensor and fall detection sensors are used for monitoring the health condition which is integrated on single system on-chip [3].

It is very important to monitor various medical parameters and post operational days. Therefore the latest development in Healthcare communication method using IoT is adapted. Internet of things serves as a catalyst for the healthcare and plays prominent role in wide range of healthcare applications [2]. Today Internet has become one of the important parts of our daily life. It has changed how people live, work, play and learn. Internet serves for many purposes like Education, Finance, Business, Industries, Entertainment, Social Networking, Shopping, E-Commerce etc. The next new mega trend of Internet is IoT. Visualizing a world where several objects can sense, communicate and share information over a Private Internet Protocol (IP) or Public Networks. The interconnected objects collect the data at regular intervals, analyze and used to initiate required action, providing an intelligent network for analyzing, planning and decision making [5].

A Remote health monitoring system is an extension of a hospital medical system where a patient's vital body state can be monitored remotely. Traditionally the detection systems were only found in hospitals and were characterized by huge and complex circuitry which required high power consumption. Continuous advances in the semiconductor technology industry have led to sensors and microcontrollers that are smaller in size, faster in operation, low in power consumption and affordable in cost [4].

In recent times, several systems have come up to address the issue of remote health monitoring. The systems have a wireless detection system that sends the sensor information wirelessly to a remote server. Some even adopted a service model that requires one to pay a subscription fee. In developing countries, this is a hindrance as some people cannot use them due to cost issue involved. There is also the issue of internet connectivity where some systems to operate, good quality internet for a real-time remote connection is required. Internet penetration is still a problem in developing countries.

Remote healthcare has become a vital service with the growing rate of senior citizens. Health monitoring, rehabilitation, and assisted living for the elderly and medically challenged humans is an emerging challenge because they require seamless networking between people, medical instruments, and medical and social service providers. This motivates the need for affordable, low-power, reliable, and wearable devices that will improve the quality of life for many elderly and physically challenged peoples [8][12].

In this paper we present a multi-parameter monitoring system an approach to a remote health monitoring system was designed that extends healthcare from the traditional clinic or hospital setting to the patient's home. The system collects a BP, heartbeat, fall detection, & temperature data parameters are being displayed on system LCD and then uploaded to IoT, using API keys the information will be fetched from IoT servers then displayed on smartphone application for remote monitoring by Doctors, care takers and even family members.

II. SYSTEM OVERVIEW

This chapter deals with the Hardware components and software used in this project. The hardware components are as listed below. The block diagram that is being implemented in this project is as shown below-

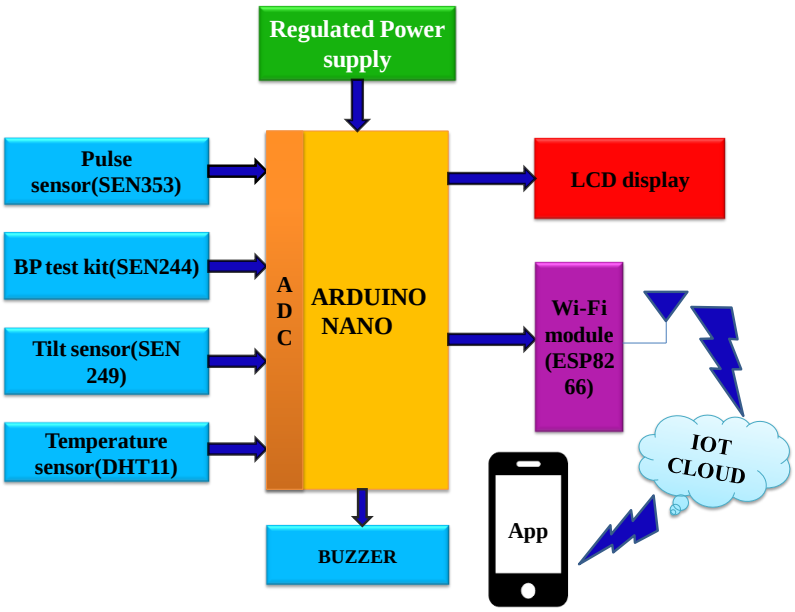

Figure 1.1: Proposed system block diagram

To design the complete working system for remote patient's health monitoring, it needs to select, study, analysis, design and testing of different sub-modules with particular sensor for measuring of biological parameters like blood pressure, pulse rate, body temperature and fall detection status of every patient. The heart of the health monitoring system is Arduino Nano powered by ATMEGA328P, which is having enough of on-chip peripherals, MIPS execution, high speed clock and sufficient internal data and program memory. It measures all the data from all the sensors connected to it and performs extensive operations to produce feasible results, finally the processed data will be displayed on LCD module for real-time monitoring and also uploaded to Internet of Things platform via the Wi-Fi gateways using ESP8266.

The pulse rate sensor is used to measure the heart rate of the patients in beats per minute. It consists of optical transmitter and receiver, when placed between finger veins or any part having heart beats, it measures heart beats regularly, in controller first beat and second beat peaks are measured to calculate pulse rate in beats per minute. Similarly Blood pressure sensor measures two numbers, First number called systolic BP, measures the pressure in blood vessels when heart beats, second number called Diastolic BP, measures pressure in blood vessels when heart rests between beats. BP is measured in mmHg (millimeter of mercury). Tilt sensors works on the principal of angular movement, it consists of rolling ball with a conduct a conductive plate beneath them. When the sensor is tilted, rolling ball displaces making open circuit. Finally temperature sensor measures the body temperature of the patient.

III. SOFTWARE SYSTEM DESIGN

i. Patient Monitoring System Flowchart:

To make the entire hardware system to work according to the design, it is necessary to develop the software code or application to coordinate and control all the peripherals connected to the system. The software program instructs the hardware to perform the tasks sequentially to meet the desired objective. Once the system is powered up the controller/processor initializes all the required I/O ports like serial ports, parallel ports, LCD and Wi-Fi module. After initialization, Biological parameters like blood pressure, heart rate, body temperature and fall detection status are measured, processed to take set actions like display, alerting and uploading to IoT for remote monitoring and medical assistance, if the measured values are below or above normal readings. If any of the BP, Heart Rate or Body temperature and fall status crosses below or above the standard limits, immediately buzzer rings and emergency message is displayed on LCD, also the information is uploaded to IoT. If the number of measurement count counts exceeds 5 no's then the patient data is uploaded to IoT using Wi-Fi network gateway.

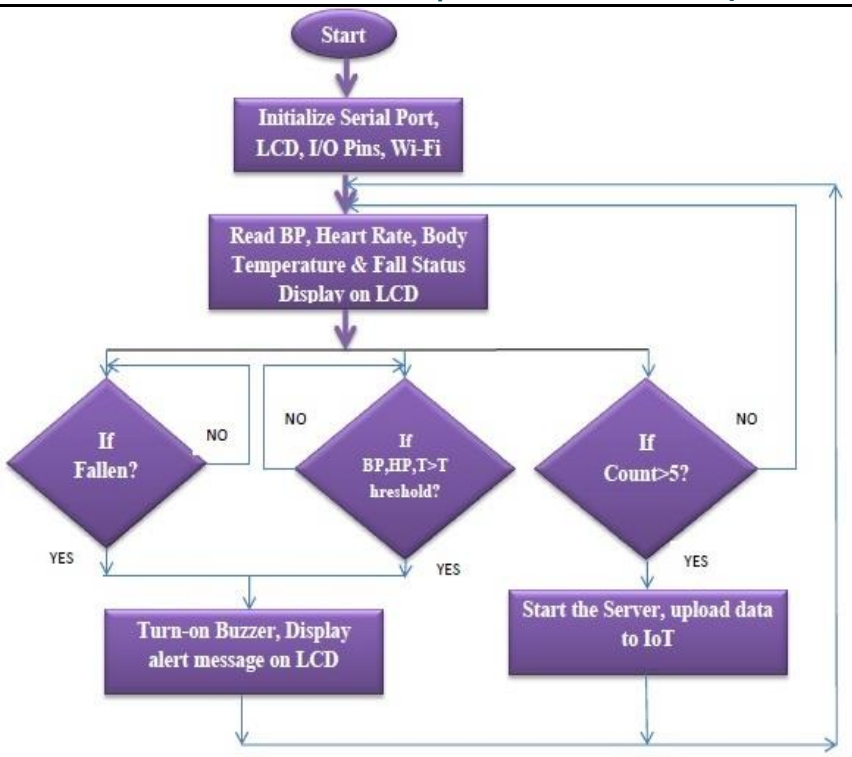

Figure 3.1: Software flowchart for patient monitoring system

.

ii. Smartphone application flowchart

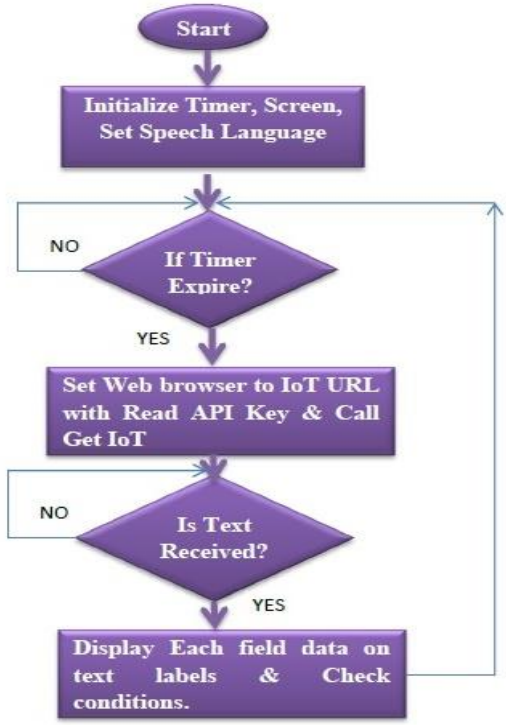

Figure 3.2: Software flowchart for Smartphone application

Android application is developed for Smartphone users to allow the remote patients health monitoring. The patient's biological data uploaded IoT from the remote devices can be read from IoT servers using READ API Key. Once the application is opened, it first initializes the screen, timer clocks, global variables and sets the available country language for text to speech conversion. If the timer clock expires, then the Read_IoT browser is set to thingspeak web URL along with READ API key and number of fields to read from and then get request is sent to the IoT server. Once the server processes the client request, it returns back the all the field data of a particular channel to the client application in JSON format. Once the Text data is received, it is checked for validity of the data, then the JSON text is decoded to extract all the field information, then displayed on the Text labels, and even conditioned to see any abnormality in the patient's health conditions.

So to design the real-time working program and application for remote patient health monitoring system we need following software tools: MIT App Inventor 2, Arduino IDE and Thingspeak IoT Platform.

IV. RESULTS & DISCUSSION

The Complete working prototype module of remote patient health monitoring system has been developed and tested for its functionality and performance, by incorporating Blood pressure sensor, Heart rate sensor, Tilt Sensor and Temperature sensor and uploaded to IoT. Here all the individual modules are studied, analyzed and tested before assembling the entire system. The working module is as shown in figure 4.1.

Figure 4.1: Hardware module of proposed system

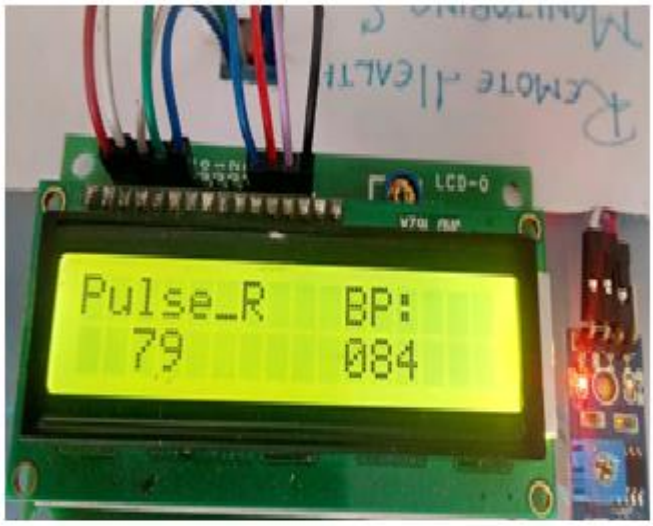

Figure 4.2: Pulse rate & Blood pressure display

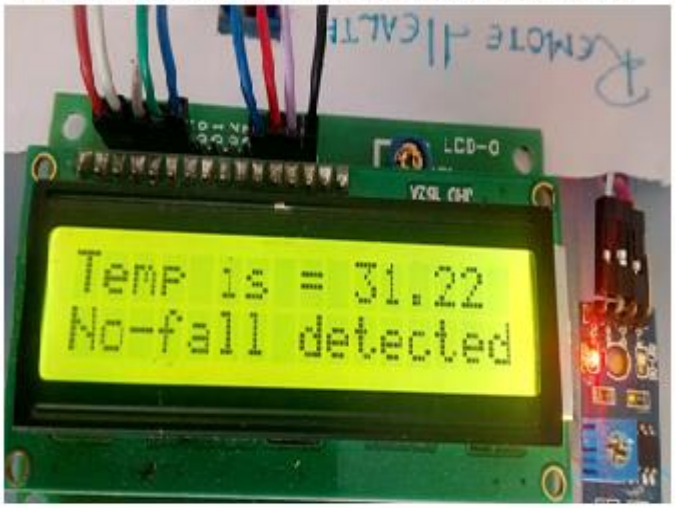

Figure 4.3: Status of fall detection & temperature

Figure 4.4: Status of fall detection & temperature

Once the patient monitoring system powered on, initializes serial ports, LCD and Digital I/O ports. Then pulse rate and blood pressure is measured and processed to check for abnormalities and finally displayed on LCD, as shown in figure 4.2. Similarly, the processor measures and processes the body temperature and fall detection status, if tilt is not detected then it displays “No-Fall Detected” on the LCD, as shown in figure 4.3. If tilt is detected then it displays “Fall Detected” on the LCD, as shown in figure 4.4.

Finally, after 5 counts measurement of BP, Pulse rate, body temperature & fall status, the controller uploads the patients data to Thingspeak IoT using ESP8266 Wi-Fi Gateway. After uploading to thingspeak IoT, the patients information is displayed on different fields as a graphical plots, as shown in figures 4.5, 4.6, 4.7 & 4.8.

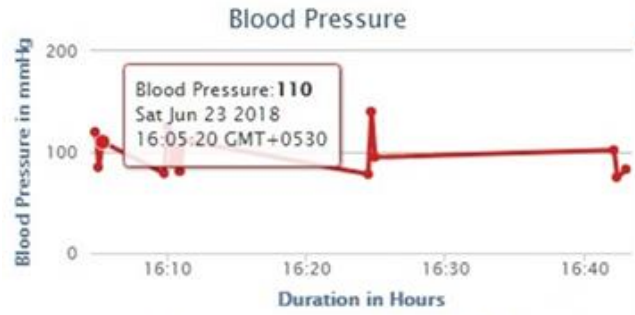

Figure 4.5: Blood pressure field graph in IoT

Figure 4.6: Heart rate field graph in IoT

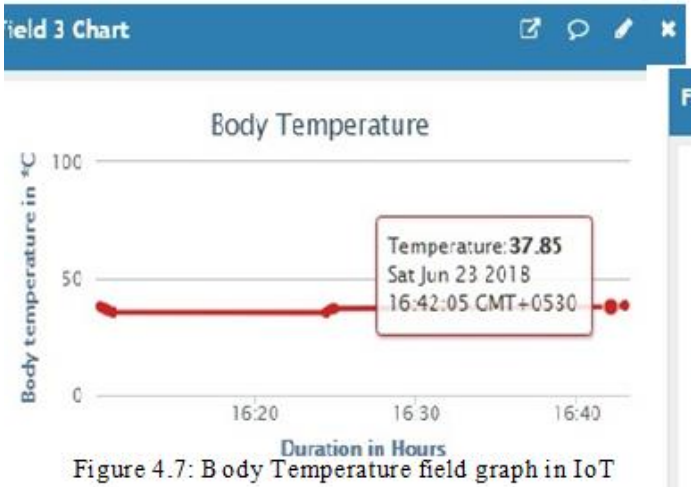

Figure 4.7: Body Temperature field graph in IoT

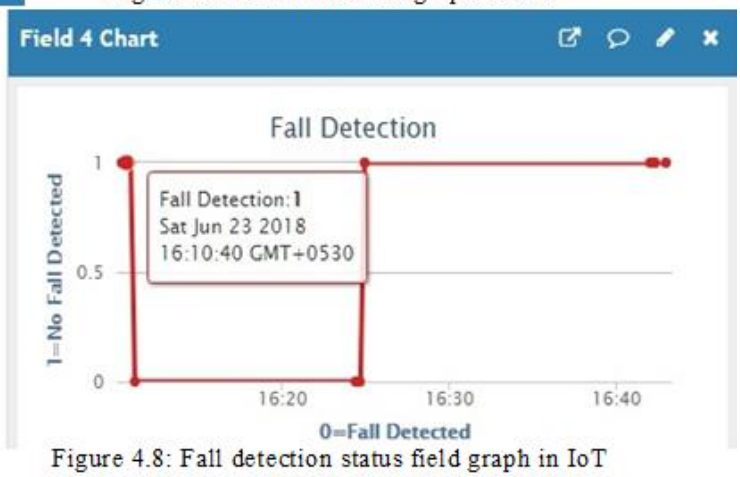

Figure 4.8: Fall detection status field graph in IoT

In figure 6.8, if logic 1 is received, it means no fall is detected, and if logic 0 is received, then it means fall is detected.

The user-friendly smartphone application is developed to ease the process of monitoring and quick delivery of quick tips to the remote patients. The android application reads the data from IoT servers using URL with API keys. Once the data is read from IoT, it decodes and analyzes to check the conditions and notify the abnormalities. Even uses Voice notifications to alert the doctors or care takers, as shown in figure 4.9.

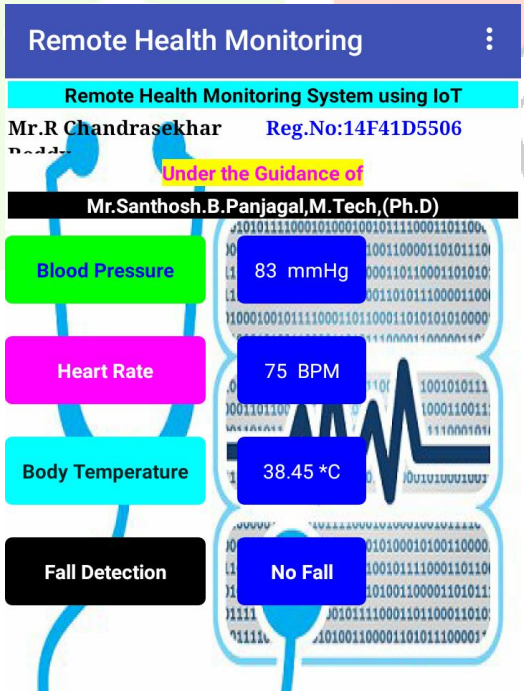

Figure 6.9: User-friendly smartphone application for remote monitoring

V. ACKNOWLEDGMENT

I would like acknowledge my guide Mr.Santhosh.B.Panjagal, Associate Professor and Dr.G.N.Kodanda Ramaiah, HOD ECE, for supporting and providing assistance to carry out my PG project work under college R&D and NewGen IEDC, Kuppam Engineering College, Kuppam. Sincere thanks to college management and departmental coordinators for the moral and ethical support.

VI. CONCLUSION AND FUTURE SCOPE

With the successful completion of the proposed work, this paper achieved the main objective of designing reliable, low cost and low power remote patient monitoring system to assist the elderly peoples and patients we often needs to present at medical observation for longer periods. The designed system has shown satisfactory results to measure, analyze and making decision on processed health parameters like, blood pressure, heart rate, body temperature and fall detection status by relaying the data onto the IoT clouds for real-time analytics and storage. The user-friendly smartphone application proves to be the companion for both patients, doctors, care takers and family members for remote monitoring and alerting. So with the mobile application monitoring doctors can provide quick first aid treatment tips or emergency medical assistance.

In future the project idea can be enhanced by linking ambulance services, nearest medical specialists to the database, based on geographical locations.

REFERENCES

[1]. JORGE GÓMEZ, BYRON OVIEDO , EMILIO ZHUMA, "PATIENT MONITORING SYSTEM BASED ON INTERNET OF THINGS" THE 7TH INTERNATIONAL CONFERENCE ON AMBIENT SYSTEMS, NETWORKS AND TECHNOLOGIES (ANT 2016) ELSEVEIR, PP. 90 – 97, 2016.

[2]. E-HEALTH SENSOR MODULE, [ONLINE] AVAILABLE: HTTPS://WWW.COOKING-HACKS.COM/DOCUMENTATION/TUTORIALS/EHEALTH-BIOMETRIC-SENSOR-PLATFORM-ARDUINO-RASPBERRY-PI-MEDICAL.

[3]. S. GRADL, P. KUGLER, C. LOHMULLER, B. ESKOFIER, "REALTIME ECG MONITORING AND ARRHYTHMIA DETECTION USING ANDROID-BASED MOBILE DEVICES", ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY (EMBC) 2012 ANNUAL INTERNATIONAL CONFERENCE OF THE IEEE, PP. 2452-2455, 2012, AUGUST.

[4]. H. XIA, I. ASIF, X. ZHAO, "CLOUD-ECG FOR REAL TIME ECG MONITORING AND ANALYSIS", COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE, VOL. 110, NO. 3, PP. 253-259, 2013.

[5]. D. THILAKANATHAN, S. CHEN, S. NEPAL, R. CALVO, L. ALEM, "A PLATFORM FOR SECURE MONITORING AND SHARING OF GENERIC HEALTH DATA IN THE CLOUD", FUTURE GENERATION COMPUTER SYSTEMS, VOL. 35, PP. 102-113, 2014.

[6]. M. S. JASSAS, A. A. QASEM, Q. H. MAHMOUD, "A SMART SYSTEM CONNECTING E-HEALTH SENSORS AND THE CLOUD", ELECTRICAL AND COMPUTER ENGINEERING (CCECE) 2015 IEEE 28TH CANADIAN CONFERENCE ON, PP. 712-716, 2015, MAY.

[7]. M. SHAMIM HOSSAIN, "AND GHULAM MUHAMMAD (2016) CLOUD-ASSISTED INDUSTRIAL INTERNET OF THINGS (IOT)-ENABLED FRAMEWORK FOR HEALTH MONITORING", COMPUTER NETWORKS.

[8]. INTERNET OF THINGS: MODEM PARADIGM OF HEALTH CARE, BY GENNADY SMORODIN; OLGA KOLESNICHENKO; YURIY KOLESNICHENKO; LYDIA MYAKINKOVA; NADEZHDA PRISYAZHNAYA; DARIYA YAKOVLEVA; LEV MAZELIS; ALEXANDER MARTYNOV; VALERIY PULIT; DARIYA DANILOVA; NIKOLAY LITVAK; SERGEY BALANDIN.

[9]. MEYSTRE, S. THE CURRENT STATE OF TELEMONITORING: A COMMENT ON THE LITERATURE. TELEMEDICINE AND E-HEALTH, 2005.

[10]. CONSULTATION, W. G. HEALTH TELEMATICS POLICY IN SUPPORT OF THE RENEWED HEALTH-FOR ALL STRATEGY IN THE 21ST CENTURY. GENEVSA. 1997.

[11]. SHIMUZU, K. TELEMEDICINE BY MOBILE COMMUNICATION. IEEE ENGINEERING IN MEDICINE AND BIOLOGY, 1999.

[12]. TANRIVERDI, H. AND IACONO, C. S. DIFFUSION OF TELEMEDICINE: A KNOWLEDGE BARRIER PERSPECTIVE. TELEMEDICINE JOURNAL, 1999.

[13]. JASEMIAN, . N. L., Y. DESIGN AND IMPLEMENTATION OF A TELEMEDICINE SYSTEM USING BLUETOOTH PROTOCOL AND GSM/GPRS NETWORK, FOR REAL-TIME REMOTEPATIENT MONITORING. TECHNOLOGY AND HEALTHCARE 13, 2005.

[14]. R. S. KHANDPUR - HAND BOOK OF BIOMEDICAL INSTRUMENTATION

[15]. R. LAKSHMI REKHAAND C. RAVIKUMAR , BIO MEDICAL INSTRUMENTATION/MEDICAL ELECTRONICS (JAN 2008)