Real Time Tele Health Monitoring System

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Abstract— Now a day's providing healthcare to people anywhere in the world is not economical and patient should visit the doctor to take up the treatment, which is a difficult task in many situations. So the developed model will integrate the patients' medical records with their daily measurements of physiological parameters (including the last checkup records) by making use of ARM processor and RS 232 etc. This can be used as a diagnosis reference for physicians, reducing the time required to modify prescriptions and enabling the nursing staff to fully understand the patients' physiological conditions. By using video conferencing, healthcare practitioners and patients can reduce the costs associated with regular office visits. To provide remote patient monitoring in which electronic devices will transmit patient health information to doctor's computer and android mobile, enabling them to monitor the patient's condition without being physically present near to the patient's bed.

Keywords- *ARM processor, RS-232.*

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I. INTRODUCTION

Tele-health monitoring system involves the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies. Digital technologies are used for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of health care providers. These measures are adopted in the interests of advancing the health of individuals and their communities.

Tele health is emerging as a critical component of the healthcare crisis solution. Tele health holds the promise to significantly impact some of the most challenging problems of our current healthcare system: access to care, cost effective delivery, and distribution of limited providers. Tele health can change the current paradigm of care and allow for improved access and improved health outcomes in cost effective ways.
Tele-health encompasses a broad definition of technology-enabled health care services. Tele health services consist of diagnosis, treatment, assessment, monitoring, communications, and education. It includes a broad range of telecommunications, health information, videoconferencing, and digital image technologies.

In our tool, Tele-health is the use of electronic information and telecommunication technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration. Figure 1 shows the working of Tele-health monitoring system.

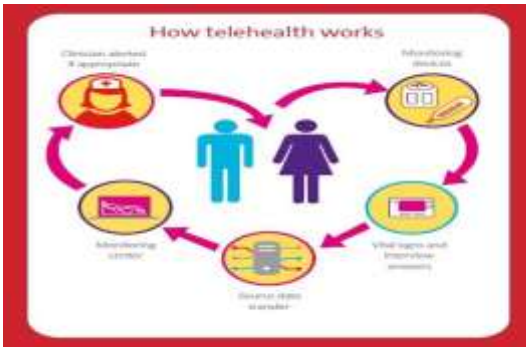

Figure 1: Working of Tele-health Monitoring System

A. Need for real time tele-health monitoring system

Communities are struggling to care for an increasing number of underserved, disadvantaged, and at-risk populations. In most communities, especially in rural areas, care is not organized to promote prevention and early intervention, coordinate services, or monitor access to and quality of care. Moreover, public and private funding to subsidize care remains inadequate, despite growing community needs associated with increases in the uninsured and aging populations. Consequently, many people are left to seek care in emergency rooms, often as a last resort, in an unmanaged and episodic manner. The costs of such care are borne by care-giving institutions, local governments, and, ultimately, taxpayers, many of whom are already burdened with the costs of meeting health-related costs of their own. 70 % of India's population lives in rural areas due to which they are unable to access medical facilities. Advancement of modern technology in the field of medicine has helped to increase the life span of the urban population. It is appalling that people in rural areas cannot enjoy the benefit of these advanced medical procedures. 90% of secondary and tertiary health care units are situated in towns and cities. This requires the villagers to travel to the cities to avail these facilities which are not possible most of the times because of the expenses which are incurred due to commutation. This leads to low penetration of health care services in rural areas. Thus, rural people suffer due to diseases because there is lack of availability of these services in rural areas. Also, there is lack of investment in health care in rural areas as it is deemed uneconomical because of the low income of villagers.

B. Problem statement

The growth of the elderly population and lack of efficient monitoring of health problems for people residing in the rural areas have altered the population structure and have necessitated the need of a health monitoring system.

II. PROPOSED MODEL

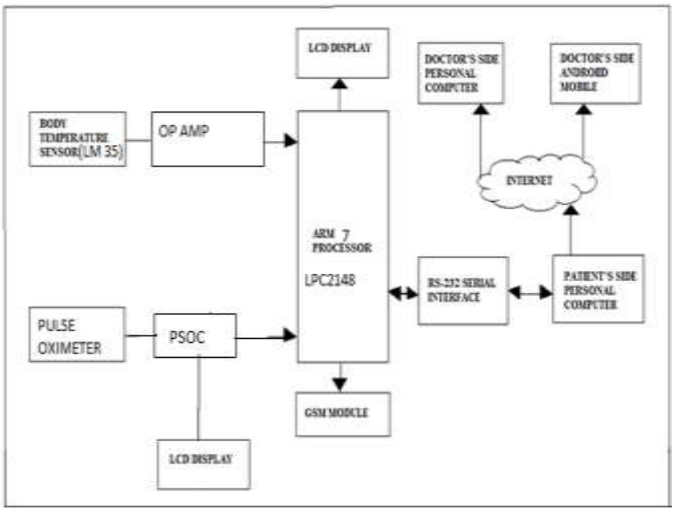

Figure 2: Block Diagram of Tele health monitoring system

The hardware structure mainly integrates the Programmable System on Chip (PSOC), ARM as the main control module, LCD display to provide Digital interface, different sensors, operational amplifier to amplify weak signals, Doctor's and patient's PC, doctor's mobile and a GSM module .

The block diagram of the overall tele-health monitoring system is shown in Figure 2. It consists of a temperature sensor LM35 which reads the body temperature. Since the output of the temperature sensor is weak, it is fed to an operational amplifier IC741 for amplification before it is given as an input to ARM7 microcontroller LPC2148 for processing and control. ARM7 converts analog signals into digital signals. The body temperature in degree Celsius is displayed on the LCD connected to the ARM7 processor. It also consists of a pulse oximeter which senses the pulse rate and SPO2 in blood. In order amplify the outputs of the pulse oximeter it is fed to a PSOC. It also converts the input analog signals into digital form so that it can be displayed on the LCD screen connected to it. The pulse rate and SPO2 content in blood is displayed on the LCD screen connected to the PSOC. The amplified digital signals from PSOC are given as input to the ARM processor from which it is sent to the patient's computer and to the GSM module through serial communication. Serial communication is enabled by using a MAX 232 IC which supports RS 232 standards. The GSM module sends a message to the doctor's android mobile automatically if there's any change in the vital parameters of the body. The patient's computer is connected to the doctor's computer via internet.

III. FLOW CHART

The project has been designed and implemented in steps which are shown with the help of a flowchart in Figure 3 and step-by-step procedure.

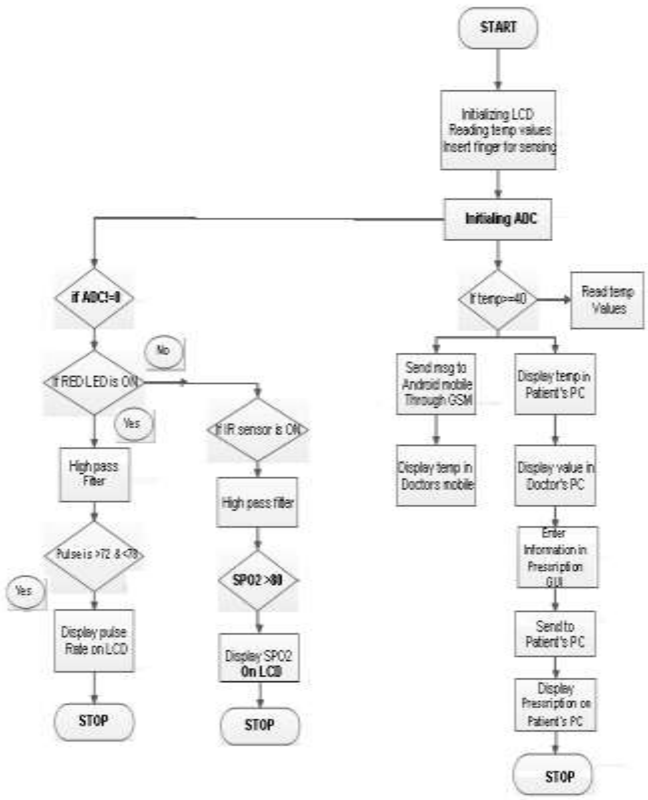

Figure 3: Design Flowchart

IV. PROCEDURE FOR TEMPERATURE SENSING AND DISPLAY

- The hardware is turned on by supplying power of 5V
- LCD initialization and ADC initialization is performed.
- Temperature is read using LM35 temperature sensor.
- The output of the temperature sensor is fed to op-amp 741 for amplification of weak signal.
- The output of the op-amp 741 is given as an input to ARM7 LPC 2148 microcontroller.
- The received voltage is converted to the corresponding temperature value by the ARM processor so that it can be displayed on a digital read out. If the temperature is less than 40 Fahrenheit, then the temperature is displayed on the LCD display connected to LPC2148.
- If the temperature is greater than or equal to 40 Fahrenheit, then the message 'Body temp High' is displayed on the LCD screen connected to LPC2148.
- It then sends a message to the Doctor's mobile using a GSM module.
- The temperature values are sent to the patient's PC using MAX 232 IC which enables serial communication between LPC2148 and COM port 9.

- The temperature values displayed on the patient's computer can be viewed by the Doctor on his computer as well has his mobile using Team viewer Software.

- Prescription is stored in a specific folder on the patient's computer by the doctor with the help of file sharing option of Team viewer software.

- Video conferencing can also be enabled between the patient and doctor using Skype for direct consultation and diagnosis.

V. PROCEDURE FOR PULSE RATE AND SP02 SENSING AND DISPLAY

- The hardware is turned on by supplying power of 5V.

- LCD initialization and ADC initialization is performed.

- If ADC value is not equal to zero, the status of red led and IR led is checked.

- The pulse oximeter is connected to PSOC (Programmable System on Chip) which has programmable analog and digital blocks and inbuilt instrumentation amplifier.

- If red LED is on and IR LED is off, the signal detected by the photo detector is given as an input to high pass filter.

- If pulse rate is greater than 72 and less than or equal to 78, it is within the normal range and it is displayed on the 16x2 LCD display connected to the PSOC.

If red LED is off and IR LED is on, the signal detected by the photo detector is given as an input to high pass filter.

- If SPO2 is greater than 80, it is within the normal range and it is displayed on the 16x2 LCD display connected to the PSOC.

- The inbuilt instrumentation amplifier in PSOC amplifies the weak incoming signals and converts it into digital form so that it can be displayed on the LCD display.

- The output of the PSOC is connected to LPC 2148 ARM 7 processor, from which it is sent to the PC with the help of MAX 232 IC which enables serial communication between LPC2148 and COM port 9.

- The pulse rate and SPO2 values displayed on the patient's computer can be viewed by the Doctor on his computer as well has his mobile using Team viewer Software.

- Prescription is stored in a specific folder on the patient's computer by the doctor with the help of file sharing option of Team viewer software.

- Video conferencing can also be enabled between the patient and doctor using Skype for direct consultation and diagnosis.

VI. SCHEMATIC DIAGRAM

The output of the temperature sensor LM35 is connected to P3 of op-amp 741. The amplified signal from the op-am is given as input to P0.10 of LPC2148 for further signal processing.

In the Pulse Oximeter schematic shown in Figure 4, Q1 is the voltage-to-current converter, which forms the DC bias level for photodiode D4. The bias generator has low impedance for constant current or low frequency signals, and suppresses the noise signals caused by various external light sources. For the modulation frequency signals, the impedance is determined primarily by R5. The Q1 base signal is formed by a PSoC programmable gain amplifier (PGA) user module, which amplifies the photodiode signal. The PGA output voltage is determined by PGA reference, which is connected to AGND in this design

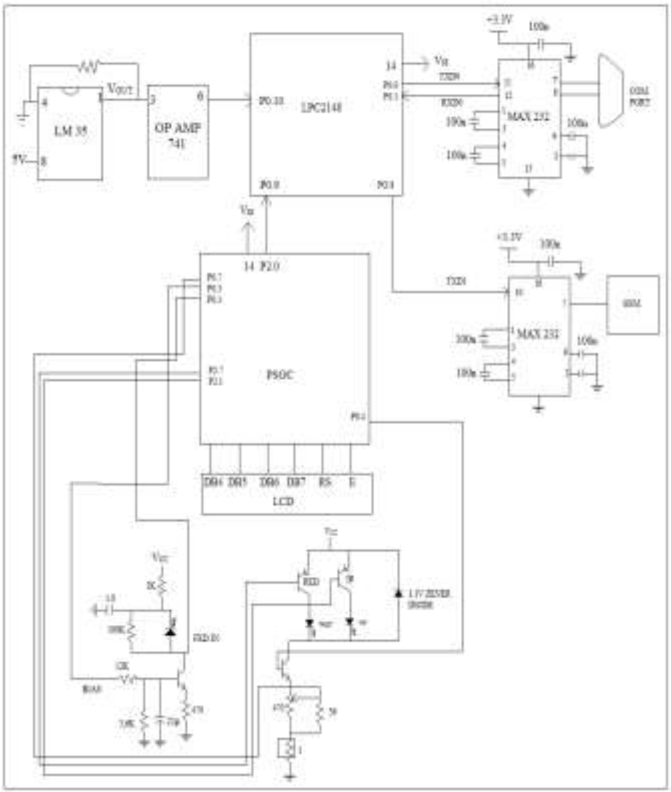

Figure 4: Schematic diagram of telehealth monitoring system

The bias generator helps reduce the required photodiode signal gain level, decrease the LED drive current, and deplete noise in the output waveform. D2 and D3 are the modulation infrared and red LEDs, respectively. D1 is the Pulse Oximeter LED that flashes every time a beat is detected. The infrared and red LEDs are switched by PNP transistors Q3 and Q4. Q2 is the regulator transistor of the programmed current source. Using the resistor R11 you can adjust the current through the infrared and red LEDs. The 3.3V Zener diode guarantees the current source will remain in a linear range when both LEDs are switched off. The calculated pulse rate and Oxygen Saturation are displayed on the low-cost, text LCD J3. The PSOC has programmable digital and analog blocks. It also has inbuilt instrumentation amplifiers. The amplified digital signal from the PSOC is fed as input to P0.9 of LPC2148. The processed signals from LPC 2148 is sent to the COM port via MAX 232 IC making use of UART0 and to GSM module via MAX 232 making use of UART1. The connections are shown in Figure 4.

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VII. RESUTS

A. Displaying pulse rate and spo2 content in blood on the 16x2 lcd display

The pulse oximeter implemented is used to sense the pulse rate and SPO2 content in the blood. After connecting the hardware to the power supply, the message 'PULSE OXIMETER' is displayed on the 16x2 LCD display as shown in Figure 5.

Figure 5: LCD displaying 'Pulse oximeter'

After a few seconds a second message 'Please insert your finger' is displayed on the LCD screen as shown in Figure 6. The patient is asked to insert his finger inside the pulse oximeter for pulse rate and SPO2 measurement. If the message is not displayed, the circuit needs to be reset with the help of the reset button.

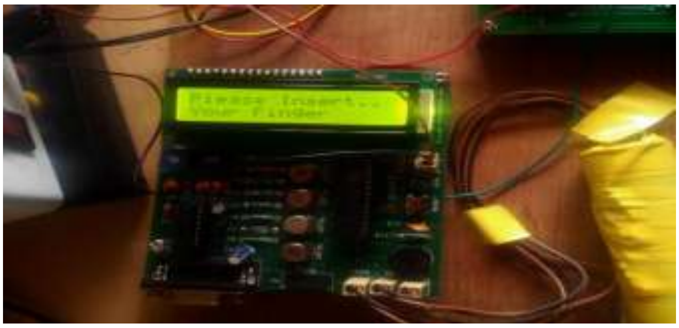

Figure 6: LCD displaying 'Please insert your finger'

If the finger is inserted correctly, the message 'Finger inserted' will be displayed on the LCD screen as shown in Figure 7.

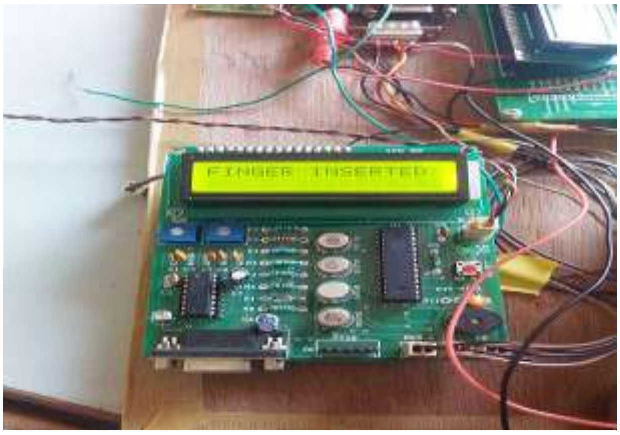

Figure 8: LCD displaying 'Finger Inserted'

It will be flowed by another message 'Please wait Calculating.' as shown in Figure 8.

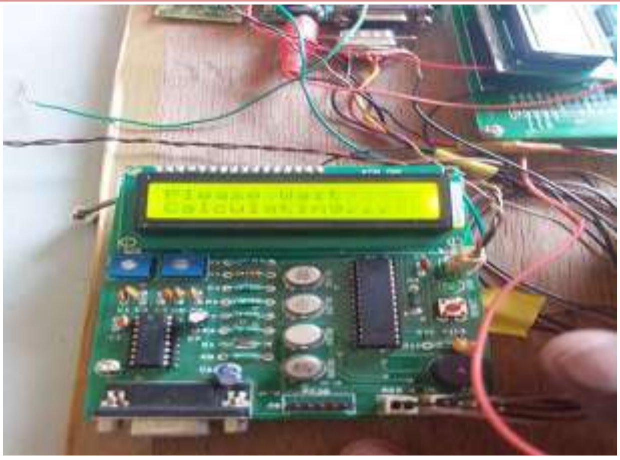

Figure 9: LCD displaying ' Please Wait Calculating'

After a few seconds, the pulse rate per minute and SPO2 content in terms of percentage will be displayed on the LCD screen.

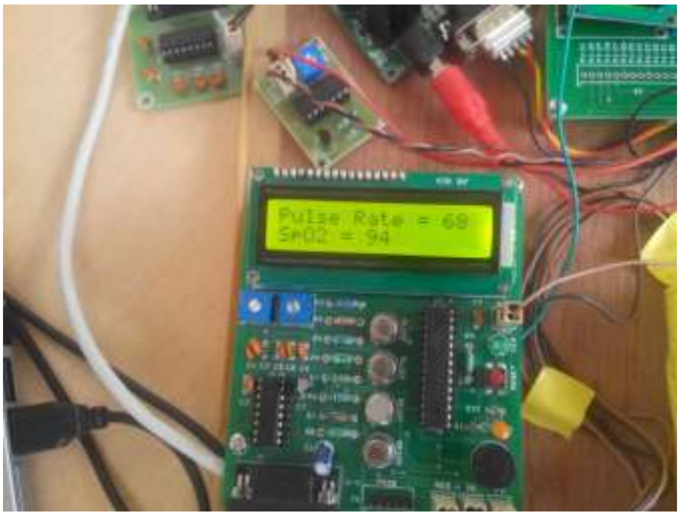

Figure 10: LCD displaying 'Pulse rate and SPO2 content'

B. Displaying body temperature on the 16x2 lcd display

When power is provided to the circuit, the temperature sensor LM35 senses the room temperature and it is displayed on the LCD screen. If we touch our fingers to the temperature sensor, the temperature slowly increases and the corresponding values are displayed on the LCD screen. At the body temperature, the temperature becomes constant and the value is displayed on the LCD screen in terms of Fahrenheit.

Figure 11: LCD displaying 'Temperature'

C. *Displaying pulse rate and body temperature of the patient on the patient's pc*

Serial communication between the hardware and the PC is made possible with the help of MAX 232 IC the output of which is connected to the COM port 9. After making the appropriate connections, the LED status of the PSOC module is checked. If it is 'on', it indicates that it is ready to communicate with the PC. We need to select the appropriate COM port and type of communication in UTF-8 Tera Term Pro. A GUI using Tera Term has been created using Java Script in which the pulse rate and the SPO2 of the patient is displayed on the patient's computer.

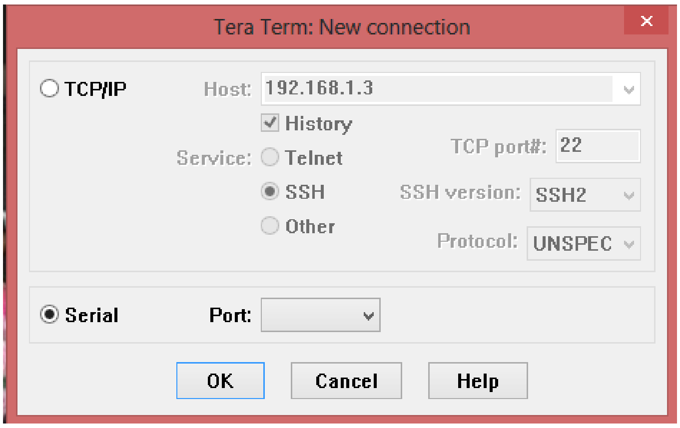

Figure 12: Dialog box to select Serial communication

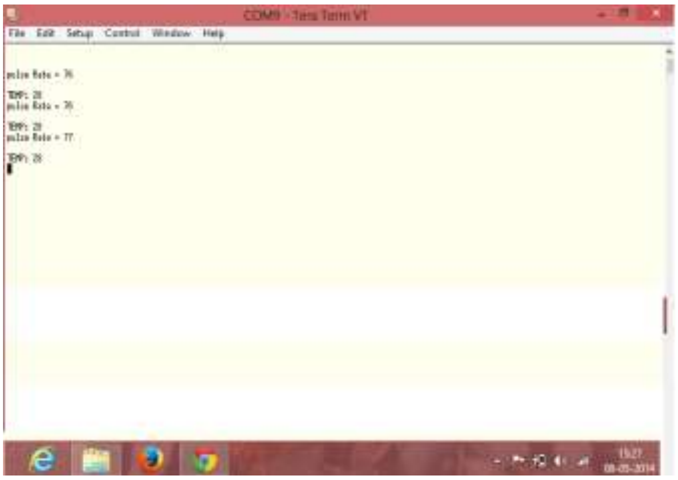

Figure 13: GUI displaying physiological parameters on patient's PC

D. *Remote controlling of the displayed information on the patient's pc from the doctor's pc/doctor's mobile using team viewer software.*

The information on the patient's screen can be controlled by the doctor using team viewer software. The doctor should enter the patient's team viewed id and password to access the pulse rate and SPO2 information displayed on the patient's PC. The doctor can write a prescription and save it in a specific folder on the patient's PC using team viewer's file sharing option. Video conferencing can also be conducted between the doctor and the patient using team viewer or Skype. The patient information can also be displayed on the Doctor's mobile using Team viewer software and entering the patient's team viewer id and password.

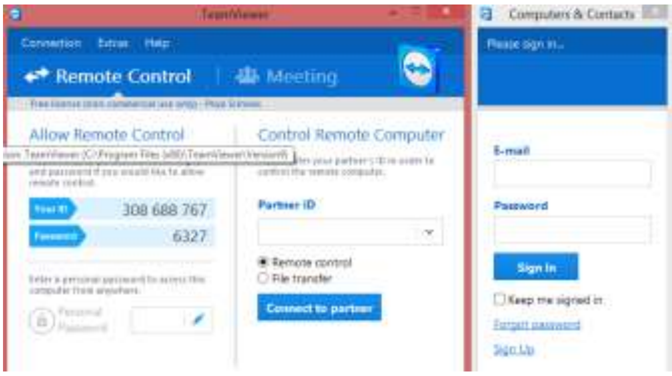

Figure 14: Patient's side

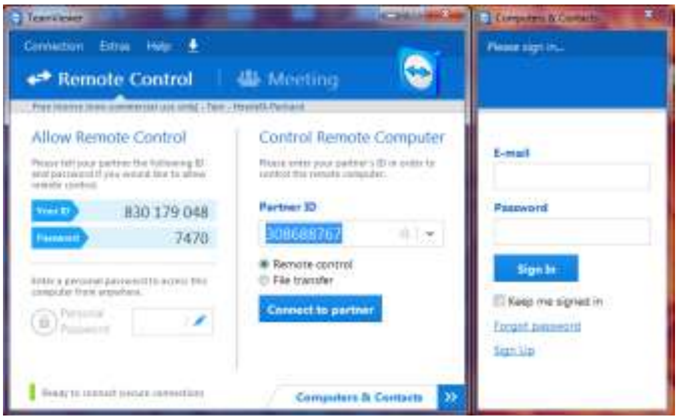

Figure 15: Doctor's side

Figure 16: Team viewer authentication window

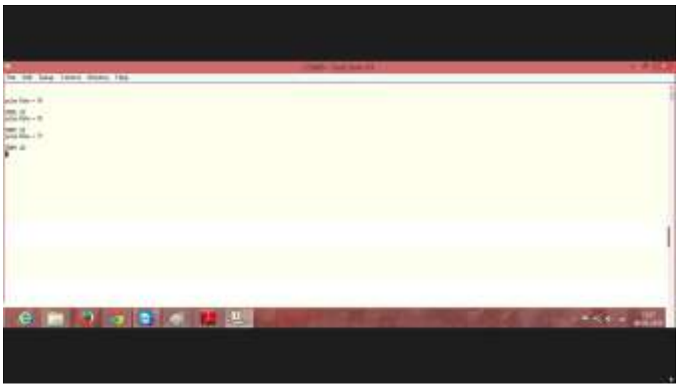

Figure 17: Remote control of physiological parameters from doctor's PC

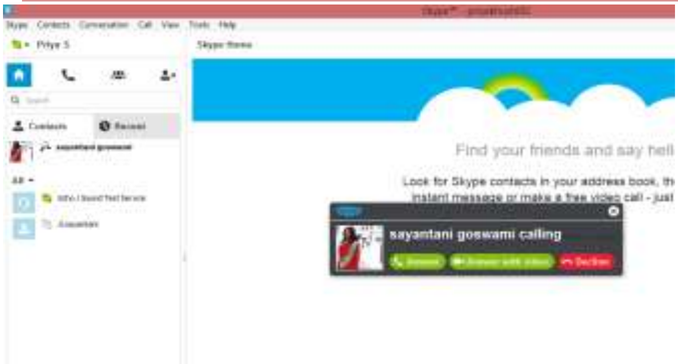

Figure 18: Skype Calling

Figure 19: Patient's side video conferencing

Figure 20: Doctor's side video conferencing

E. Sending a message to the doctor's mobile using the GSM module

If the body temperature of the patient exceeds 40 Fahrenheit, a text message will be automatically sent to the doctor's android mobile and will be displayed in the android application created for displaying this information. The IP address of the patient's PC should be entered in the application to facilitate transfer of information.

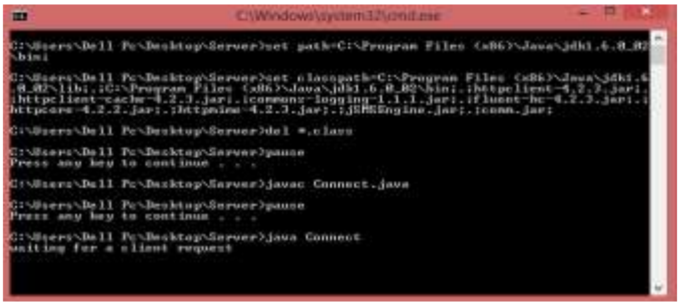

Figure 20: Entering IP address of Doctor's mobile to facilitate communication

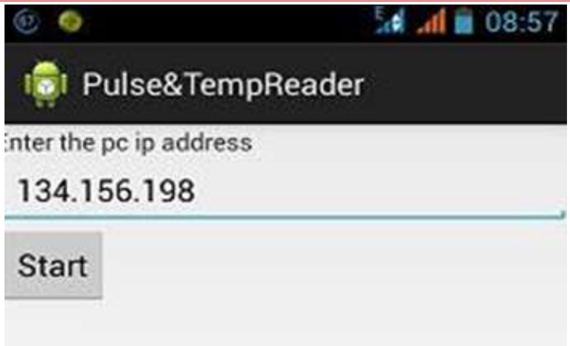

Figure 21: Entering IP address of PC

E. Maintaining patient's database in google documents using cloud computing and analyzing patient's data

A Google document as shown in Figure 22 is created in Google Drive which stores the pulse rate, SPO2 content and Body temperature in an excel document as shown in Figure 23 and stores the same in cloud.

Figure 22: Patient's database form

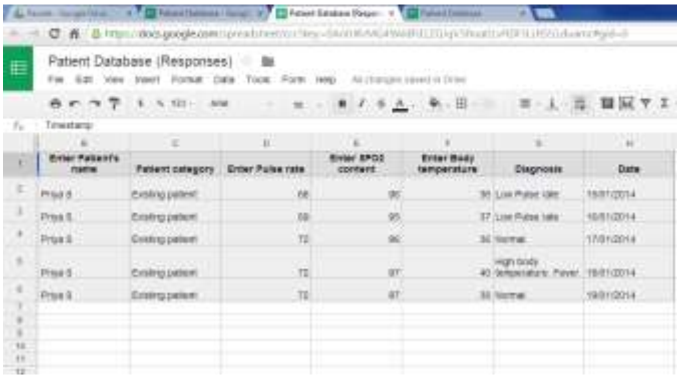

Figure 23: Patient's information stored in datasheet

VIII. CONCLUSION

The growth of elderly population and isolation of rural areas from technically equipped medical centers have necessitated the need to implement a real-time tele-health monitoring system to ensure proper consultation and diagnosis can be meted out to them without requiring them to travel to the doctor's chamber. The developed model will integrate the patients' medical records with their daily measurements of physiological parameters. This can be used as a diagnosis reference for physicians, reducing the time required to modify prescriptions and enabling the nursing staff to fully understand the patients' physiological conditions. By using video conferencing, healthcare practitioners and patients can reduce the costs associated with regular office visits.

We have successfully incorporated a tele-health monitoring system which efficiently measures three primary physiological parameters – pulse rate, SPO2 content in blood and human body temperature. This has been implemented using a temperature sensor LM35 and by constructing a pulse oximeter using red led, IR sensor and photo detector and ARM7 LPC 2148 microcontroller.

Both the hardware and software of this model was tested by measuring the vital parameters of a number of people. It also intimates the doctor if there's an abnormal change in the vital parameters. This feature was also tested by increasing the temperature beyond body temperature using a solder iron.

The next step is to convert the model into a working module to be used by various physicians and patients to enable real time remote patient monitoring.

IX. FUTURE SCOPE

Tele-health monitoring would be more efficient if a large number of psychological parameters can be measured. In future, more sensor modules can be added to implement ECG measurement, blood pressure measurement among others. This would ensure more efficient monitoring of patients.

Also, at present, the doctor can view only the patient's name and details of the various measured physiological parameters. A GPRS module can be incorporated which would also send the location of the patient. Thus, in case of an emergency, this information can be forwarded to the ambulance services, ensuring prompt action.

This can also be modified to enable communication between various pathological laboratories of the hospital and the Doctor. This would ensure the results are automatically forwarded to the doctor once available, thus ensuring no delay in catering to the needs of patients.

Also, the various sensor modules can be developed further to reduce their effective size. This would enable the patients to carry the equipments anywhere they go. This would make the entire system more efficient and handy.

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