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Microcontroller
Biomedical

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Design and development of an automatic smoke suction unit for diathermy machines

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Abstract

In this research paper, high frequency a.c. of the order of 1-3 MHz frequency is generated using crystal oscillator and other low frequency of 30 KHz is generated using astable multivibrator designed using IC 555. HF, high current with low voltage is used for precise skin dissection and blended effect of HF, LF, low current and high voltage is used for coagulation purpose. One of the important modifications done in this diathermy machine is the smoke suction unit used to evacuate the harmful smoke generated during diathermy. This smoke suction unit is fully automatic, its suction power changes according to the amount of smoke generated during surgical diathermy. Smoke Sensor MQ2 is interfaced with microcontroller for this process. Microcontroller 89S52 is used in this research work to control the smoke suction unit. Embedded C language is used for the programming and circuit is implemented using Proteus Simulator.

Keywords: high frequency, low frequency, blended effect, surgical diathermy, smoke sensor MQ2.

Introduction

Electrosurgical Surgical Diathermy (ESD) machine has evolved to become the modern-day scalpel being used for cutting and coagulating tissues. The Surgical diathermy machine involves the use of high frequency AC of the order of 1-3 MHz for the purpose of precise cutting or else to freeze tissue or seal blood vessels to cease bleeding [1].

This application of electrosurgery causes burning or many times damage to the tissues if safety precautions are not followed. Such hazards can be controlled by controlling the frequency and power of the device at the time of electrosurgery. In electrosurgery, voltages are provided by the generator, and current is delivered to the tissue through the electrode tip of the instrument [2]. The amount of thermal energy delivered and the time rate of delivery will dictate the observed tissue effects. In general, below 45°C, thermal damage to tissue is reversible. As tissue temperatures exceed 45°C, the proteins in the tissue become denatured, losing their structural integrity. Above 90°C, the liquid in the tissue evaporates, resulting in desiccation, if the tissue is heated slowly or vaporization if the heat is delivered rapidly. Once the tissue temperatures reach 200°C, the remaining solid components of the tissue are reduced to carbon [3].

Operating doctors, staff and patients regularly comes in contact with surgical smoke generated during surgical procedures while dissecting skin or tissues. During such procedure it is found that heat is produced and as a result smoke or haze is generated. Such smoke or haze puts great health hazards. It is also found that such smoke creates major biochemical hazard and is as hazardous as cigarette smoke [4][11].

MQ-2 is a smoke sensor that has high sensitivity to type of gases such as LPG, Propane, Hydrogen, smoke and carbon monoxide. Besides having high sensitivity, MQ-2 is low cost and suitable for different applications. In this work the smoke sensor will be interfaced with microcontroller so that it will automatically vary the power of suction unit so that suction power is directly proportional to the amount of smoke produced during surgical diathermy procedures [5].

MQ-2 is a gas sensor that has a high sensitivity to types of flammable gases such as LPG, Propane, and Hydrogen. Besides having high sensitivity, MQ-2 was chosen because of its low cost and suitable for different applications. The gas sensor will be configured via OpenCR which is like Arduino.

Methodology

ESD machine is operated in two modes Monopolar and Bipolar

A. Monopolar mode

In this type of diathermy electrical current follows the path from Electrosurgical unit to active electrode. The active electrode comes in contact with the skin of the patient. The current generated from electrosurgical unit passes through this active electrode through the body of the patient. This current then returns though the return electrode connected to the buttock or to the leg. Thus, the direction of current is from electrosurgical generator through the active electrode, through the patient, through the return electrode and back to electrosurgical generator from where it originated.

B. Bipolar mode

In this type of diathermy, the active electrode and return electrode both are fitted on the forceps like structure. The electrical current passes only through the part or portion of the tissue we want to treat and then returns back to electrosurgical unit. Important point is that surgical current does not travel through the patient's body but instead is confined only to the part or tissue between the bipolar electrodes. Bipolar electrosurgery thus restricts passage of current though the body of patient and thus it is found that this type of electrosurgery offers very less amount of unintended dispersal of current. Another significant feature of this type of diathermy is that the surgical current does not flows through other parts of the body but remains concentrated only on the tissues in contact. The result is that surgery becomes safe and accurate and damage to the tissues is also less. Apart from this bipolar electrosurgery faces one drawback which is, due to use of low power sometimes it is not useful for cutting application [6].

To detect the smoke produced during surgical diathermy and control the suction power of suction unit

MQ2 smoke sensor is used in this work. MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas. MQ2 is a metal oxide semiconductor type gas sensor. Concentrations of gas are measured using a voltage divider network present in the sensor. This sensor works on 5V DC voltage. It can detect gases in the concentration of range 200 to 10000ppm [7].

Experimental Work

A surgical diathermy machine consists of a high frequency power oscillator [9]. The RF generator provides an undamped high frequency current (typically 1-3 MHz) which is suitable for making clean cuttings. The function generator produces low frequency current (typically 30 KHz)[10]. Modulator is used for blending the current of radio frequency oscillator and function generator. By blending the current of RF oscillator and function generator, the degree of coagulation of wound edges may be chosen according to the requirement. The waveform selection and signal generating stage present in modulator provides the desired waveform for cutting or coagulation. The mode selector block is used for selecting the type of mode such as Electrotomy, Coagulation, Fulguration, or Desiccation. The power output stage employs power transistors such as MOSFETs to amplify the waveforms and output them though an output isolation. This is then applied through a system of electrodes, where the current usually takes the path from the active electrode and back through the return electrode in case of monopolar mode, or alternatively flows through both the active electrodes in case of bipolar mode. Hand switch or foot switch is used to control the amount of current applied to the power amplifier circuit which controls the current flowing though the electrodes.

The smoke generated from the surgical electrodes in detected by MQ2 sensor. It contains a sensing element, mainly aluminium-oxide based ceramic, coated with Tin dioxide, enclosed in a stainless-steel mesh. Sensing element has six connecting legs attached to it. Two leads are responsible for heating the sensing element; the other four are used for output signals. Oxygen gets adsorbed on the surface of sensing material when it is heated in air at high temperature. Then donor electrons present in tin oxide are attracted towards this oxygen, thus preventing the current flow. When reducing gases are present, these oxygen atoms react with the reducing gases thereby decreasing the surface density of the adsorbed oxygen. Now current can flow through the sensor, which generated analog voltage values.

These voltage values are measured to know the concentration of gas. Voltage values are higher when the concentration of gas is high [8]. The gas sensor and smoke suction unit are interfaced with Microcontroller 89S52, so that if the concentration of gas increases the suction power of suction unit also increases.

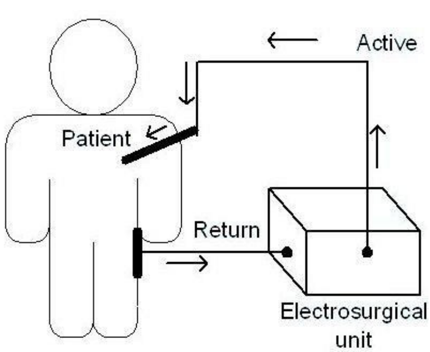

Fig. 1 Monopolar mode

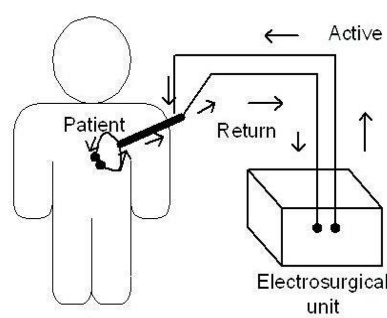

Fig. 2 Bipolar mode

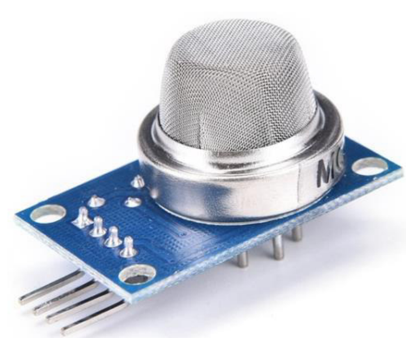

Fig. 3. MQ-2 Gas Sensor

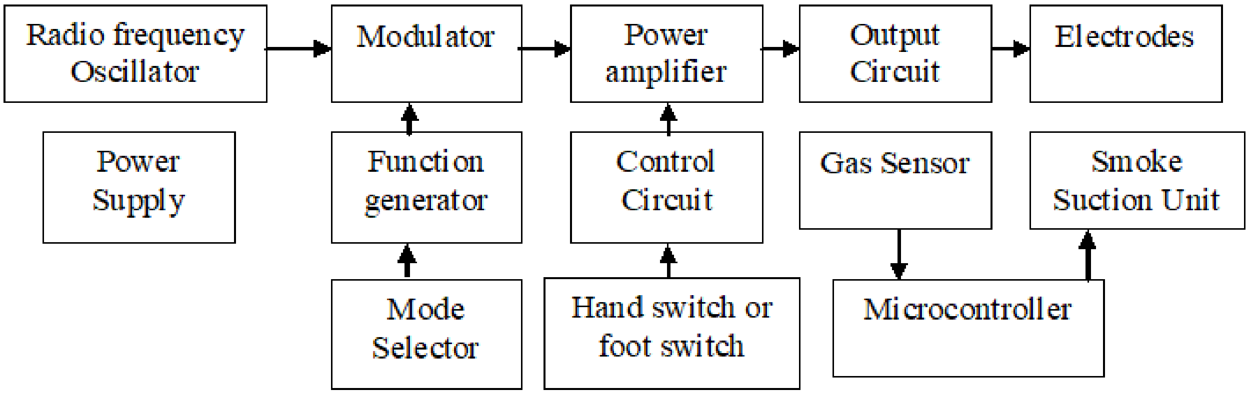

Fig. 4. Block diagram of ESD machine

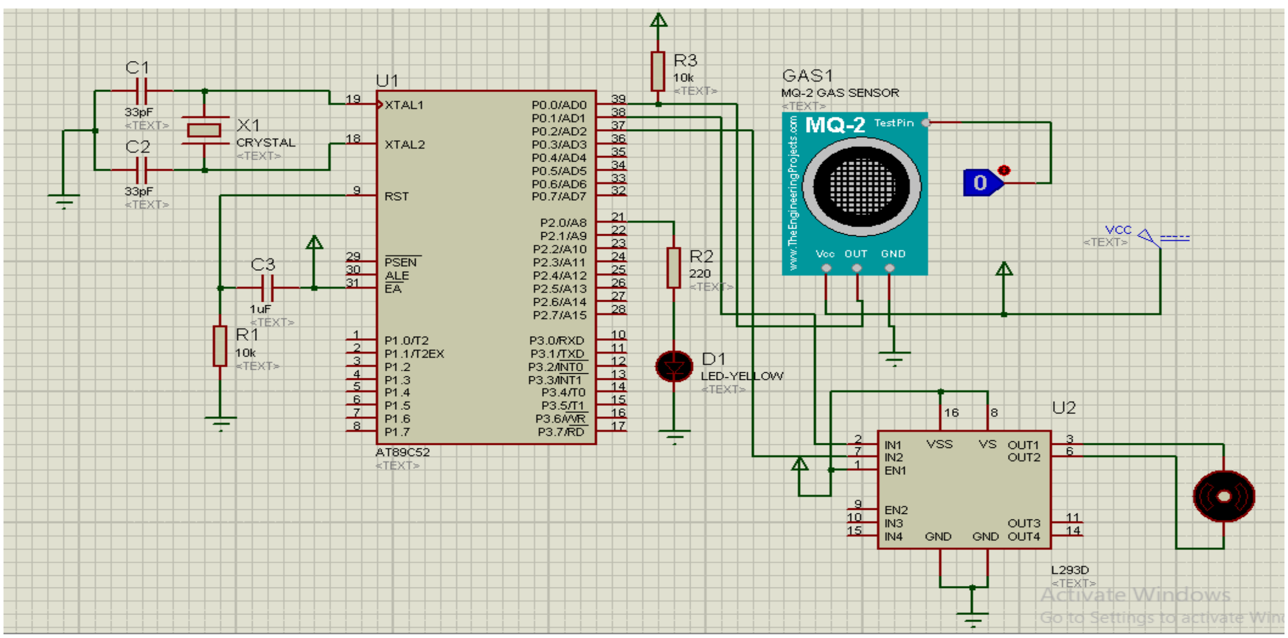

Fig. 5 Circuit diagram of automatic surgical smoke suction unit

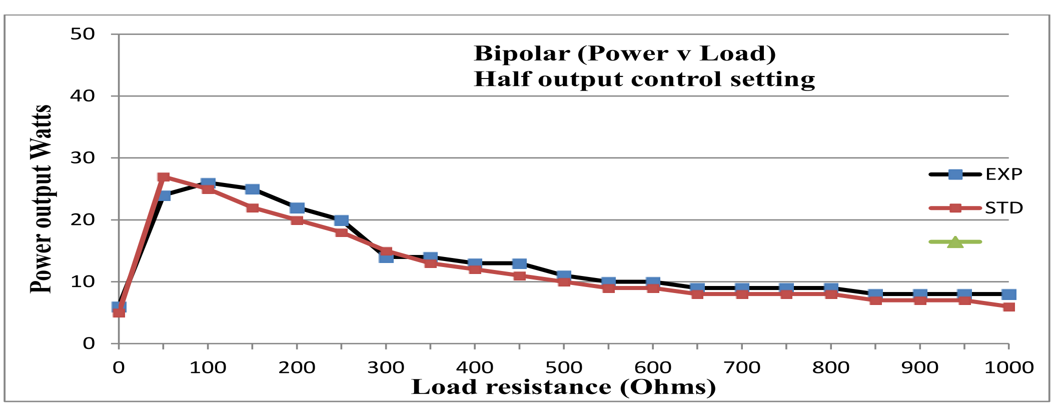

Fig. 6: Variation of Output power for various values of load resistance

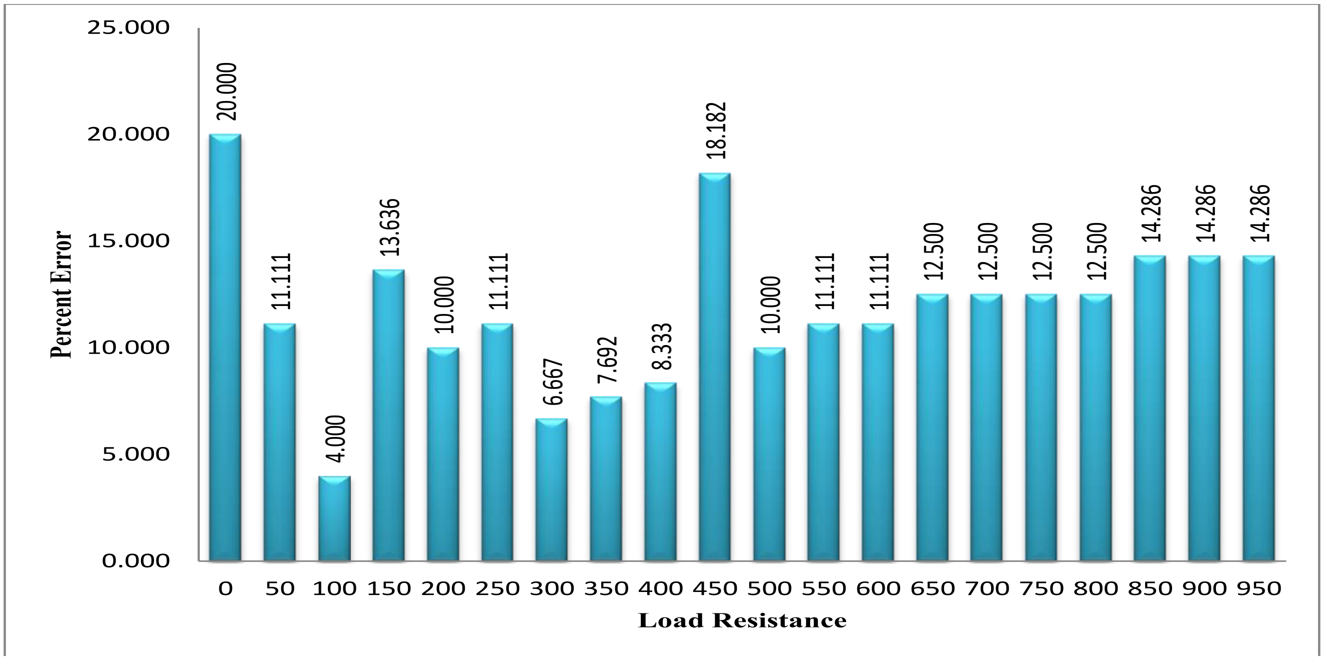

Fig. 7: Variation in Percent error for measured Power output.

Table 1: Output power recorded for various values of load resistance using bipolar electrode for half output control setting

Sr.	Load Resistance	Experimental Value	Standard Value	% Error
1.	0	6	5	20.000
2.	50	24	27	11.111
3.	100	26	25	4.000
4.	150	25	22	13.636
5.	200	22	20	10.000
6.	250	20	18	11.111
7.	300	14	15	6.667
8.	350	14	13	7.692
9.	400	13	12	8.333
10.	450	13	11	18.182
11.	500	11	10	10.000
12.	550	10	9	11.111
13.	600	10	9	11.111
14.	650	9	8	12.500
15.	700	9	8	12.500
16.	750	9	8	12.500
17.	800	9	8	12.500
18.	850	8	7	14.286
19.	900	8	7	14.286
20.	950	8	7	14.286

21.	1000	8	6	33.333

Table 2. Power output recorded for various values of load resistance using bipolar electrode for full output control setting

Sr. No	Load Resistance (Ohms)	Experimental Value Power output (Watts)	Standard Value Power output (Watts)	% Error
1.	0	10	12	16.667
2.	50	28	30	6.667
3.	100	47	50	6.000
4.	150	45	44	2.273
5.	200	36	38	5.263
6.	250	32	34	5.882
7.	300	28	30	6.667
8.	350	26	27	3.704
9.	400	24	25	4.000
10.	450	22	23	4.348
11.	500	19	20	5.000
12.	550	17	19	10.526
13.	600	16	18	11.111
14.	650	15	16	6.250
15.	700	15	15	0.000
16.	750	14	14	0.000
17.	800	14	13	7.692
18.	850	13	12	8.333
19.	900	12	12	0.000
20.	950	11	11	0.000
21.	1000	10	11	9.091

Results & Discussions

Observations obtained for various physiological parameters are given below. Data for all the subjects were recorded in the same environmental conditions like room temperature, atmospheric pressure, humidity etc. The data obtained by standard device were compared with that obtained through experimental measures, by the current setup.

$$\% \text{ Error} = \frac{\textit{Experimental value} - \textit{Standard value}}{\textit{Standard Value}} \text{X100}$$

The peak output voltage % error is ranging from 4.000 to 33.333. The lowest power recorded was 6 W and the highest power recorded was 26 W.

The peak output voltage % error is ranging from 0.000 to 16.667. The lowest power recorded was 10 W and the highest power recorded was 47 W.

Conclusion

The designed ESD machine have ensured the safety of patients using output transformer, smoke suction pump designed with a low cost with high quality performance. ESD machine provides the electrosurgeon with lots of flexibility to perform various types of surgical procedures efficiently, greater safety, less health hazard and less tissue trauma.

With this kind of work an advanced and cost-effective surgical diathermy machine is designed which will be very useful in hospitals and operating theatres where accurate cutting and coagulation without blood loss, not letting the life of electrosurgeon and operating staff at any sort of risk. Advanced research in the field of biomedical instrumentation will definitely produce efficient, hazard free, accurate diathermy equipments that will lead to large scale use of diathermy equipments in various sections of surgery.

Conflicts of interest: The authors stated that no conflicts of interest.

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APPLICATION OF IoT- IN WIRELESS MICROCONTROLLER BASED PREPAID ENERGY METER

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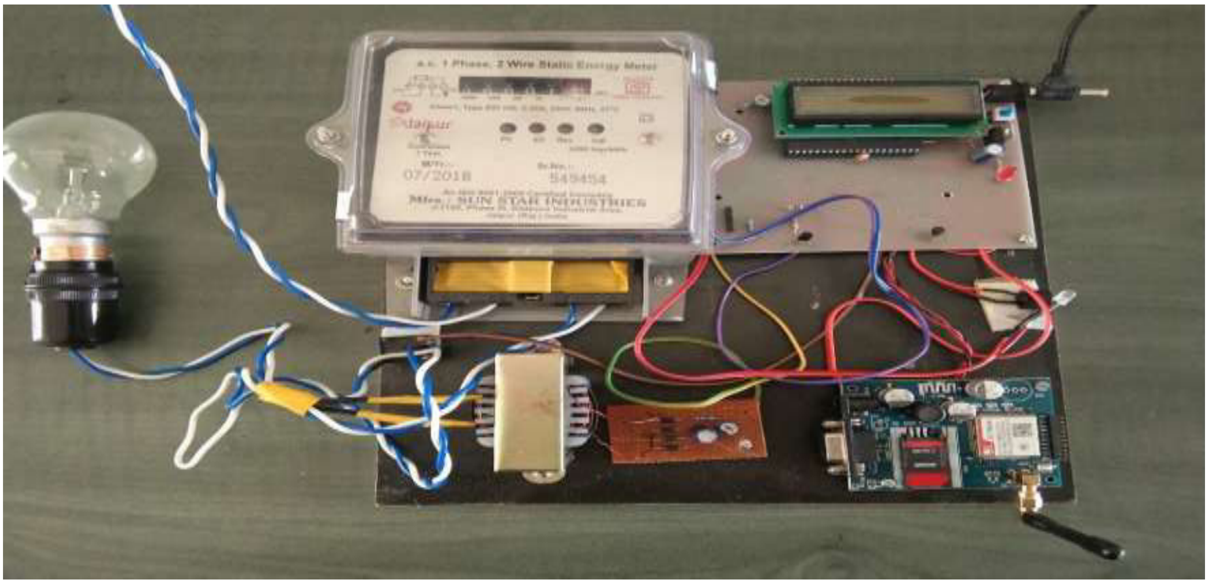
Abstract : The present paper describes how ICT plays an important role in a microcontroller based intelligent module of prepaid ENERGY METER. It is useful to modify the billing process and collection of amount to the power distribution companies. An automated module has been designed here to make the entire process online through an web app proposed to the distribution Company. The idea is to develop an automated microcontroller based Pre-Paid energy meter with EPROMS to keep the count of power unit consumed and power units available for the consumer. The Intelligent module then can send warning messages to the consumer when the available power unit drops below certain level. Power consumed is shown by the energy meter in form of 1 unit or 1 kilo watt hour of energy consumed. 1 kWh refers to the electrical energy required to provide 1000 watts of power for 1 hour. The function is exactly similar to prepaid SIM used in mobile

Keywords: Microcontroller, EPROM, Electronic meter

I. INTRODUCTION



CONSTRUCTION OF POWER METERS: In this meter an aluminum disc is placed two electromagnets, one of whose one coil is connected to the load and the other coil of another electromagnet is connected to the supply voltage. The interaction of the fluxes between the two coils provides a torque to the disc, which starts rotating, with the revolutions proportional to the load current. The counter records the number of revolutions and displays them, which indicates the energy consumed.

NEED FOR PREPAID ENERGY METER SYSTEM:

A human intervention is needed for the distribution company to carry out entire process of recording the units utilized by the consumers. Right from noting the reading and preparing the bill is very tedious job and the accuracy not guaranteed due to errors in human reading. To eliminate various problems, the most convenient method is to use prepaid meter in future.

EMBEDDED SYSTEM:
An Embedded System is a combination of microcontroller based hardware and typical software to undertake specific task. Embedded systems uses microcontroller to perform its own task.
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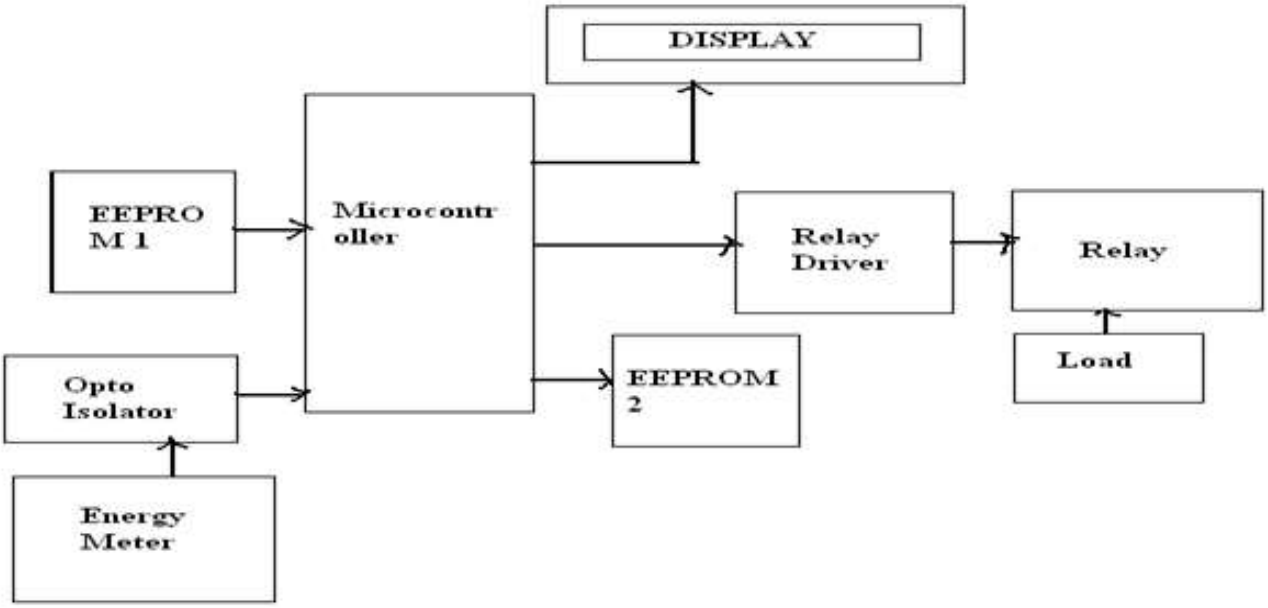
GSM MODULE : A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging.

Working :



Prepaid Energy Meter System basically like in a mobile phone recharging, the consumer buys a recharge from the distribution companies web app and gets some energy units in return for an amount specified by the distribution company as per the consumers usage. The Power Units will keep reducing for every unit of energy consumed and once zero, the power supply would be automatically cut off. The amount deducted for every unit of energy consumed can be controlled by the distribution unit according to the peak hours.

A simplest type of Prepaid Energy Meter consists of two EEPROMs interfaced to a microcontroller. One EEPROM contains the recharged balance Units. The microcontroller reads this balance and stores it in the other EEPROM along with the tariff .The energy meter supplies pulses to the microcontroller for every unit of energy consumed. The microcontroller increases the spent energy unit by one and decreases the balance amount in the EEPROM by the fixed tariff. As soon as the balance unit in the EEPROM comes down to zero, the microcontroller sends a signal to the relay driver which in turn switches off the relay, such that the main supply to the load is switched off. An LCD is also interfaced to the microcontroller which displays the amount of energy consumed. The recharge card is actually an EEPROM in which the allocated energy units is stored. The Microcontroller reads the balance amount and stores it along with the tariff and the energy units allocated in its RAM and are programmed to delete off the information present in the EEPROM (making the card invalid for further use). The energy meter gives electric signal to the opto isolator which consists of an LED and an opto-transistor combination such that the LED glows and emits light for every electric signal received by the energy meter (which sends a electric signal for every unit consumed). The opto-transistor starts conducting and sends high and low pulses to the microcontroller. The microcontroller is programmed such that a counter is kept incrementing for every pulse rate, which gives the value of the energy consumed.

Another EEPROM is interfaced to the microcontroller where the balanced amount and the energy units consumed are stored. For every increment in count, the balanced amount in this EEPROM is deducted. Finally when the balance amount is zero, the microcontroller sends a low signal to the Relay driver to give a high signal at its output, which switches off the relay. Normally the microcontroller gives a high signal to the input pin of the relay driver, which develops a logic low signal at its corresponding output pin and the relay coil is energized, thus connecting the load to the main supply. Also warning messages are send to the consumer mobile phone at some predetermine level to indicate the reducing available power unit. This enables the consumer to recharge before the power is cut off.

BENEFITS OF PREPAID METER

- In the conventional System (Post Paid) the consumers pay the bill after almost a month after they have consumed the Power, whereas in the prepaid system the Distribution company gets the money as soon as the consumer recharge for the same.
- In the conventional system large man power is needed to take reading of the units consumed by the consumer, preparing bill for the same, distribution of the bills for every household and at the end collection of the bills, which is completely eliminate in the Prepaid system
- The consumer in the prepaid system get constant warning regarding the units consumed by them which lead to proper management and use of the power by the consumer.
- The prepaid system completely eliminate defaulters which is a big problem faced by the distribution company and provides them with full control over distribution system.

ICT REPLACE WITH IOT

Machine-to-Machine communication is the association of information and communication technologies (ICT) but Internet of Things or IoT is a global infrastructure for the information society, which allows advanced services by interconnecting objects (physical or virtual) using technologies existing or evolving interoperable information and communication". A long distance communication refers to a combination of hardware and software making it possible for information exist in an ICT (Information Technology) network.

CONCLUTION : It is highly accurate as the whole idea of reading the units and then billing manually or any other means is eliminated. Consumer cannot escape from paying the electricity bill and the State Electricity Board gets free from debts. On the consumer front, the tedious task of paying the bill and waiting anxiously for the bill is eliminated. Wastage of energy is diminished as now only the required energy will be consumed as allotted. The power grid can monitor the overall energy consumption and any tampering attempts are actually of no use and can be detected if still prevalent.

FUTURE SCOPE

In future this concept will helps for designing the better product to the consumers. It should be possible by wireless communication. The designing of hardware of this product is affordable to consumer and also efficient to achieve the work.

In incoming days the product will be world wide of all energy meter. We are thinking about to add new future in our product to provide world wild connection of all energy meter with advance feature. ICT manage all the function of energy meter.

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Application of Manifold Sensors in Wireless Digital Thermometer

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ABSTRACT

This paper describes the application of a manifold sensors in wireless digital thermometer for measuring temperature from different sensors using single wireless digital thermometer. In this paper primarily temperature sensor LM35 is used. ADC0808 is used to convert analog signal obtained from temperature sensor into digital format so that the special parallel to serial encoder will transmit the signal using Tx module to remote receiving end. At the receiving end the transmitted signal is received by receiver module. Reverse action is carried out on the signal to what happed at the transmitting end and temperature detected by sensor is displayed on digital multi-meter on mV scale.

Keywords: Temperature Sensor, ADC, Encoder

I. INTRODUCTION

Temperature is certainly among the most commonly measured parameters in industry, science, and academia. Recently, the growth of wireless instrumentation technology, along with some clever innovations, has provided new ways to apply temperature measurement sensors combined with personal computers to collect, tabulate, and analyse the data obtained.

Wireless monitoring system is, as their name suggests, monitoring systems that can be installed without the need to run cabling or wires. Wireless monitoring systems are the ultimate in quick, easy and neat monitoring installation solutions. Because they are wireless they are very discreet and unobtrusive, there is no buildings' decoration spoiling nor is there an unsightly wire highway on wall surfaces. Wireless monitoring systems are more convenient than hard wired systems and it means that even the most unlikely places can have a wireless monitoring a system installed and in a fraction of the time.

Temperature measurement in today's industrial environment encompasses a wide variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. Temperature is a very critical and widely measured variable for most applications. Many processes must have either a monitored or controlled temperature. The paper deals with measurement of temperature using temperature sensor LM35. In all eight LM 35 sensors are been used in the current work.

II. METHODOLOGY

Temperature measurement can be done using temperature sensor LM35 but the problem arises when one has to measure more than one temperature at a time. To overcome this problem an approach has been shown in the paper to sense temperature from eight sensors at a time.

At the transmitting end, we have temperature sensor LM35, ADC 0808, Encoder HT12E2, Sequential Data Selector and Transmitter Module. An 8 bit ADC continuously scans and converts signals from eight different temperature sensors. The sensors are selected sequentially by a 3 bit binary addressing system. At any instant of time an 8 bit ADC generates an 8 bit binary number equivalent to the analog signal obtained at the output of a particular temperature sensor, being selected by 3 bit binary addressing system. By using special parallel-to-serial encoders, this 8-bit data, along with the binary address of the sensor, is sent serially to the remote receiving end. Communication between the two ends are met with the help of a pair of 433MHz UHF transmitter and receiver modules operating in ASK/OOK mode. At the receiving end, the transmitted signal is received by a 433MHz ASK/OOK RF receiver module. The received 8-bit serial signal is then converted back to its original parallel form, by using special data decoders HT 12E. An equivalent analogue signal is then developed from this data by an 8-bit digital-to-analogue converter (DAC). A digital multimeter connected at the output of the DAC is used to show the temperature on mV scale.

III. EXPERIMENTAL SETUP & WORKING

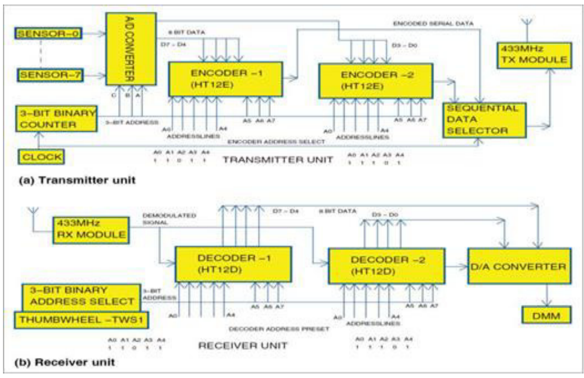

Figure 1. Block Diagram Of Manifold Sensors In Wireless Digital Thermometer

Figure **1.a** shows the block diagram of the transmitter unit for the wireless addressable digital thermometer. Eight LM35 IC temperature sensors are connected to ADC 0808. Although the ADC is capable of accepting a total number of eight sensors through its eight input lines, less number of sensors could be used as well as, whenever desired. IC 7404 configured as a CMOS oscillator with the help of resistors and capacitor feeds the ADC with necessary clock pulses required for conversion processes.

Output voltage of LM35 series IC temperature sensors follows linearly (@10mV/°C) the centigrade temperature of its surroundings, taking 0mV at 0°C temperature. The ADC continuously scans its eight input lines. The scanning process is governed by a 3-bit binary up counter built around CD4029. The counter places a continuously-changing 3-bit binary number on A-B-C input lines of the ADC. Scanning rate is dependent upon the clock constructed around timer NE555, and is 8Hz, approximately. Hence, each of the eight sensors is allowed to send data to the ADC for approximately one-eighth of a second, irrespective of whether all sensors are connected or not.

Here, IC 0808 is configured in continuous operational mode. So, whenever a particular sensor is addressed, output lines of the ADC reflect the present analogue output status of the sensor. Output of the ADC goes to data input lines of special encoders HT12E; higher nibble to first HT12E and lower nibble to second HT12E, respectively. As TE input of encoders is permanently grounded, the encoders are configured to produce encoded data continuously. These two encoded digital outputs are alternately steered to TX1 (TX-433MHz), a UHF RF transmitter module, to modulate UHF carrier wave generated by the module.

Encoder output: Whenever IC 555 output pulse goes high, output of HT12E is steered to TX1 through diode. At the same time, due to the presence of transistor inverter, output of HT12E is inhibited to reach TX1 through the gate. As soon as the clock pulse returns to logic 0, output of HT12E gets its passage to TX1 through gate of 7408.

So, in essence, analogue data of a sensor is converted and the resultant 8-bit digital data is sent to the remote end using ASK/OOK modulation, in a complete clock cycle of IC 555.

Modulated signal is radiated into space through a wire, acting as an antenna, connected at the antenna point of the module.

Figure **1.b** shows the receiving unit of the wireless addressable digital thermometer. RX1, a 433MHz RF receiver module, is used to receive and demodulate ASK-modulated RF signal transmitted by TX1 of the transmitter unit. Demodulated output is a train of rectangular pulses comprising a 4-bit data nibble and destined for a particular decoder as explained earlier.
Transistor BC547 is used as a pulse amplifier to amplify the signal output from RX1 and, hence, raises the pulse height to CMOS compatible logic -1 (>3.5V at 5V). This compatible output is then fed to CMOS NAND gate 4011. NAND gate helps to get pulses of perfect rectangular-wave shape. Output of IC 4011 is fed to decoders HT12D. Address lines of the decoders are preset to receive data from two encoders HT12E, respectively.
LEDs connected at their outputs flicker to indicate reception of valid data. Decoding speed is 200kHz (approximately). Decoded data is then fed to DAC 0808. Analogue current output of the DAC is loaded. Voltage developed across it is fed to a digital multimeter, which shows the temperature on mV scale. A thumbwheel switch is used to change the preset address of the decoders. The switch changes the last three LSB of the address.

III. RESULT AND DISCUSSION

Table 1. Temperature recorded by different techniques and deviation

Sr. No	Actual	Experimental	Deviation
1.	37.4	37.2	0.2
2.	37.6	37.3	0.3
3.	37	37.1	-0.1
4.	36.8	36.9	-0.1
5.	37	36.8	0.2
6.	36.5	36.3	0.2
7.	37.5	37.3	0.2
8.	36.7	36.4	0.3
9.	37.5	37.3	0.2
10.	36.9	37	-0.1
11.	37.2	37	0.2
12.	37.6	37.4	0.2
13.	36.7	36.9	-0.2
14.	36.8	36.5	0.3
15.	37.5	37.3	0.2
16.	36.9	37	-0.1
17.	37	37.2	-0.2
18.	37.3	37.1	0.2
19.	37.4	37.2	0.2
20.	36.5	36.3	0.2

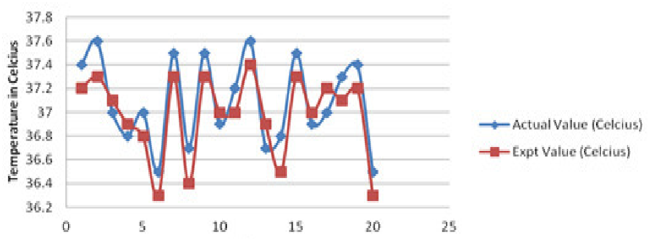

Figure 2. Graph representing the comparison of data for Temperature by different techniques.

For proper operation of this wireless thermometer, reference current (to pin 4 of DAC0808) of the receiver unit should be pre-adjusted. To do this, follow the steps below:

Connect a known voltage source (not exceeding +5V) to any input of the ADC, say, at pin 4 of the ADC.

Switch on the transmitter unit. Connect a DMM across Resistor of the receiver unit. Set the range switch to DC 200mV range, positive lead to ground and negative lead to top of Resistor. Switch on the receiver unit. LEDs at decoder outputs should start glowing to indicate the received voltage data. If source voltage is 1.5V, status of LEDs should be as listed in Table I. So, received voltage = (D× 5)/256 = (76×5)/256 = 1.50

where D is the weight of the binary numbers represented by LED7 through LED14. Now, adjust trim potmeter to get 150.00mV on the dial of the multimeter. Connect another voltage source at the input and see that the multimeter shows it correctly. If required, re-adjust the trim potmeter. After proper calibration, enclose the circuit in two separate boxes with suitable connections of input and LED indicators.

STATUS OF LEDS IN THE RECEIVER UNIT

LED	7	8	9	10	11	12	13	14
Data	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Weight	128	64	32	16	8	4	2	1
Status	OFF	ON	OFF	OFF	ON	ON	OFF	OFF

IV. CONCLUSION

Although the system can be used best to measure temperatures in hazardous or inaccessible areas (like a radioactive zone), the same can also be used by a hospital doctor to monitor, from a fixed location, the body temperatures of multiple patients lying in different rooms without visiting each patient in person.

A hotel control room can monitor temperatures of all the rooms at the same time by using multiple units. The unit can also be used (with certain modifications) as a wireless digital voltmeter.

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A Non- Invasive Blood Pressure Measurement Using Embedded Technology

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ABSTRACT

A Health care is one of the fast emerging fields today. With the average age of general population increasing each year the credit goes to cutting edge of medical research. New methods are developed almost every month to as a solution to numerous health problems for which accurate diagnosis is the need of the day. The Biomedical equipment provides accurate reproduction of body signals and automated diagnosis and patient monitoring systems. The field of biomedical instrumentation is an integral part of medical research. Sometimes it becomes necessary to monitor physiological events from a distance like monitoring a patient in an ambulance and in other applications away from the hospital, collection of medical data from a home or office and use of telephone links for transmission of medical data.

In this research work it is to study the Non- Invasive Blood Pressure Measurement of patients using embedded technology which has the low cost, reliable, and portable and it is used in many medical laboratories and industries. In present development, the real time blood pressure biomedical signal is measured using an optical measurement circuit based plethysmography technique(PPG) contineously for a long period of time.The detected measured signal amplified using an operational amplifier circuit and interface with the microcontroller. The numerical reading values of systolic and distolic blood pressure remotely recorded and displayed with the help of LCD and stationary computer.

Keywords: Blood Pressure, Wireless, Non-invasive, monitoring system etc.

I. INTRODUCTION

“Health is Wealth”, is true not only for an individual, but is perhaps equally important for society in large. A Health care is one of the fast emerging fields today. With the average age of general population increasing each year the credit goes to cutting edge of medical research. New methods are developed almost every month to as a solution to numerous health problems for which accurate diagnosis is the need of the day. The Biomedical equipment providing accurate reproduction of body signals and automated diagnosis and patient monitoring systems. The field of biomedical instrumentation is an integral part of medical research.

Blood Pressure:

Blood pressure is the most often measured and most intensively studied parameter in medical and physiological practice. Pressure measurements are a vital indication in the sucessful treatment and management of critically ill patients in an intensive cardiac care unit or the patients undergoing cardiac catheterisation.

The meaurement of BP are of great importance because it is used for detection of hypertension (high blood pressure). Hypertension is a continuous, consistent, and independent risk factor for developing cardiovascular disease. Hypotension can cause the blood supply to the brain, heart and other tissues to be too low, and hypertension is strongly correlated with higher risk for cerebral stroke and heart infarct. Blood pressure measurement is also important for particular disease patients, such as hemodialysis patients. Hence, in the daily life, blood pressure measurement and management is very useful for handling health situation and plays a preventive function.

II. METHODOLOGY

Photoplethysmography Unit (PPG):

Figure 1. Photoplethysmography Technique

pressure monitors are based on oscillometric method accepted and widely used mobility, they require suitable for home-care and long-term monitoring of BP for homecare inexpensive method that is and does not require These requirements can be which will be designed using technique. method used to measure volume in the tissues. It utilizes contains an infrared light a part of the tissue photo-detector receives the obtained from this technique which can be used to is shown in fig. 1 where used as the source and a phototransistor is used as the detector.

More to the point, a developed technique based on a noninvasive continuous blood pressure measurement using volume oscillometric method and photoplethysmograph technique has been investigated , and the study uses high intensity LED and a LDR (Light Dependent Resistor) and placed them at the edge of a finger. The concept is that the resistance of the LDR changes according to the light intensity received by the LDR. The change in resistance is proportional to the change of blood volume and as well as blood pressure in the finger. The result showed the systolic and diastolic blood pressure on a mini LCD. In addition, a non-invasive blood pressure monitor was developed using photoplethysmograph method.

III. EXPERIMENTAL WORK

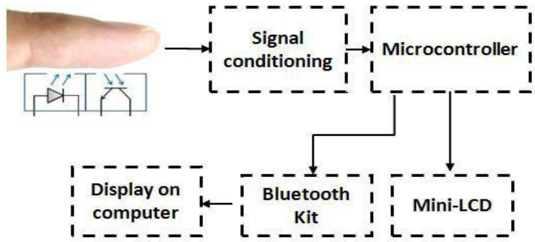

Figure 2. Circuit diagram of system.

A. Sensing Stage

The detection of the blood pressure signal is based on using optical measurement technique called photoelectric plethysmography (PPG). This technique has the ability to detect the volume of blood pressures in the arteries. The PPG basic form utilizes two components: a light source to illuminates a part of the tissue (e.g. fingertip) and a photo detector to receive the light. Transparency of living tissue to light makes it possible for some part of the light from the source to pass through the tissue to the photo-detector.

However, some part of the light is absorbed by the blood, bone, muscle and skin in the tissue. The volume of the blood in the vessel varies while the volume of other part remains constant. Therefore the light absorption is varied only by the change of volume of blood (increases or decreases) and the returning light to the photo-detector changes according to the change of blood volume. The electrical resistivity of the photo-detector changes depending on the amount of light falling on it. This change of resistivity results is the change of electrical current flowing in the detector which is converted into PPG signal.

Figure 3. Optical Sensor

B. Signal Conditioning Stage:

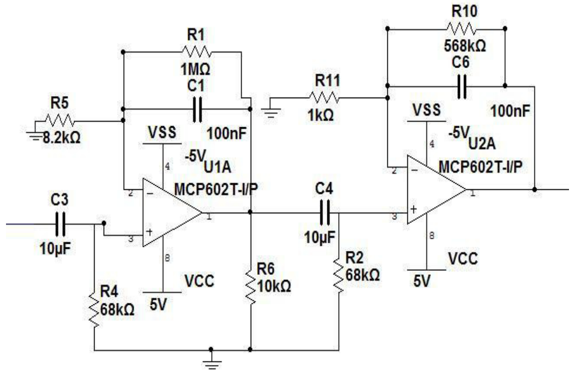

Figure 4. Circuit Diagram

After the sensor detected the changes in the volume of blood pressures, a low frequency and low magnitude biopotential signal is received by the photodiode. As the detected PPG signal is so weak, it must undergo some signal conditioning (e.g. amplifying and filtering) so that it can be used for further processing. Since the output voltage of the photo-detector has a large amount of dc component which requires a filter to suppress out the dc component. A good filter choice will be the use of an active bandpass filter because its first cut off frequency can be used to remove direct current (DC) and its second cutoff frequency can be used to remove unwanted high frequency components in the signal like power line interference (50 Hz). In addition, the filter is also used with a very high gain for amplifying the signal. Two stage bandpass filter are used and each stage has different gain.

C. Microcontroller Stage:

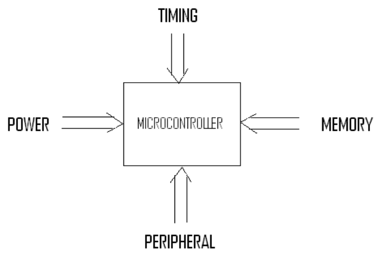

Figure 5. Essential block of microcontroller requirement (PIC18F252)

PIC18F252 is the 28 pin IC, having 10 bit inbuilt A/D converter with five input channels. Operating frequency is DC-40MHz, 32k bytes program memory and data memory is of 1536 bytes. The output of the signal conditioning stage is fed into a microcontroller where it is processed (sampling and quantizing). The PIC18F252 microcontroller is used in this system where it has a built-in ADC. The PIC18F252 device family can operate at speeds up to 12MIPS and has a hardware multiplier for faster calculation of control algorithms. The microcontroller finds out the smallest (represents DBP) and the largest (represents SBP) value form the output voltage using a program written in MPLAB X IDE.

The microcontroller then displays the measured blood pressure information in mini LCD and transmits them through a Bluetooth device to any stationary enabled computer device. Buzzer alert of the system helps the patient itself to be aware of his/her condition and can take necessary steps towards medication. At the same time, physician can also diagnose the patient from a remote location as system provides SMS alert at critical situations. The Bluetooth interface provides a convenient and low power consumption method for data transmission. This system provides users an easy-to-interface interface and simple blood pressure management environment.

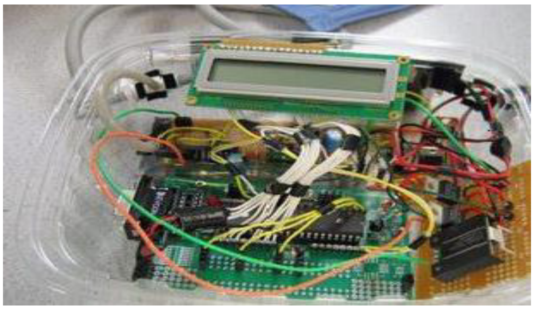

Figure 6. Experimental Work

D. LCD (Liquid Crystal Display) with Driver.

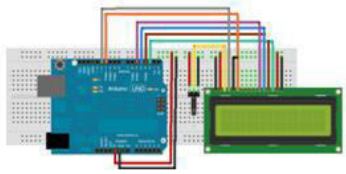

Figure 7 . LCD (Liquid Crystal Display)

A liquid crystal display is a type of display used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them.

E. Bluetooth Technology

By using Bluetooth (SKKCA-21) Remote Control. SKKCA-21 module offers simple yet compact Bluetooth platform for embedded applications. It has a surface mount layout which makes the process of development and application easier. The Bluetooth transmits the reading to the PC equipped with Bluetooth. The display on computer is acquired using special software called Parallax-Serial-Terminal. It is simple terminal software which allows users to display results through predefined serial ports.

F. RF Transceiver Module.

Figure 8. RF Module

An **RF module** (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through Radio Frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver.

IV. RESULT AND DISCUSSION

Age	Gender	PPG(reading)
20	Female	79
26	Female	78
38	Male	84
56	Male	65
60	Male	70

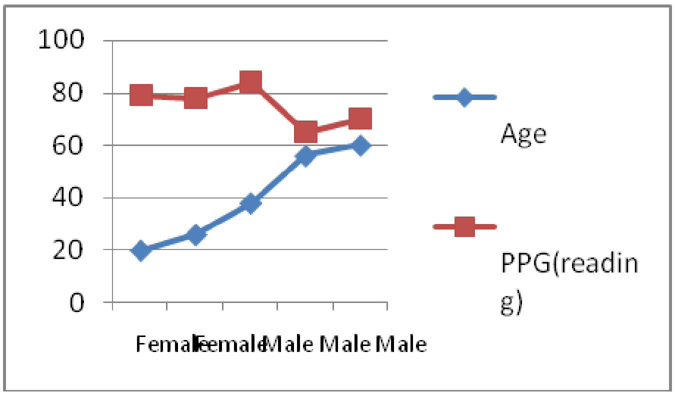

Figure 9. Graph in between Age, Gender and PPG readings.

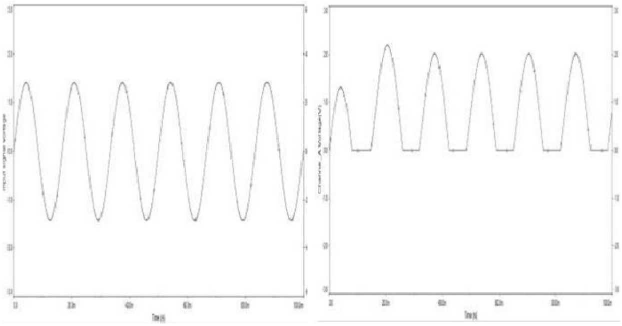

Figure 10. Input and output waveform of amplifier in Multisim

V. CONCLUSION

With this proposed system the blood pressure can be measured continuously for a long period of time and also remotely monitored. The small embedded system can display the systolic and diastolic blood pressure on a mini LCD as well stationary computer which is a Bluetooth enabled device though Bluetooth wireless technology. In case of any abnormal changes in the blood pressure readings, the system alerts using a buzzer and it also send a message to the predefined number(i.e. a physician number) using GSM. Furthermore, the obtained results will be compared with existing devices data like a sphygmomanometer to verify the accuracy of the developed instrument. This system provides users an easy-to-use interface and simple BP management environment. The Bluetooth interface provides a convenient and low-power consumption method for data transmission. This work may further be extended in future to include more number of physiological parameters like heart rate, oxygen saturation, respiration rate etc. to be monitored for a long period of time. GPS system can be used to spot the exact position of the patient and thus can provide immediate help if required.

VI. FUTURE SCOPE

The Scope of research work intended to design and construct an Non invasive blood pressure measurement using Wireless Technology which has the low cost, reliable, and portable and it is used in many medical laboratories and industries where we can get better and more accurate result as compared to other devices.

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An Economical Non-Invasive Epidermis Thickness Measurement by the Application of Oct

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***Abstract* – The skin is the largest multifunctional organ in the body. It behaves as a protective physical barrier by absorbing UV radiation, preventing microorganism invasion and chemical penetration, and controlling the passage of water and electrolytes. There is always a need for developing a novel application for epidermal thickness estimation by non-invasive methods. Non-invasive methods such as Montecarlo method, Infrared diffuse reflection spectroscopy, Infrared light method, Pulsed Ultra Sound, Optical Coherence Tomography, Laser Scanning Microscopy are some of the widely used methods for epidermis thickness estimation. A cost effective non-invasive method to determine epidermal thickness from the intensity of light transmitted in visible region is proposed. Light is passed through the epidermis layers, and then measured what is transmitted back out of the surface. It is observed that transmittance is linearly dependent on the thickness of the epidermis and thus the method can be used for thickness estimation.**

***Keywords* – Epidermis Thickness, LSM, OCT.**

I. Introduction

Skin thickness determination is valuable for various applications. The thickness of skin tissue and the individual layers provide valuable diagnostic information in a number of circumstances. For example, skin thickness is an important indicator of changes in the skin due to chronological ageing and photo ageing. Skin thickness measurements also provide important information related to a variety of endocrine disorders.

Skin thickness is an important skin property in cosmetology, dermatology and pharmaceutical science. It varies significantly between the face and other body parts, and changes with age and environment factors. Changes that markedly affect aesthetics, such as wrinkles, sagging and skin elasticity are the result of physiological changes in the epidermis and dermis layers. Measuring the structural conditions of the epidermis and dermis has, until now, only been possible using complex methods and has required cumbersome equipment.

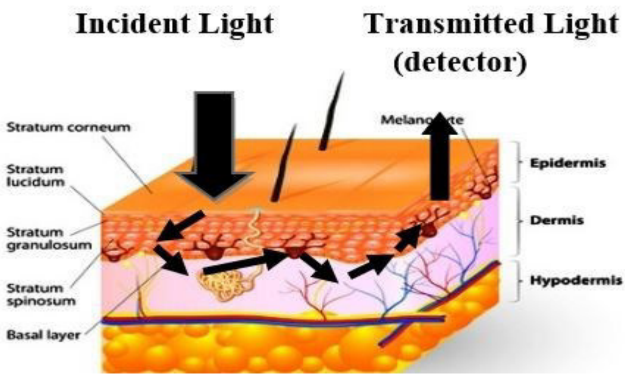

Fig. a. View of a multilayered structure of the epidermis, dermis and hypodermis, along with path of a single photon within the skin.

II. Invasive & Non-Invasive Thickness Measurement

Techniques that can be used to measure the thickness of the epidermis can be categorized in two groups

(a) Invasive:

In Invasive techniques thin cross-sections is obtained from biopsies and prepared using the conventional paraffin-formalin preservation method. This method, offers large amount of data about the sample, has less than 1 μm resolution in deep tissues. Unfortunately, during preparation of the tissue, it deforms and changes the thickness of the sample, due to this reason this method is not used for exact epidermal thickness measurements.

(b) Non-Invasive:

This technique employs two common methods as follows

(1) Laser Scanning Microscopy (LSM):

It is considered a high resolution technique with less than 1 μm resolution. It has the advantage that it produces very good quality horizontal images of the skin but the disadvantage is that a fluorescent agent must be injected to ensure a good image and to determine the exact thickness of the epidermis.

(2) Optical Coherence Tomography (OCT):

It has a typical resolution of 10–30 μm. It is used to obtain images at depths in the range of millimeters. Its advantage is that vertical or in-depth images are better captured but disadvantage is that contrasting agent must be applied.

The above two non-invasive can be efficiently used to determine skin thickness, but these techniques are expensive and difficult to implement. We propose an alternative to the above mentioned technique in the present study: a simple and economic technique, which is non-

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invasive and capable of determining epidermal thickness as a function of the measured transmittance in the visible region of the spectrum. The proposed method is based on the study made by Meglinski and Matcher in which the spatial distribution of detector sensitivity, inside a multilayer medium with strong scattering and absorption, is analyzed.

III. Experimental Setup

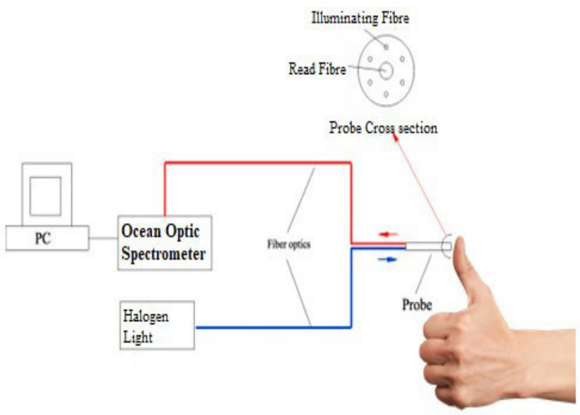

Fig. b. Experimental setup used to measure the transmitted light intensity

As shown in fig b. The experimental setup consists of a halogen light source, an Ocean Optics spectrometer and a reflectance fiber. The reflectance fiber has a central fiber and six outer fibers joined together. The central fiber is connected to the spectrometer and the outer fibers are connected to the light source, such that one collection fiber and six illumination fibers are available. The light emitted from the source travels across all of the outer fibers until it reaches the skin. A portion of the reflected beam is collected by the central fiber, which carries the beam to the spectrometer, from there it is given to ADC or Data acquisition System and then to PC for further store, analysis and processing.

IV. Procedure

The Experiment was carried on in each fingertip of the left hand of 10 persons.

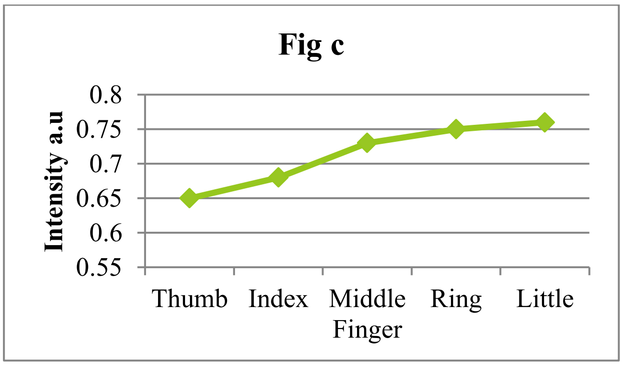

Fig c shows the Transmittance of five fingers in one of the sample.

In order to calibrate our measurements, we determined the thickness of the fingertips using OCT images and then related them to the transmittance intensity measured for each fingertip.

Once the images were acquired, it is identified the epidermal-dermal boundary by an imaginary line. For each image, ten data points (over the line mentioned above) were chosen to obtain the median epidermal thickness.

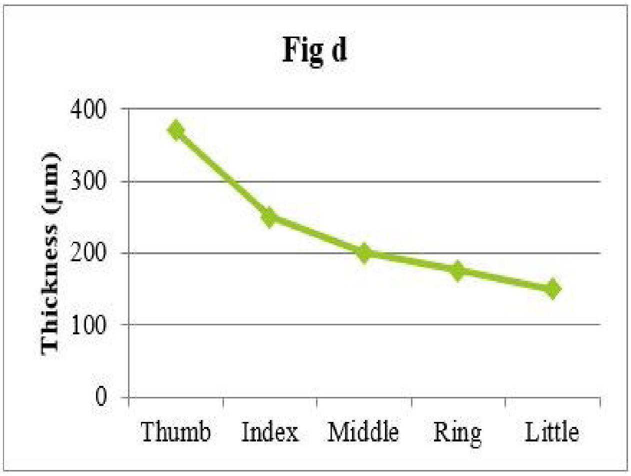

Fig. d. shows the epidermal thickness measurements for thumb, ring, median, index and little finger for one subject

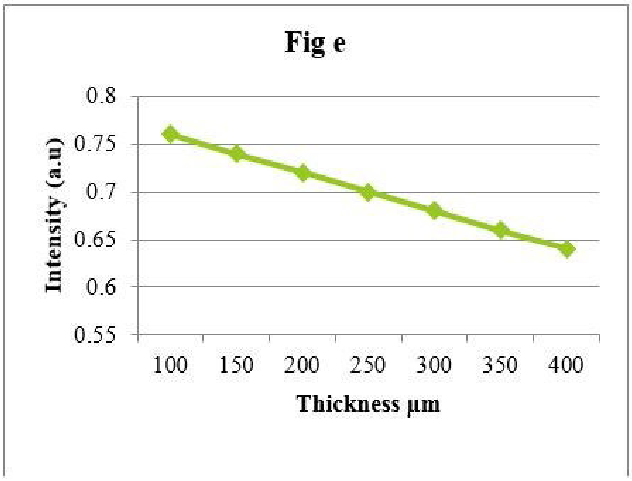

Fig. e. shows the mean intensity of the transmittance measured *in vivo*, as a function of the mean epidermal thickness (obtained by OCT images).

V. Discussion

Earlier different methods such as cross sections cuts, OCT and LSM were used to determine epidermis thickness. Each of these techniques has certain property that makes it suitable for specific applications. The proposed method demonstrates that a noninvasive technique, using transmittance can be used to determine epidermal thickness

From the above procedure thumb has the greatest epidermal thickness and little finger has the least. The technique can be used as a simple, economic and non-invasive method to measure epidermal thickness.

VI. Conclusion

The technique proposed can effectively measure thickness of the epidermis, by a simple noninvasive transmittance measurement. The technique depends on OCT to compare the thickness to the measured transmittance. After the calibration is done we can measure the thickness of epidermis. Though this technique is not very accurate but it is very cheap method to determine thickness of the epidermis.

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