A REVIEW OF VARIOUS TECHNOLOGIES AND TRANSMISSION MODES FOR DESIGN AND DEVELOPMENT OF A TRANSMISSION ENABLED GLUCOMETER

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Abstract

This paper presents the various technologies used for design and development of the glucometer. It also focuses on Various parameters such as different data acquisition methods, various microcontrollers and also different transmission capabilities used are studied in detail. The transmission methods regularly adopted as per review are as follows 1.gsm 2.bluetooth 3.zigbee 4.wi-fi among these the best transmission capability was found in gsm. Available software's such as keil, c++ compiler and SQL data base were also studied in detail to store and transmit the data. Different sensors for measurement of glucose was studied in detail which comprised of 1.amperometric sensors2.fibreoptic sensors 3.spectroscopic sensors among them amperometric sensors were found to be best suitable. Parameters such as data rate, range and complexity of the device are analysed.

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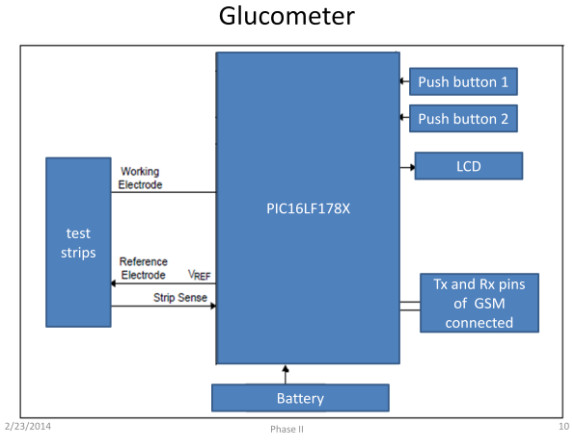
1. INTRODUCTION

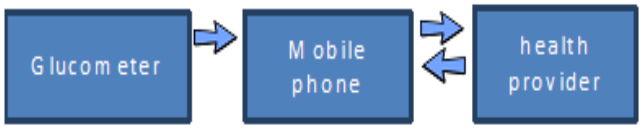
Diabetes is a chronic illness which requires regular monitoring of blood glucose levels, this monitoring helps in preventing complications. This will be fruitful if opinion can be taken by a doctor which is not easily possible owing to shortage of doctors especially in rural areas. This objective of patient doctor interaction can be achieved by glucometer having transmission capabilities.

2. DIFFERENT METHODS OF APPROACH FOR SENSING OF GLUCOSE

The Data Acquisition Module (DAM) is composed a PIC microcontroller [3][6]and a GSM[9][10] module The microcontroller performs serial data transfer of patient's data from the medical device to the GSM module. It also acts as a temporary store for data acquired from medical devices in case of unavailability of GSM [11] services.



The GSM module used to transfer data acquired by the microcontroller to the doctor's mobile phone The TX and RX pins of the GSM module are initially connected to the microcontroller's Universal Asynchronous Receiver/ Transmitter (UART)[6]. Such a connection allows for serial data transfer [2][3] to the GSM module which will then transfer data to the patient's mobile. If the doctor cannot handle the situation the data will be sent to the health providers in super specialized hospital through the dbms software [1][20]



3. AVAILABLE MICROCONTROLLERS

A microcontroller is a small low cost and self contained computer that can be used as an embedded system. Usually they must have low power requirements since many devices that we control are battery operated. Hence well suited for long lasting battery applications the types of micro controller are characterized by their bits, memory and instruction set namely microcontroller 8051,AVR,PIC.[6] Usually 8051 consumes more power than AVR ,we can program easily in AVR when compared with 8051,the speed of AVR is better than 8051 but when we see PIC they have much lower power consumption at 5v.usually PIC's code is completely efficient allowing typically less program memory than other microcontrollers. It is of low cost and has got high clock speed and has embedded A/D convertors and can be used in various medical applications such as

glucometers sphygmomanometers, pulseoximeters, Digital thermometer, ECG.

4. GLUCOSE SENSORS REVIEW

Glucose sensors are developed based on different technology platforms such as

Amperometric Sensors [4][7][8] – an enzymatic electrochemical sensor was developed for continuos glucose monitoring based on a miniaturized[7]planar.the sensor was manufactured by using polymer film technology

Fibreoptic Sensors [4]– these sensors use the enzyme oxidation of glucose in combination with optical oxygen sensor as transducer. A fibre optic dual sensor setup was integrated into a flow through cell. one sensor measures oxygen only. while the second sensor is with an enzyme layer. the advantage of this approach is excellent selectivity of the oxygen optode transducer

Spectroscopic Glucose Sensor[7][8] – A mid infrared sensor for continuos glucose monitoring in combination with a subcutaneous or vascular body interfacewas developed to meet the demand for reagent free assays.the sensor is designed to ensure the utmost reliability need for ICU.

From the types of glucose sensors discussed above the constraint can be found in fibreoptic and spectroscopic sensors due to their level of accuracy. The level of accuracy is better in amperometric sensors[4][18] when compared with the other types

5. VARIOUS WIRELESS TECHNOLOGIES

The most common types of wireless technologies used are
WI-FI - Almost everyone can access the internet in a given area but WI-FI still requires a internet connection this is then led to wireless router that sends and receives data to and from mobile devices depending on the strength of WI-FI signal this wireless technology can cover a single house[10][17] or even a whole school campus. To increase its range signal extenders are used[12][13]

Bluetooth – this has smallest area of effect.A Bluetooth connection only works with a few meters it is widely used to replace cables when transferring data.bluetooth is not ideal when it comes to transferring large amounts of data as it tends to be a slower and can consume a significant amount of power[12][16]

Zigbee[10]- it is widely used today in areas where low power consumption and low cost are absolutely necessary in area where Bluetooth[14][15] would have proven costlier and consumed greater power.zigbee will be able to eliminate the necessity of cables and wires[9][10]

GSM –it usually operates in the 900 and 1800MHz bands.thegsm user will use sim cards for the connection with the service provider.sim cards are small in size with removable memories and can hold a lot of data and number of identifications which are required to access any wireless service provider.the power consumption is usually less[14][15]

	ZigBee	802.11 (Wi-Fi)	Bluetooth	UWB (Ultra Wide Band)	Wireless USB	IR Wireless
Data Rate	*20, 40, and 250 Kbits/s*	11 & 54 Mbits/sec	1 Mbits/s	100-500 Mbits/s	62.5 Kbits/s	20-40 Kbits/s 115 Kbits/s 4 & 16 Mbits/s
Range	*10-100 meters*	50-100 meters	10 meters	<10 meters	10 meters	<10 meters (line of sight)
Networking Topology	*Ad-hoc, peer to peer, star, or mesh*	Point to hub	Ad-hoc, very small networks	Point to point	Point to point	Point to point
Operating Frequency	*868 MHz (Europe) 900-928 MHz (NA), 2.4 GHz (worldwide)*	2.4 and 5 GHz	2.4 GHz	3.1-10.6 GHz	2.4 GHz	800-900 nm
Complexity (Device and application impact)	*Low*	High	High	Medium	Low	Low
Power Consumption (Battery option and life)	*Very low (low power is a design goal)*	High	Medium	Low	Low	Low
Security	*128 AES plus application layer security*		64 and 128 bit encyption			
Other Information	*Devices can join an existing network in under 30ms*	Device connection requires 3-5 seconds	Device connection requires up to 10 seconds			
Typical Applications	*Industrial control and monitoring, sensor networks, building automation, home control and automation,*	Wireless LAN connectivity, broadband Internet access	Wireless connectivity between devices such as phones, PDA, laptops, headsets	Streaming video, home entertainment applications	PC peripheral connections	Remote controls, PC, PDA, phone, laptop links

6. AVAILABLE SOFTWARES FOR STORAGE AND TRANSMISSION

Thekeil[20] and embedded c++ compiler supports the microcontroller families embedded c++[20] is a subset of the c++ programming language that is easy for c programmers to understand and use. the embedded c++ language satisfies the requirements of embedded software designs and avoids the overhead that is introduced eith full c++implementations [19]The primary advantages of these two softwares are Small language specification that retains object orientated features[15],avoids excessive memory consumption, produces predicable run time requirements, generates ROM able code, removes non standard extensions to c++ language features that are not authorized by ANSI/ISO are eliminated and the web applications for mobile phones or pc to the health provider in the super specialist hospital the best possible applications are DBMS preferably SQL data base[19].

7. GLUCOMETERS AVAILABLE IN THE MARKET [9]

Year	Development	Example	Company
1957	First reagent strip using glucose oxidase reaction	Clinistix	Ames
1964	Modified reagent strip for blood glucose	Dextrostix	Ames
1970	Reflectance photometry with Dextrostix	Ames Reflectance Meter	Ames
1973	Mains-powered, single analogue scale	Eyetone	Ames
1974	Reduced blood volume, strip wiping	Reflomat	Boehringer Mannheim
1980	Digital display, whole blood standard	Dextrometer	Ames
1980	Automatic timing	Glucochek/Glucoscan	Lifescan
1981	Improved countdown timer with audio alarm	Glucometer I	Ames
1981	Stored calibration, low/high result alarms	Glucometer I	Ames
1986	Data storage of results	Glucometer M	Ames
1987	Non-wipe, automatic timing, 45-second measurement time test strip	OneTouch	Lifescan
1987	First biosensor enzyme electrode sensors	Exactech	Medisense
1991	Capillary-fill sampling with 5 µL blood	HemoCue	
1997	Downloading results to personal computers	Glucometer Esprit	Bayer
2001	Plasma calibration	OneTouch Ultra	Johnson & Johnson
2002	Catering for visually impaired persons	AccuChek Voicemate	Roche
2003	Biosensor using coulometry, alternative site testing	Freestyle Freedom	Abbott
2003	Autodisc of 10 strips replaced reagent strips	Ascensia Breeze	Bayer
2005	17-test strip barrel	AccuCheck Compact	Roche
2008	Talking blood glucose meter	SensoCard Plus	BBI

8. CONCLUSIONS

Based on the review done the best possible approach for the transmission enabled glucometer can be done by using the amperometric glucose sensors and GSM wireless technology and the softwareskeil,c++compiler and SQL data base are used for storage and transmission of data

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