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# Smart Textile based Lifelong Wearable Personal Health Data Recorder

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**ABSTRACT**: Field of wearable computing has great implications for medical applications including early detection, treatment, compliance monitoring, care for the frail and elderly, telemedicine, physical therapy and many others. The proposed system of early warning system for heart disease by smart textile electronics and android application. Generally our normal wearable dresses are act as health recorder devices, it aims to facilitate users to early detect heart disease which can be used independently. To make it easier for monitoring the ECG of their patients outside the hospital. This system designed and developed for ECG monitoring and alarm based on android smart phone. E-textiles are fabrics that feature electronic interconnections woven into them, presenting physical flexibility and typical size that cannot be achieved with other existing electronic manufacturing techniques. ECG sensor interfaces with Lilly pad control unit and normal woven acts as a conducting element. The measured signals are compiled to the controller by CCS compiler and data's are sending via android mobile to the patient and hospital.

**KEYWORDS:** E-Textiles, ECG, Lilly pad, Bluetooth, CCS Compiler, AVR Studio.

## I.INTRODUCTION

Today patient monitoring system is a challenging one in the field of medical field, there are several new technologies are innovated by the researchers for biomedical instrumentation and data communication. One of the most challenging areas is Electro Cardiogram, Electro Encephalogram and Electro myography. In these signals are taken out by the wired electrodes. This may cause an improper signal from the electrodes for the patient. So medical electronic equipments has been designed to avoid the malfunction of the data recording system of the human body. The main concept behind the human body data recording system has been improved by the Body Area Network to communicate all the data from the human body. Data recording system for the any human part is shock free, reliable, wait less and compact. For overcome all the technologies necessary parameters are achieved by the wired and wireless sensor nodes.

An intelligent method for efficient data transfer and data analysis is achieved by smart textiles based wearable health data recorder for EGC and EEG signals. The term smart textiles refer to a broad field of studies and products that extend the functionality and usefulness of common fabrics. Smart textiles are defined as textile products such a fabric, filaments and yarns together with woven, knitted on non woven structures, which can interact with the environment or user. The convergence of textiles and electronics can be relevant for the development of smart materials that are capable of accomplishing a wide spectrum of functions, found in rigid and non-flexible electronic products now a day's smart textile will serve as a means of increasing social welfare and they might lead to important savings on welfare budget, they integrate a high level of intelligence.

Sensors provide a nervous system to detect signals, thus in a passive smart material the existence of sensors is essential. The actuators act upon the detected signals either autonomously or from a central control unit together with the sensors, they are the essential element for active smart materials. Fabric based sensing has been a large field of research in the biomedical and safety communities. The fabric sensors can be used for EGC, EEG and EMG sensing, fabrics incorporating thermocouples can be used for sensing temperature. Luminescent elements integrated in fabric could be used for bio photonic sensing, shape sensitive fabrics can sense movement and combined with EMG sensing to derive muscle fitness. Carbon electrodes integrated into fabrics can be used to detect specific environmental or biomedical features such as oxygen, salinity, moisture or contamination.

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## II. RELATED WORKS

Body area networking is enabled by the rapid development of wireless sensor networks and biomedical engineering. The health care system has a specific communicating technology from transferring the data to the patient monitoring system to the doctors. There is several methods have been proposed for the efficient transfer of health recorded data. Even though every method has some of the disadvantages in it. We assume that the health care system is a body area network system which is based on performance evaluation of UMTS (Universal Mobile Telecommunication system) and Ultra wide Band technology [1]. Wiring system for sensor node connections providing power and signal lines to each of the sensor nodes must be realized with the minimum number of wires. This is because wires are hard to implement in stretchable textiles, they are most fragile and expensive part of such a smart textile requiring that their number should be kept to a minimum [2]. This method should provide data rates of at least several full frames per second for the system to be usable in real time, this includes gathering data of every sensor in the system in each frame and transmitting the gathered data for processing [3]. Active functionality could include power generation or storage, human interface element, radio functionality or assistive technology. Power generation can be achieved through piezoelectric elements that harvest energy from motion or photo voltaic elements [4]. A self test to detect a heart attack using wearable sensors and mobile phones uses sensor nodes placed over the human body for pickup the signal from the human parts which are powered by the external battery, which shows the non reliability of the data recording system [5]. A smart phone can be used to diagnose the rate of the signals from the wireless sensors which should provide a necessary action by the hospital through it. An android application is developed for communicating the data from the sensors by cloud storage of the internet thus the required action is taken by the controller [6].

## III. PROPOSED SYSTEM MODEL

The proposed smart textile prototype contains 63 sensor nodes connected in a line topology with four wires from one node to the next, from the below figure. Two of the wires provide power to the network and the other two are used for synchronization and communication. For the purpose of stability and noise reduction signals travelling through several nodes are repeated. This setup proves that data from a branch of chained network nodes can still be gathered at a rate of more than 50Hz while using power supply voltage of 3.6V and 200 sensor nodes and still maintaining the voltage drop over the chain to a manageable amount.

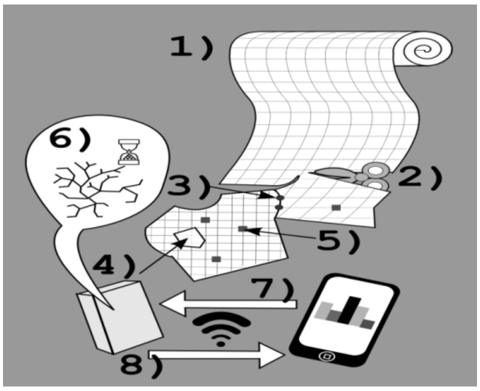


Fig 1: E-Textile Formation.

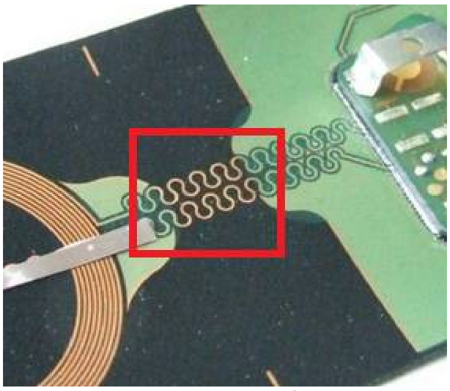

Fig 2: Data transmission from sensors.

It was determined that the wires themselves must be made from solid copper because the high and unstable resistance of the elastic wiring made from elastic substances enriched with electrically conductive particles. A much more stable and desirable solution for stretchable wiring has been developed by this method. This technology consists of developing circuits with specific shape allowing for small deformations and then laminating these circuits on some sort of textile. The line topology used in the previously mentioned prototype has no built in redundancy in case of cut or damaged wires. At the moment grid shaped topology is being developed with wires connected to each node from all four sides in straight angles. Although such solution will probably yield much better redundancy results in case of cutting the textile, development and testing of this concept is still required. After the fabric has been cut, a important

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part of the system calibration will graph based on load balancing to ensure that each sensor node can work with similar load thus reducing the overall system frequency and consequently power consumption.

## IV.SYSTEM ARCHITECTURE

### a) METHODOLOGY

The proposed system module is divided into two parts namely as data gathering unit and data transferring unit, following figure shows the block diagram of both the units,

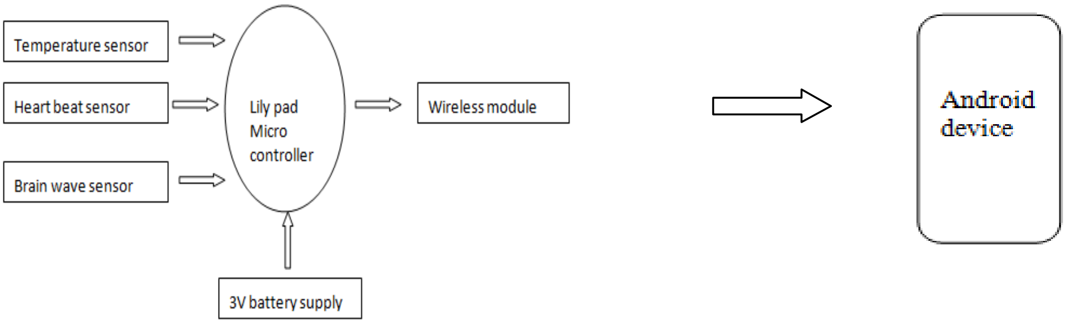


Fig 3: Data Gathering and Transferring units.

Temperature sensor senses the temperature of our body, heart beat and brain wave sensors sense the heart beat and brain waves from the body, these signals are given to the lily pad controller, the lily pad controller is a simple board of small computer, it can be stitched to fabric and connected to other electronic pieces with conductive thread. Lily pad microcontroller sends the data to the android mobile through blue tooth. The wireless communication carried out to optimize motion and power management. All are compiled with Pro-level optimization in ANSI C.

### b) LILY PAD CONTROLLER

The Lily pad Arduino simple board is a small computer; it can be stitched to fabric and connected to other nodes with conductive thread. This Lily pad board has 11 pins, the silver petal like tabs that ring the outside of the board. Each of these pins, with the exception of (+) and (-), can control an attached input or output device like light, motor or switch. This board is based on ATMEGA 328V microcontroller, the controller is the black square in the centre of the board, and you can program this lily pad board using Arduino programming environment. This board has 11 pins as 9 pins for input and output pins, on-off switch and build in battery socket.

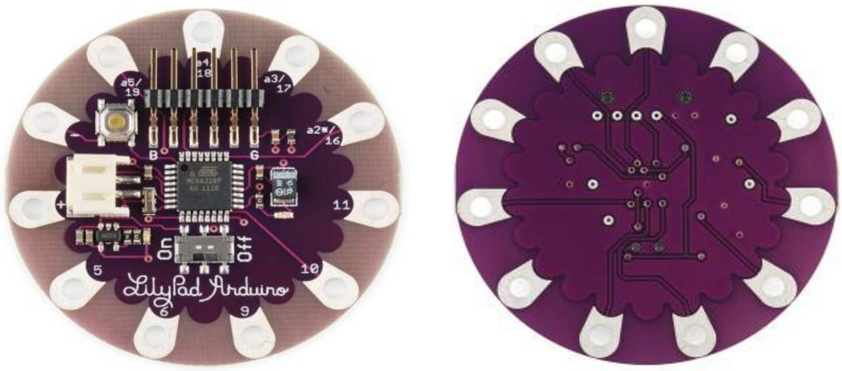


Fig 4: Lily Pad Arduino Microcontroller.

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**c) OPERATION FLOW**

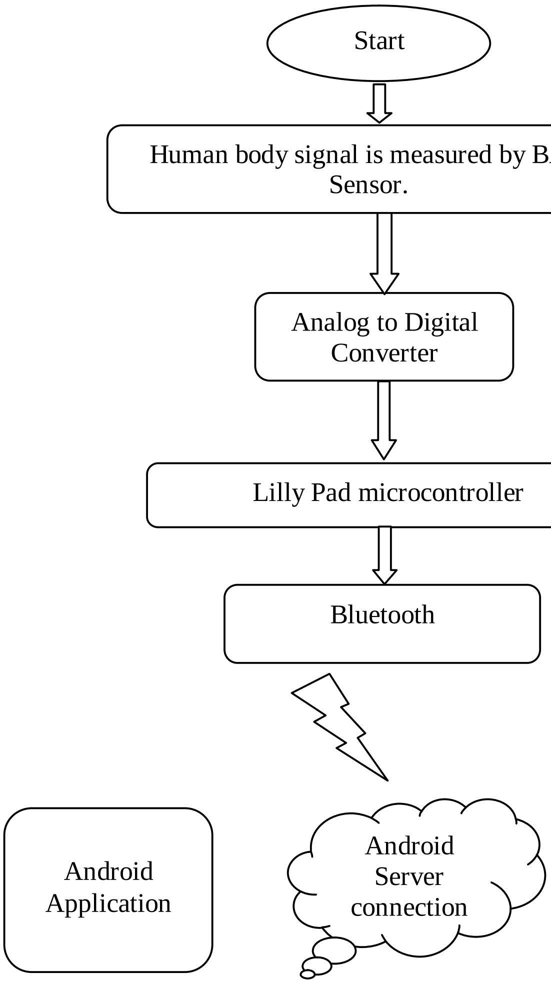


Fig 5: Operation flow.

**d) CONDUCTIVE MATERIALS**

Besides sensors and actuators there is a group of materials that conducts electricity, these are the conductors they are usually not categorized as sensors or actuators but due to their conductive properties, they are useful in smart applications. As pathway to transferring data information but they are also important components in the creation of sensors and actuators. Metals like silver and copper are the most conductive materials. Carbon has good conductivity and is used both in its own pure silicon; however in the creation of sensor conductive polymers could be used since these applications are not always dependent on high conductivity.

## V. E-SEWING

In terms of intelligence, the smart system will require a central processing unit that will carry out data to the different sensors and decide action on the basis of the results. The processing unit consists of hardware and software causes unique dynamic behaviour in real time. The traditional package of computing material is a computer that allows data processing as well as communication. The processing unit is a complex structure of electronic circuitry that executes stored program instructions. Included in this structure are integrated circuits, secondary storage, power supply and communication technologies.

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Fig 6: Sewing the thread.

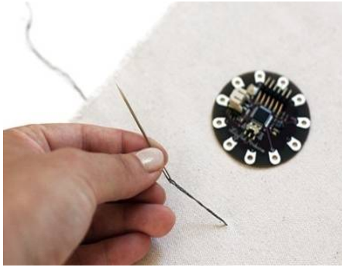

Fig 7: Stitching to the cloth.

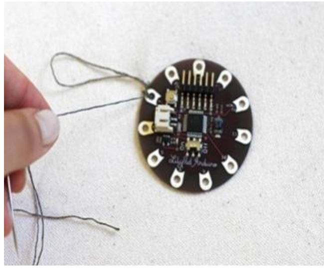

Fig 8: Connecting to the Lily pad

Most integrated circuits are made of silicon because of the semiconductor properties of the substance. Another type of circuit suitable for wearable application is organic electronics. These materials are flexible, light weight, strong and have a low production cost, however the electronic properties of the conducting polymers do not match those of silicon. The most common power sources are AA batteries or Lithium batteries. This describes how to sew a simple lily pad Arduino circuit using Lily pad and an output board. The basic sewing information is needle, tying a knot and stitching.

## VI. DESIGN AND RESISTANCE MEASURING

Plan the circuit on a paper sheet, one between the (-) tab the output board and (-) tab on the Lily pad and the other between the (+) tab of the output board and one of the I/O tabs on the Lily pad. Once the connections have been done also went to mark them on the fabric with a piece of chalk. Chalk will wash out of fabric without leaving any marks. Thread the needle and tie a knot at the end of the thread. Push the needle through the fabric, from the back to the front of the fabric so that knot will appear on the back of the fabric. Align lily pads (-) tab with needle, sew through the (-) tab pushing the needle back to the fabric. Now see around the Lily pads (-) tab at least three times this will ensure that the conductive thread makes a strong electrical connection with the tab.
Start sewing towards the (-) tab of your output board, following along any makes have made on fabric. Ready to sew output board on bring the needle to the front side of the fabric, push the needle through (-) tab in output board and on through the fabric. The common use scenario of a smart textile, facilitating rapid, low cost development and deployment of wearable computing follows.

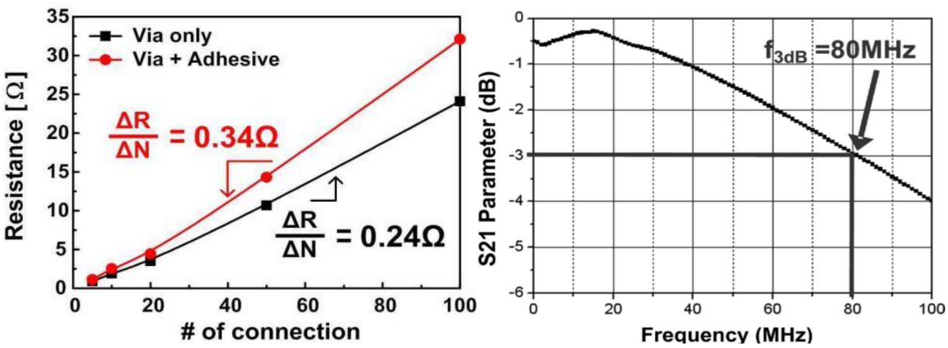


Fig 9: Measurement of via and conductive resistance.

The cloth with wiring integrated within a universal grid is mass produced resulting in rolls of smart textile similar to the rolls of ordinary textile. Clothing is tailored from the smart textile in the same way as ordinary clothing. Wiring from different physical parts of the clothing such as sleeves and torso is connected together in the same network. The measured sheet resistance of the conducting film on the P-FCB is 44 MΩ/m, as determined by the four point probe method. Although no noticeable degradation has been observed even after 50 laundry cycles more durability examinations will be required with an automatic testing system. The following measurement results of the proposed conductive adhesive resistance.

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## VII.ADVANTAGES

In one wiring dimension more than 200 sensor nodes can be connected with existing technology, while still providing acceptable voltage drop for stable data transmission of 20 bytes per sensor node, 50 times per second resulting in data rate of approximately 200 kB/s. In a multidimensional branching setup where range to each sensor node would be kept below this threshold, the limiting factor would be communication clock frequency which using the available clock in the used microcontrollers would allow for at least 1000 sensors with similar data rate. Smart textiles present a challenge in several field such as the medical, sport and artistic communities, the military and aerospace. The early European commission's $6^{th}$ and $7^{th}$ framework programs provided significant research and development funding for personal health monitoring through smart wearable systems and for projects targeting the integration of sensors, energy sources, processing and communication inside the clothing. Particular attention in this review is devoted to describing the materials and methodologies to develop smart textiles. Each scientific approach will be followed by a review of the related work carried out by companies, universities and research institutions.

## VIII. CONCLUSION

Textile represents an attractive class of substrates for realizing wearable bio sensors. Electronic textiles or smart textiles describe the convergence of electronics and textiles into fabrics which are able to sense, compute, communicate and actuate. As many different electronic systems can be connected to any clothing a wearable system becomes more versatile and the user can change its look depending on environmental changes and individual preference. The vision of wearable computing describes future electronic systems as an integral part of our every day clothing serving as intelligent personal assistants. Therefore such wearable sensors must maintain their sensing capabilities under the demands of normal wear which can impose sever mechanical deformation of the underlying garment or substrate. One promising approach to reduce the rigidity of electronic textile and enhance its wear ability is to replace PCBs by flexible electronics.

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