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Smart Textile for Healthcare Monitoring

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ABSTRACT

An electrocardiography SoC, flexible electrodes, battery, and antenna are all combined into a form- fitting cloth. This "smart shirt" records a 12-1ead ECG, which is the clinical standard. Using a flexible antenna and on-chip ISM band radio, the data is securely transferred wirelessly, consuming less than lmW and enabling secure, continuous cardiac monitoring on a smartphone.

Keywords: Electrocardiography (ECG),System-on-Chip (SoC),FIexibIe electrodes,Battery,12-lead ECG,WireIess data transfer,ISM band radio

Introduction

Technological breakthroughs have caused a tremendous upheaval in the healthcare sector in recent years. Smart textiles are one of these inventions that really sticks out as a ground-breaking idea that might completely change healthcare monitoring. Smart textiles provide a unique, non-invasive, and extremely successful method to patient care by seamlessly integrating electronics into fabrics. Conventional healthcare monitoring techniques frequently entail large, unpleasant gadgets that limit patients' range of motion and jeopardize their comfort. Smart textiles, on the other hand, do away with these limitations by integrating sensors, actuators, and other electrical parts right into garments. This allows for ongoing physiological parameter and vital sign monitoring without interfering with the patient's day-to-day activities. Smart textiles have a broad range of uses in healthcare that go beyond simple monitoring. These textiles provide a comprehensive solution for proactive healthcare management, ranging from tracking physical activity and identifying irregular heart rhythms to monitoring blood glucose levels and evaluating sleep quality. Moreover, real-time data transmission and analysis are made easier by their seamless integration with wearable technology and wireless communication systems, which allows for prompt intervention and individualized treatment plans. Improving patient outcomes and increasing the effectiveness of healthcare delivery are two major benefits of using smart textiles in healthcare monitoring. Smart textiles enable medical practitioners to make well-informed judgments and take preemptive measures to avert unfavorable outcomes by giving them access to precise, real-time data. As sensor technology, materials science, and data analytics continue to progress, smart textiles have the potential to become a vital component of the healthcare system. Smart textiles have the potential to revolutionize healthcare delivery by enabling continuous, non-invasive monitoring of patients' health state. This rrñght lead to a more proactive, tailored, and patient-centric approach to healthcare delivery. Smart textiles are expected to be crucial in creating a healthier and more connected world as we move forward with health care.

Methodology

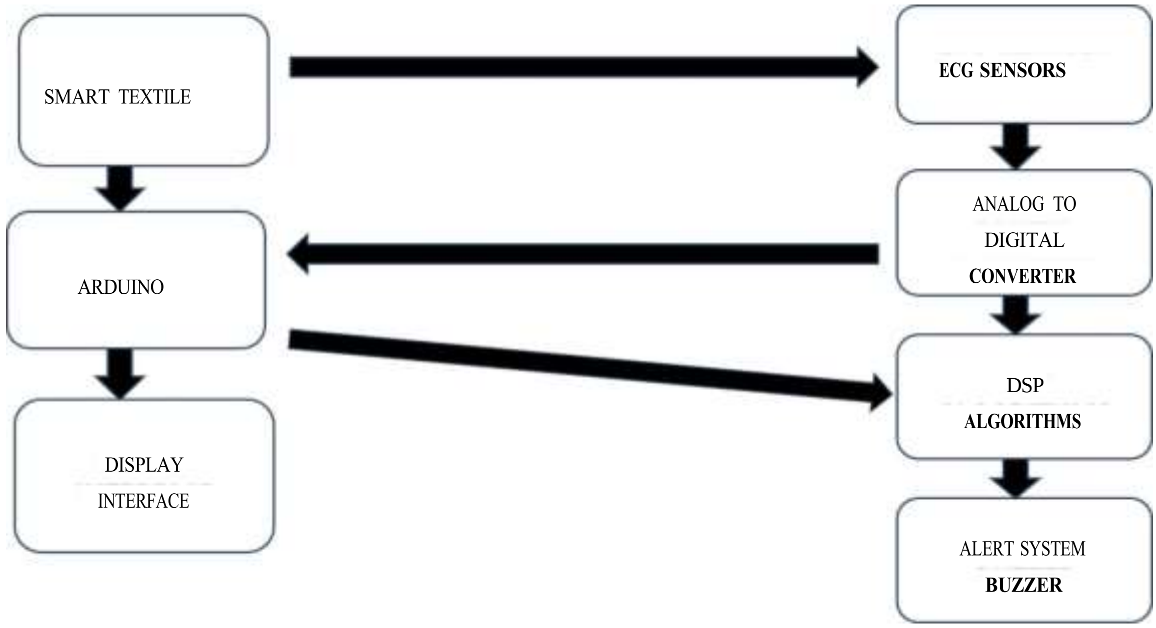

Fig: Block diagram of Smart Textile For Healthcare Monitoring

1. **Smart Textile Fabric:** Fabric with conductive and flexible materials that is integrated with Textronic E-Textile Sensors. records physiological signals from the body, such as the ECG.
2. ECG **Sensor:** Contains an analog front-end, a signal amplifier, and sample electrodes. Captures and enhances the electrical impulses that the body produces.
3. Analog **Processing:** Uses a variety of filters for signal conditioning as well as an ana1og-to-digita1 converter (ADC). transforms analog ECG sensor signals into digital format and prepares the signal for additional processing.
4. **Arduino Nano Microcontroller:** This microcontroller handles communication, data processing, and component interface enables communication, applies methods for data compression and heart rate analysis, and processes digital information.
5. **Digital Signal Processing:** Performs data compression, transmission, and heart rate analysis among other digital signal processing activities.eva1uates ECG readings, calculates heart rate, handles data compression, and controls communication with other devices.
6. **Display Interface: A** visual output interface for information display (LCD, LED, etc.). gives the user access to pertinent data, such heart rate or system condition.

Proposed System:

The utilization of smart textiles for ECG measurements is a revolutionary development in the wearable health technology space. This suggested approach aims to establish a network of discrete yet extremely effective ECG electrodes by sewing conductive textiles or threads into garments. A small, light monitoring device that can be discreetly attached or integrated in the textile is a crucial part of this system. The smart textile is made of materials that favor durability and breathability, with an emphasis on user comfort. Because washable materials are used, the item is practical and appropriate for daily usage. This smart textile technology has applications in a range of healthcare settings, including as preventive care and remote patient monitoring. Healthcare practitioners can evaluate and intervene remotely in the event of an abrupt cardiac incident thanks to continuous ECG monitoring. Thus, the suggested solution solves the demand for inconspicuous, ongoing, and easily accessible ECG monitoring by fusing technological innovation with user-centric design..

Literature Survey

1. **Authors:** Mathew Ridder and **Luis** Lopez **Ruiz.**

TITLE: E-textiles and Multi-i Model **Harvesting for Self-Powered** Cardiac **Monitoring** and Vigilance Maintenance, **August 23, 2001.**

The nexus between engineering and medicine has given rise to remote patient monitoring. Many of these applications fall under the category of cardiac monitoring, and the use of wearable monitors in routine clinical practice has been driven by the necessity to record fleeting cardiac events. The problems of user comfort, skin irritation, and motion artifacts are addressed by a customized ECG shirt consisting of knitted compression fabric with embedded dry electrodes.

2. **Hui** Yang, Chen **Kan, and Wensin Tong.**

TITLE: Wearable **Textile Sensitivity Analysis** for ECG Sensing.

Biomedical & Health **Informatics 2018 IEEE** EMBS **International** Conference.

The new generation of wearable electrocardiogram (ECG) sensing equipment is brought about by rapid advancements in material science and mobile technology. Specifically, because of their great reusability and flexibility, sensing textiles have found extensive application in cardiac monitoring. The sensitivity of textile-based ECG sensing to four factors—contact pressure, textile positioning, user activity, and muscle activity—is experimentally investigated in this work.

3. AUTHORS: V S **Prakash, Sarthak Sahu, Avvaru Srinivasulu, and N.** Sriram.

TITLE: Smart **Testile** Electrode Belt **For Recordings - A Pilot Study with Indian Population.** The International Conference on Signal **Processing and Communication** (ICSPC - **2019) is taking** place **in 2019.**

This work demonstrates that the suggested design of a silver-plated nylon woven (SiPNyW) textile electrode can record an ECG signal while the patient is immobile. This signal quality is comparable to that obtained by a typical Ag/AgC1 ge1 e1ectrode.ECGs were recorded using a textile electrode belt with a Lead-I configuration based on SiPNyW.For the purpose of HRV analysis, 147 healthy Indian volunteers between the ages of 18 and 45 participated in this study. According to the findings, the quality of the ECG signal obtained by cloth electrodes and Ag/AgC1 electrodes was about equal.

4. DR. Malti Bansal, Bani Gandhi is the author.

TITLE: Smart ECG **Monitoring Using Textiles** Based **on CNTs.**

The third conference on recent developments in power **engineering, automation, and control is scheduled for 2019.**

A key technological advancement in the healthcare industry is the evolution of flexible, conformal, and stretchy electronics integrated with commercially accessible electronic modules placed on a soft and elastic substrate. The needs for healthcare have changed over time, shifting from being hospital-centric to home-centric. ECG signals from the patient, which can subsequently be sent to the physician for professional guidance. Thus, we shed light on CNT-based textiles for intelligent ECG monitoring in this study.

5. **Authors: Manabu Yoshida and Toshihiro Takeshita.**

Title: CUBIC Embedding Amplifier Circuit with Flocked Electrode for Smart ECG Testile

Application.2010; Tsukuba, National Institute of **Advanced Industrial** Science **and Technology**

They presented a unique dry electrode configuration for the development of smart electrocardiogram (ECG) textile. Ag-plated fiber was flocking onto a dimethylpolysiloxane (PDMS) cube using electrostatic flocking technology as the dry electrode. Its construction allowed for consistent contact pressure. It is possible to create a highly functional and versatile vital signs monitoring system by employing this electrode structure to integrate electrical devices like a MEMS sensor, battery, MCU, and RF-IC inside the cubic dry electrode.

6. AUTHORS: Tsair Kao **and Chien-Lung** Shen.

TITLE: Wearable **Band Monitoring Exercise** ECG **Using** a Fabric-Based **Sensor,2006**

Smart textiles have garnered a lot of attention lately, particularly for wearable clothing that can capture vital signs. Our study presents a system for monitoring the exercise electrocardiogram (ECG) using fabric-based garment sensing; a Bluetooth-based wireless communication configuration for transferring the signals into a PDA; and an algorithm for extracting the appropriate ECG signals from the raw data. The testing findings while at rest, walking, or running demonstrate that this wearable clothing system can accurately and steadily obtain the RRI and ECG.

7. AUTHORS: Joshua Di Tocco, Carlo Massaroni, and Daniella Lo Presti.

TITLE: Sensor **positioning** affects cardiac **monitoring using a** smart textile based **on polymer-**

encapsulated **FBG,2018 is the year.**

One of the most cutting-edge categories of wearables for continuous, non-invasive heart activity monitoring is smart textiles. One well-known method relies on identifying the vibrations that the heartbeat causes on the surface of the chest. Various sensor placements have been studied in the literature, but it doesn't seem like there are any widely acknowledged standard points for the identification of heart-induced motions.

8. **Writers:** W. Chen, S. Bangag Oetomo, M.D.

Title: Developing Testile Neonatal ECG **Monitoring Capabilities Through Multi-Sensor Captures,August 30, 2011, Boston,** Massachusetts, USA, **33rd Annual International** Conference of **the IEEE EMBS** conference.

Because textile electrodes can create inadvertent low signal quality and motion artifacts, it might be difficult to maintain accurate monitoring when building an ECG monitoring system incorporated with textile electrodes for comfort. We suggest the ideas of "diversity measurement" and "context awareness" to enhance the design of a cozy monitoring system for prematurely born infants in the Neonatal Intensive Care Unit (NICU) and to increase dependability. We have developed design criteria and meta-insights regarding the function of clinical validation in the design process as a result of our exploratory system level approach.

9. Hassan Bajwa, **Linfeng Zhang, and Ali Alzaidi** are the **authors. TITLE: Wireless ECG** System Based on Smart **Texti1es,2011 is** the year.

There have also been new reports on non-contact electrodes and smart textiles. This research presents a wireless ECG system that makes use of smart textile sensors. An essential component of a wireless ECG system is a non-contact ECG electrode that was created using clever materials and several textile technologies. Together with the system level radio design that might be merged with the suggested ECG electrode and textile-based conformable antenna, this study will also provide the design of the integrated conformal patch antenna based on textiles.

10.Authors: Bani Gandhi, **Malti Bansal.**

TITLE: ECG Electrodes for Smart ECG Monitoring for biomedical applications.Third International Conference on I-SMAC (Internet of Things in Social Media, Mobile, Analytics, and Cloud) Proceedings (I-SMAC **2019).**

The healthcare sector is under tremendous pressure due to the world's population growth. In addition to being more linked and portable, healthcare systems should be dependable. The sensors that are utilized to measure the Electrocardiogram (ECG) for different CVDs are the most important thing. Carbon nanotubes (CNTs) have several benefits, including flexibility, conductivity, and low weight. As a result, they can be incorporated into fabrics or utilized to create electrodes. Therefore, those who have CVDs can use these electrodes or sensors in their daily lives to help detect the condition early and improve their quality of life.

Summary of Literature Review

TABLE: Literature review summary

Published year	Author name	Title of the paper	Proposed technique	Limitations
2018 [1]	Hui Yang, Chen Kan, and Wenxin Tong.	Sensitivity Analysis Of Wearable Textiles For ECG Sensing.	Bitalino Sensor	Cost of the Sensor is more
2001 [2]	Mathew Ridder and Luis Lopez Ruiz.	Self Powered Cardiac Monitoring- Maintaining Vigilance With Mult-i Model Harvesting And E-Textiles.	Wearable monitors. Self powered system.	Battery life lirrrit the duration. Represent high noise.
2019 [3]	VS Prakash, Sarthak Sahu, Avvaru Srinivasulu, and N. Sriram.	Smart Textile Electrode Belt For Recordings - A Pilot Study with Indian Population.	Ag/AgCl gel electrode. Conductive fabric. AD8232 single lead	Gel may cause irritation.
2019 [4]	Malti Bansal, Bani Gandhi is the author.	CNT Based Textiles For Smart ECG Monitoring.	MWCNT(Multi walled nanotubes) SWCNT(Sing1e walled nanotubes)	Biocompatibility concerns. Washability & durability.
2010 [5]	Manabu Yoshida and Toshihiro Takeshita.	Cubic Flocked Electrode Embedding Amplifier Circuit For Smart ECG Textile Application.	Dry electrode known as dimethyl poly siloxane cube(PDMS) ECG amplifier, MCU,RF—IC are embedded in PDMS cube	Electrical insulations Integration Challenges. Biocompatibility.

2006 [d]	Tsair Kao and Chien-Lung Shen.	Wearable Band Using a Fabric-Based Sensor for Exercise ECG Monitoring.	Fabric based garment sensing system	Potential interference from motion artifacts during physical exercise
2019 [7]	Joshua Di Tocco, Carlo Massaroni, and Daniella Lo Presti.	ECG Electrodes for Smart ECG Monitoring for biomedical applications	Integration of carbon nanotubes (CNTs) into wearable electrocardiogram (ECG) sensors or electrodes.	High sensitivity and specificity
2018 [8]	W. Chen, S. Bangag Oetomo, M.D.	Cardiac monitoring with a smart textile based on polymer-encapsulated FBG: influence of sensor positioning.	Computational Modeling	Chest surface vibrations can be affected by motion artifacts caused by factors such as body movement, respiration, and external environmental disturbances.
2011 [9]	Hassan Bajwa, Linfeng Zhang, and Ali Alzaidi are the authors.	Designing For Reliable Textile Neonatal ECG Monitoring Using Multi- Sensor Recordings.	System-Level Approach, Diversity Measurement	Complexity in hardware design
2011 [10]	Bani Gandhi, Malti Bansal.	Smart Textiles Based Wireless ECG System.	Textile—Based Conformal Patch Antenna	Signal Quality and Reliability

Conclusion and Future Scope

In order to advance the automotive and medical industries, smart textiles are used in a variety of industrial and healthcare sectors. Their monitoring as well as other technological features are crucial. Innovation and investment in smart textiles benefit each of the corresponding industries. A number of issues, including the weaving techniques and flexibility, need to be fixed. The smart textiles will be even more beneficial if the silica fiber is swapped out for another viable fiber. There is little doubt that smart textiles will make a big impact in the realms of technology and medicine.

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3. Piezoelectric Energy Harvesting from Intelligent Textiles by Waqar, S., Wang, L., and John, S. Elsevier, Amsterdam, The Netherlands, 2015, Electronic Textiles, pp. 173-197. 978-0-08-100201-8 is the ISBN. [Scholar Google]

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