TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 11552 - 11558

Smart Stretcher and Integrated Medical Intelligence Systems for Unconscious Person

[1]K.Sujatha, [2]V.Srividhya, [3]R.S. Ponmagal, [4]V.Karthikeyan, [5]R. Shobarani, [6]Su-Qun Cao

[3]Asso.Professor, [6]Professor
[1,4]EEE Department, [3,5]CSE Dept.,
Dr. MGR Educational and Research Institute
[2]EEE Department, Meenakshi College of Engineering
[6]Faculty of Electronic Information Engineering, Huaiyin Institute of Technology,
Huaian City, Jiangsu Prov., China.

Article Info
Volume 83
Page Number: 11552 - 11558
Publication Issue:
March - April 2020

Article History
***Article Received**: 24 July 2019*
***Revised**: 12 September 2019*
***Accepted**: 15 February 2020*
***Publication**: 16 April 2020*

Abstract

India stands the second largest in the population worldwide. Excess population serves as a major problem in our country. Statistics have reported that one death per minute occurs because of unpredictable and unexpected accidents. To save a life is auspicious as well as precious. The idea here is to provide an intelligent smart health system using some sensors and microcontrollers which are implemented in stretcher. The aim of this system is to save many human lives by connecting the patient related information to the intensive care unit in hospital, as their physical parameters are updated to hospital before their arrival to hospital.

Keywords: *Bluetooth low energy (BLE), ECG telemonitoring, healthcare, Internet of Things (IoT), telehealth care, wearable monitoring system, wearable sensors.*

1. Introduction

The global challenge for the human race is the monitoring of health conditions. Hence, the stream related to development of healthcare systems has taken priority in the last ten years. The major idea is to build a consistent patient monitoring system as a contribution to healthcare department by offering an online setup to monitor the patients, directly hospitalized or associated with their routine life style. Recently, the patient monitoring systems is one of the major advancements because of its improved technology [1,2,3,4]. The drawback with the current systems in use requires the visit of patients directly to the hospitals for consultation with the physician so as to gather information about the particular disease diagnosis and prevention. The second drawback is that the patient monitoring system (PMS) which are existing are not reliable and so to develop a more sophisticated system the technology is used to construct a smart system [5,6,7,8].

Based on the survey, till now, even hospital aide informs the live status of patient, there is no any smart system to inform patients live condition to nursing home through online. Also it is must to inform immediately about accident to relatives and police station to take appropriate legal action. To overcome these issues, we are proposing an idea to implement a smart system in stretcher in ambulance itself. In existing, it is also noted that minimum two workers are required to push stretcher safely. The proposed system will help to overcome this problem also.

2. Proposed System

The proposed system consists of two sections namely stretcher section and hospital section. In stretcher section, there are many health monitoring sensors to monitor patient live health parameters that are implemented in stretcher [9,10,11,12]. This information is updated to hospital via server for every second. Also it is necessary to inform about accident and patient personal details to nearby police station along with location. For this, a biometric sensor is used to get patient personal information. This information is updated to hospital and police station through Internet of Things. With this information, an alert will be messaged to patient's relatives by cop. Second section is hospital section. After reaching hospital, it is must to admit the patient in intensive care unit as soon as possible. But there are many obstacles that may interfere between entrance and care unit. Till now, hospital workers move the stretcher manually [13,14,15,16]. It may take some time delay due to applying human power. To solve this issue, a stretcher control mechanism is implemented in this system which is controlled by microcontroller. By initiating this mechanism, stretcher moves automatically by stretcher moving mechanism with guidance of human. If the stretcher moves very fast or uncontrollable, then an emergency stop switch will be activated automatically to stop litter. A sonic humidifier sensor is implemented to detect whether any person or other object interferes in stretcher path. If any interfere occurs, alerting system is activated to avoid such interferes [17,18,19,20].

3. System Overview

The flowchart of the proposed system is shown in Fig. 1. The system can access multiple patients simultaneously.

1) It has three ECG electrodes, an analog ECG front end, an MCU with an onboard radio transmitter.
2) An interface for smartphone which receives patient data and transmits it to a remote server using internet.
3) An IoT server to accumulate the ECG data and transmit it to the physician's smartphone.
4) User interfaces for physicians to see patients' ECG signal and HR remotely, by adding or removing patients to the database from both web interface and cell phone interface.

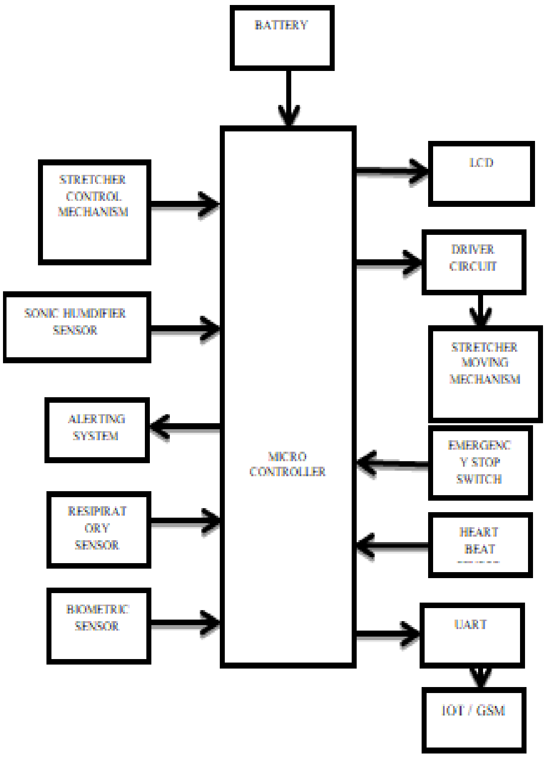

Figure 1: Stretcher Section

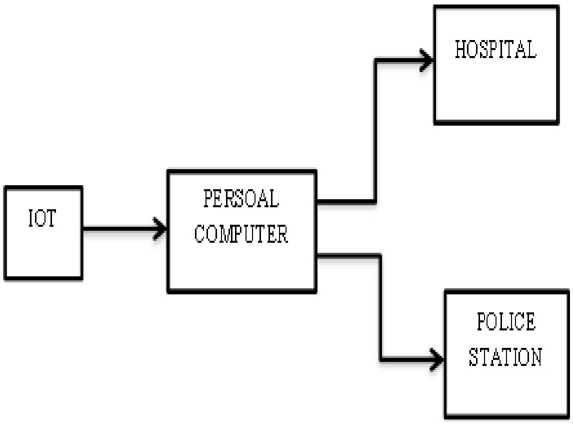

Figure 2: Monitoring Section

The monitoring section depicted in Fig 2, indicates the communication from the computer to the police station and hospital using IoT. Fig 3, denotes the stages in the proposed system.

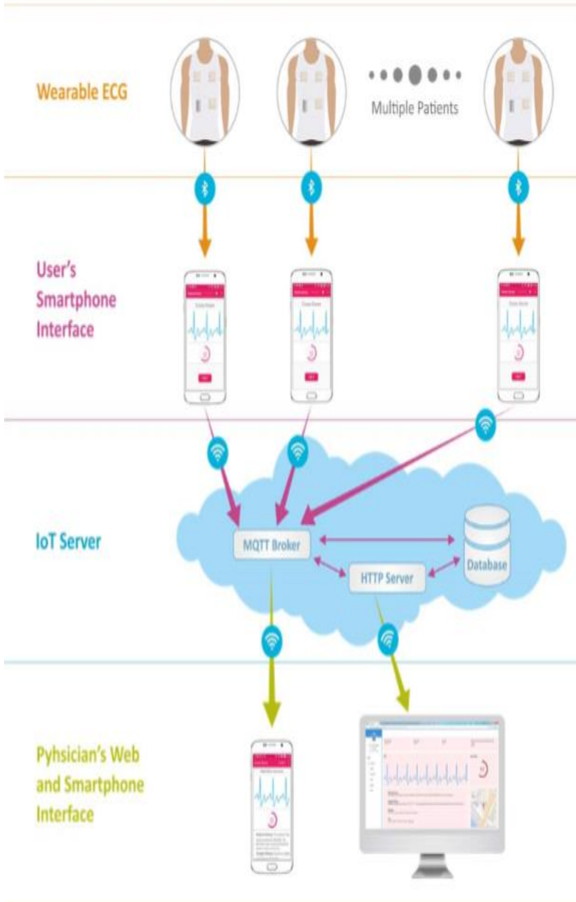

Figure 3: Architecture for the proposed system

4. System Hardware Design

A. Micro controller

Microcontroller is a small computer on a single chip. A microcontroller has general purpose chip when compared with a microprocessor, to generate a multiple functions and to handle various tasks [21-30]. CMOS (complementary metal oxide semiconductor) technology is used as an effective tool for fabrication of microcontrollers. It consumes less power and is more resistant to power spikes. It is an integrated chip and forms a part of an embedded system. The microcontroller consists of a CPU, RAM, ROM, I/O ports, and timers to perform various operations like arithmetic and logical operations [31-36].

B. Respiratory Sensor

The Respiration Sensor is used to monitor abdominal or theoretical breathing, in biofeedback applications such as stress management and relaxation training shown in Fig 4. Besides measuring breathing frequency, this sensor also gives you an indication of the relative depth of breathing. The Respiration Sensor for Nexus can be worn over clothing, although for best results we advise that there only be 1 or 2 layers of clothing between the sensor and the skin. The Respiration Sensor is usually placed in the abdominal area, with the central part of the sensor just above the navel. The sensor should be placed tight enough to prevent loss of tension [37].

Figure 4: Respiratory sensor

C. Heart Beat Sensor

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it as shown in Fig 5. When the HEART BEAT detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse [38]. Heart Beat is sensed by using a high intensity type LED and LDR [39].

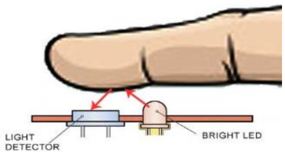

Figure 5: Heartbeat sensor

D. Biometric Sensor

Biometric sensor is an optical type sensor. R305 fingerprint module is fingerprint sensor with TTL UART interface for direct connections to microcontroller UART or to PC through MAX232 / USB Serial adapter. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person. The FP module can directly interface with 3V or 5V Microcontroller. A level converter (like MAX232) is required for interfacing with PC serial port as shown in Fig 6.

E. Force Sensor

This is a force sensitive resistor with a round, 0.5" diameter, sensing area is shown in Fig 7. This FSR will vary its resistance depending on how much pressure is being applied to the sensing area. As the force increases the resistance decreases. At the time when no pressure is exerted on the FSR its resistance is large, whose value is nearly 1MΩ. The FSR can detect the forces in the range of 100g to10kg. The area of contact of the electrodes is inversely proportional to the resistance.

Figure 6: Bio metric sensor

March - April 2020
ISSN: 0193-4120 Page No. 11552 - 11558

Figure 7: Force sensor

F. Ultrasonic Sensor

Ultrasonic sensor emits ultrasonic pulses, and by measuring the time of ultrasonic pulse reaches the object and back to the transducer. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor as shown in Fig 8.

Figure 8: Ultrasonic sensor

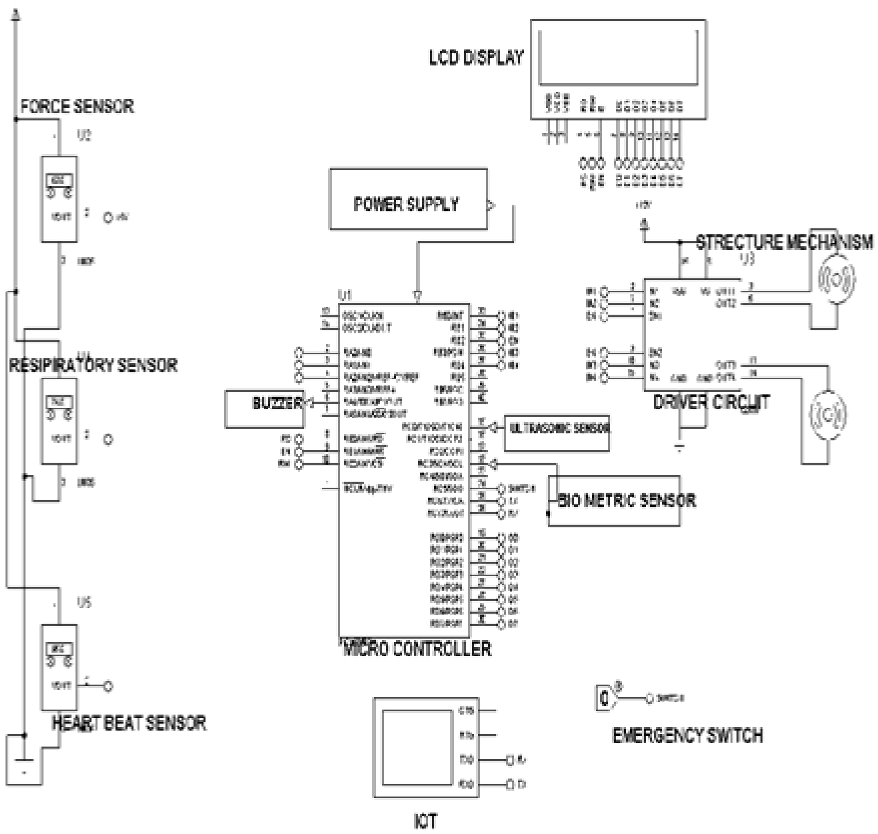

Figure 9: Circuit diagram

March - April 2020
ISSN: 0193-4120 Page No. 11552 - 11558

Table 1: Readings from Glucometer

Blood Sugar Chart			
Category of a person	Fasting Value (mg/dl)		Post Prandial (mg/dl)
Min Value	Max Value		Value 2 hours after consuming glucose
Normal	70	100	Less than 140
Early Diabetes	101	126	140 to 200
Established Diabetes	More than 126	-	More than 200

Table 2: Digital Thermometer

Temperature	Characteristic
98.6˚ F	Normal Temperature
> 98.6˚ F	Illness

Table 3: Heart Rate Meter

Ages	Heart Rate
New born baby	120 to 160
Baby aged from 1 to 12 months	80 to 140
Toddler aged from 1 to 2 years	80 to 130
Child aged 7 to 12 years	75 to 110
Adult aged 18+ years	60 to 100
Adult athlete	40 to 60

Table 4: Measurement of BP

BP Category	BP rate
Very high BP	>140 mm of Hg
High BP	<=120 and > 140 mm of Hg
Normal BP	>120 and < 90 mm of Hg
Low BP	>=90 and <=70 mm of Hg
Very low BP	>=70 mm of Hg

5. Results and Discussions

The circuitry is illustrated in Fig 9. The prototype of the proposed smart health monitoring system is shown in Fig 10 which is attached to rear surface of the stretcher so that the system behaves in a smart way. Nearly 32 patients were tested with this system. Out 32 patients, the sample size contained nearly 10 patients whose body parameters were normal and remaining 22 patients had variations in Blood Pressure (BP).

6. Conclusion

Health care devices form an important fragment in the society, which helps in indigenous automation in measuring the body parameters. Also the transparency of this system helps patients to trust it. As continuous monitoring of patient condition is performed, physician can analyze current status of patient which will help to take decision him to provide suitable treatment.

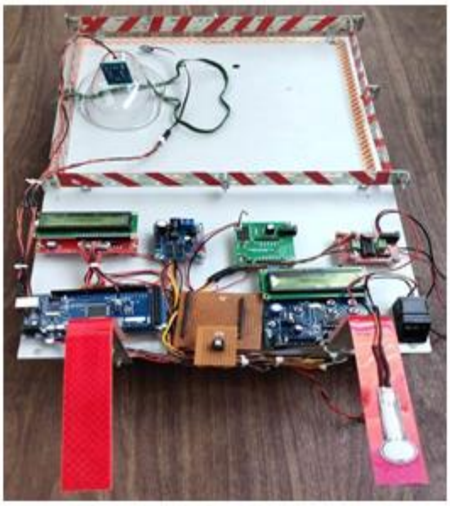

Figure 10. Implemented hardware module

March - April 2020
ISSN: 0193-4120 Page No. 11552 - 11558

References

[1] Cardiovascular Diseases (CVDs), World Health Org., Geneva, Switzerland, 2018.
[2] S. Shirmohammadi, K. Barbe, D. Grimaldi, S. Rapuano, and S. Grassini, "Instrumentation and measurement in medical, biomedical, and healthcare systems," IEEE Instrum. Meas. Mag., vol. 19, no. 5, pp. 6–12, Oct. 2016.
[3] E. Nemati, M. J. Deen, and T. Mondal, "A wireless wearable ECG sensor for long-term applications," IEEE Commun. Mag., vol. 50, no. 1, pp. 36–43, Jan. 2012.
[4] A. M. Khairuddin, K. N. F. K. Azir, and P. E. Kan, "Design and development of intelligent electrodes for future digital health monitoring: A review," inProc. IOP Conf. Ser., Mater. Sci. Eng., vol. 318, no. 1, Mar. 2018, p. 12073.
[5] J. Crawford and L. Doherty, Practical Aspects of ECG Recording. Keswick, U.K.: M&K Update Ltd, 2012.
[6] M. S. Mahmud, H. Wang, A. M. Esfar-E-Alam, and H. Fang, "A wireless health monitoring system using mobile phone accessories," IEEE Internet Things J., vol. 4, no. 6, pp. 2009–2018, Dec. 2017.
[7] G. Gargiulo et al., "An ultra-high input impedance ECG amplifier for long-term monitoring of athletes," Med. Devices, Auckl, vol. 3, pp. 1–9, Jul. 2010.
[8] B. Chamadiya, K. Mankodiya, M. Wagner, and U. G. Hofmann, "Textilebased, contactless ECG monitoring for non-ICU clinical settings," J. Ambient Intell. Humaniz. Comput., vol. 4, no. 6, pp. 791–800, Dec. 2013.
[9] G. Andreoni, C. E. Standoli, and P. Perego, "Wearable monitoring of elderly in an ecologic setting: The SMARTA project," in Proc. Sensors Appl., 2015, pp. 1–18.Renewable Energy Policy Network for the 21st Century, "Advancing the global renewable energy transition," REN21 Secretariat, Paris, France, 2017 [Available Online].
[10] B. Taji, S. Shirmohammadi, V. Groza, and I. Batkin, "Impact of skin– electrode interface on electrocardiogram measurements using conductive textile electrodes," IEEE Trans. Instrum. Meas., vol. 63, no. 6, pp. 1412–1422, Jun. 2014.
[11] R. Castrillón, J. J. Pérez, and H. Andrade-Caicedo, "Electrical performance of PEDOT:PSS-based textile electrodes for wearable ECG monitoring: A comparative study," Biomed. Eng. OnLine, vol. 17, no. 1, p. 38, Dec. 2018.
[12] A. Achilli, A. Bonfiglio, and D. Pani, "Design and characterization of screen-printed textile electrodes for ECG monitoring," IEEE Sensors J., vol. 18, no. 10, pp. 4097–4107, May 2018.
[13] T. Pola and J. Vanhala, "Textile electrodes in ECG measurement," in Proc. 3rd Int. Conf. Intell. Sensors, Sensor Netw. Inf., 2007, pp. 635–639.
[14] C. Liao, M. Zhang, M. Y. Yao, T. Hua, L. Li, and F. Yan, "Flexible organic electronics in biology: Materials and devices," Adv. Mater., vol. 27, no. 46, pp. 7493–7527, Dec. 2015.
[15] P. Rai, S. Oh, P. Shyamkumar, M. Ramasamy, R. E. Harbaugh, and V. K. Varadan, "Nano-bio-textile sensors with mobile wireless platform for wearable health monitoring of neurological and cardiovascular disorders," J. Electrochem. Soc., vol. 161, no. 2, pp. B3116–B3150, Dec. 2013.
[16] A. Cömert, M. Honkala, and J. Hyttinen, "Effect of pressure and padding on motion artifact of textile electrodes," Biomed. Eng. OnLine, vol. 12, no. 1, p. 26, Apr. 2013.
[17] L. Rattfält, "Smartware electrodes for ECG measurements: Design, evaluation and signal processing," Ph.D. dissertation, Dept. Biomed. Eng., Linköping Univ., Linköping, Sweden, 2013.
[18] T. Liang and Y. J. Yuan, "Wearable medical monitoring systems based on wireless networks: A review," IEEE Sensors J., vol. 16, no. 23, pp. 8186–8199, Dec. 2016.
[19] Y. G. Lim, K. K. Kim, and S. Park, "ECG measurement on a chair without conductive contact," IEEE Trans. Biomed. Eng., vol. 53, no. 5, pp. 956–959, May 2006.
[20] C. Park, P. H. Chou, Y. Bai, R. Matthews, and A. Hibbs, "An ultrawearable, wireless, low power ECG monitoring system," in Proc. IEEE Biomed. Circuits Syst. Conf., Nov./Dec. 2006, pp. 241–244.
[21] I. G. Trindade et al., "Design and evaluation of novel textile wearable systems for the surveillance of vital signals," Sensors, vol. 16, no. 10, p. 1573, Sep. 2016.
[22] M. A. Yokus and J. S. Jur, "Fabric-based wearable dry electrodes for body surface biopotential recording," IEEE Trans. Biomed. Eng., vol. 63, no. 2, pp. 423–430, Feb. 2016.
[23] D. Pani, A. Dessì, J. F. Saenz-Cogollo, G. Barabino, B. Fraboni, and A. Bonfiglio, "Fully textile, PEDOT:PSS based electrodes for wearable ECG monitoring systems," IEEE Trans. Biomed. Eng., vol. 63, no. 3, pp. 540–549, Mar. 2016.
[24] J. Yoo, L. Yan, S. Lee, H. Kim, and H.-J. Yoo, "A wearable ECG acquisition system with compact planar-fashionable circuit board-based shirt," IEEE Trans. Inf. Technol. Biomed., vol. 13, no. 6, pp. 897–902, Nov. 2009.
[25] F. Lamonaca, G. Polimeni, K. Barbé, and D. Grimaldi, "Health parameters monitoring by smartphone for quality of life improvement," Measurement, vol. 73, pp. 82–94, Sep. 2015.

[26] P. S. Pandian et al., “Smart Vest: Wearable multi-parameter remote physiological monitoring system.,” Med. Eng. Phys., vol. 30, no. 4, pp. 466–477, May 2008.

[27] H. Dai, S. Jiang, and Y. Li, “Atrial activity extraction from single lead ECG recordings: Evaluation of two novel methods,” Comput. Biol. Med., vol. 43, no. 3, pp. 176–183, Mar. 2013.

[28] J. S. Arteaga-Falconi, H. Al Osman, and A. El Saddik, “ECG authentication for mobile devices,” IEEE Trans. Instrum. Meas., vol. 65, no. 3, pp. 591–600, Mar. 2016.

[29] K. Luo, J. Li, and J. Wu, “A dynamic compression scheme for energyefficient real-time wireless electrocardiogram biosensors,” IEEE Trans. Instrum. Meas., vol. 63, no. 9, pp. 2160–2169, Sep. 2014.

[30] A. Dionisi, D. Marioli, E. Sardini, and M. Serpelloni, “Autonomous wearable system for vital signs measurement with energy-harvesting module,” IEEE Trans. Instrum. Meas., vol. 65, no. 6, pp. 1423–1434, Jun. 2016.

[31] C. Gomez, J. Oller, and J. Paradells, “Overview and evaluation of Bluetooth low energy: An emerging low-power wireless technology,” Sensors, vol. 12, no. 9, pp. 11734–11753, 2012.

[32] J. M. Bland and D. G. Altman, “Statistical methods for assessing agreement between two methods of clinical measurement,” Lancet, vol. 327, no. 8476, pp. 307–310, Feb. 1986.

[33] Z. Zhang, Z. Pi, and B. Liu, “TROIKA: A general framework for heart rate monitoring using wrist-type photoplethysmographic signals during intensive physical exercise,” IEEE Trans. Biomed. Eng., vol. 62, no. 2, pp. 522–531, Feb. 2015.

[34] J. Dong, J.-W. Zhang, H.-H. Zhu, L.-P. Wang, X. Liu, and Z.-J. Li, “A remote diagnosis service platform for wearable ECG monitors,” IEEE Intell. Syst., vol. 27, no. 6, pp. 36–43, Nov./Dec. 2012.

[35] U. Satija, B. Ramkumar, and M. S. Manikandan, “Real-time signal quality-aware ecg telemetry system for IoT-based health care monitoring,” IEEE Internet Things J., vol. 4, no. 3, pp. 815–823, Jun. 2017.

[36] E. Spanò, S. Di Pascoli, and G. Iannaccone, “Low-power wearable ECG monitoring system for multiple-patient remote monitoring,” IEEE Sensors J., vol. 16, no. 13, pp. 5452–5462, Jul. 2016.

[37] S.-C. Lee and W.-Y. Chung, “A robust wearable u-healthcare platform in wireless sensor network,” J. Commun. Netw., vol. 16, no. 4, pp. 465–474, Aug. 2014.

[38] I.-J. Wang et al., “A wearable mobile electrocardiogram measurement device with novel dry polymer-based electrodes,” in Proc. IEEE Region 10 Annu. Int. Conf. (TENCON), Nov. 2010, pp. 379–384.

[39] A. Ankhili, X. Tao, C. Cochrane, D. Coulon, and V. Koncar, “Washable and reliable textile electrodes embedded into underwear fabric for electrocardiography (ECG) monitoring,” Materials, vol. 11, no. 2, p. 256, 2018.