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ULTRA LOW POWER SECURE IoT PLATFORM FOR DIAGNOSIS RESPIRATORY AND CARDIOVASCULAR DISEASES

S. Jamuna[1], M. Naveen[2]

1Student, Department of Applied Electronics, Gojan School of Business and Technology, Chennai, India
2Asst. prof., Department of electronics and communication engineering, Gojan School of Business and Technology , Chennai, India.

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Abstract*: In Internet of Things (IoT) technology the health-care sector through remote, continuous, and non-invasive monitoring of patients. However, there are two main challenges faced by the IoT-enabled medical devices: energy- efficiency and security/privacy concerns. An ultra-low power and secure IoT sensing/preprocessing the prediction of ventricular arrhythmia using ECG signals. the proposed architecture is designed using an Application Specific Integrated Circuits design flow in 65-nm Low Power Enhanced technology. it consumes the power of 62.2% less than that of the state-of-the-art approaches, it occupying 16.0% smaller area. The proposed system uses ECG key that enables protection of communication channel and offers protection also at the hardware level that means protect from reverse engineering. The security infrastructure is kept at 9.5% for area and 0.7% for power.*

Key*Words*:*Internetofthings(IoT),Implantablemedical devices(IMD),Electrocardiogram(ECG),Instrumentalamplifier(IA),ventriculararrhythmia(VA),ventricular fibrillation (VF), Ventricular tachycardia (VT).*

I. INTRODUCTION

Developments in electronics and wireless communication technologies have spawned an era of Internet of things (IoT) . Composed of a large number of simple interconnected components that employ massive communication to augment each other's functionality, IoT enabled devices and systems find applications across healthcare,smart buildings, and intelligent transport systems . In the healthcare sector, millions of IoT-enabled implantable medical devices (IMDs) and wearable devices are being deployed, which range from cardiac defibrillators and insulin pumps to ECG processors and fitness trackers Comprising typically 1) a sensing module,2) a communication module, and 3) an application module, IoT- enabled solutions help tremendously in improving patient care, enhancing the overall quality of life .These integrated platforms allow continuous aggregation and intelligent mining/pre-processing of health data that can be transmitted either periodically or judiciously based on the detection of certain events, over the network to medical facilities for further evaluation. Reliance on battery/harvested power and continual monitoring operation for extended lifetimes imposes strict power consumption constraints on IMDs/wearable devices . Thus, energy efficiency is a major concern in these devices.

II.EXISTING METHOD

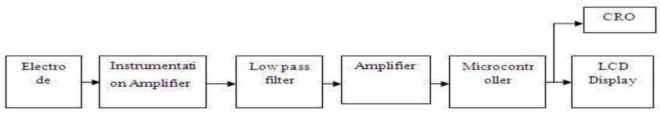


Fig 1 Block Diagram of Existing System

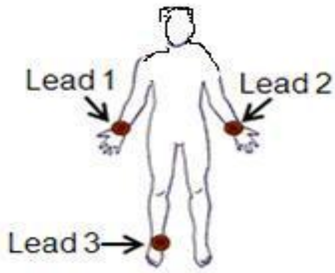


Fig 2 A 3 – Lead connection

The system consists of an silver chloride (Ag / Cl) sticking electrode or a sensor,. The second stage is an Instrumentation amplifier (IA), which has a high gain (1000) .The output of IA, is passed through the low pass filter with a cut off frequency of 150Hz. This block is used to convert the ECG signals to square waveform. Cathode Ray Oscilloscope is used to display the output waveform. Microcontroller is used to perform the counting of pulses. LCD is used to display the heart rate.

A. Electrode: It converts physical signals into electrical voltage. The voltage is in the range of 1 mV ~ 5 mV. The sensor pair is stuck on the right arm (RA), left arm (LA) and right leg (RL) of the subject (see Figure 2).

B. Instrumentation Amplifier: it is the most popular instrumentation amplifiers (INAs). Analog instrumentation amplifier to amplify the ECG voltage from electrodes, which is in the range of 1mV to 5mV.we are using op-amp 741, with a gain of 1000 and power supply is +12V to -12V.

C. Low pass filter: It is used to remove the unwanted signals like noise. the frequency range of ECG is 0.04HZ to 150 Hz, and its cut off frequency of 150HZ.

D. Amplifier: It consists of a simple non inverting amplifier which is designed to control the ECG signals, and the output of amplifier is fed to the microcontroller to count the heart rate.

E. Microcontroller: Microcontroller is used for counting of the pulses., it is used to count heart rate .
F. LCD: It is used to displaying the result on a text based LCD (Normal, Low, High).

Drawbacks of the Existing System

It sense only heart beat rate not sense the respiratory , body temperature and humidity.

The health parameters of the patient are send through the Zigbee, Bluetooth Communication protocol. These protocols have short communication ranges to transmit the data. At any time the doctor can't able to see the health parameters of the patient

III. OVERVIEW OF PROPOSED METHOD

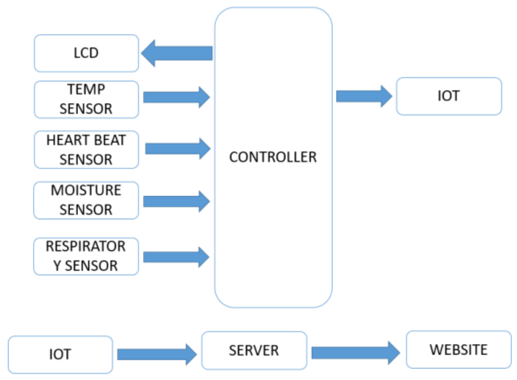


Fig 3 Block Diagram of Proposed System

An ultra-low power and secure IoT sensing/preprocessing platform for prediction of ventricular arrhythmia using ECG signals. Our proposed solution is able to predict the on-set of the critical cardiovascular events up to 3 h in advance with 86% accuracy and also sensing body temperature, humidity and respiratory problems. Here four sensors are used for sensing temperature, humidity, heartbeat and respiratory.

Pic microcontroller collects the data from the sensors and sends the data through IOT. The protected data sent can be access anytime by the doctors by typing the corresponding exclusive IP address in any of the internet Browser at the end user device(eg. Laptop, Desktop, Tablet ,Mobile phone).

The microcontroller is connected to IOT which provides information to doctor/caretaker when the heart rate is greater than 90 or less than 60 and when temperature is less than 20 or greater than 35.LCD is connected to microcontroller to display the transaction process and healthcare data. patient health status is continuously send to doctor. Therefore continuous monitoring of patient data is achieved.

ADVANTAGES OF PROPOSED SYSTEM

In this system is used to record the data from different sensors and stores the data to the cloud by using the technology called IoT.

The proposed system mainly focuses the situation where the doctors and patients are at the distant location and it is very important to give the entire details about the heartbeat, respiration details and the temperature of the patient to the doctor. This system records the entire details of the patients on cloud. So that anyone either doctor or relatives of that patients can monitor his condition from anywhere.

IV.LITERATURE SURVEY

The purpose of the Literature Survey is to give the brief overview and also to establish complete information about the reference papers. The goal of Literature Survey is to completely specify the technical details related to the main project in a concise and unambiguous manner.

[1] H. Kim, R. F. Yazicioglu, T. Torfs, P. Merken, H.-J. Yoo, and C. Van Hoof

The ESP consists of three heterogeneous processors and performs filtering, data compression, ECG classification, and encryption. A data reduction scheme, consisting of skeleton and Huffman coding, are employed to reduce the on-chip memory capacity and memory access power. Clock gating and voltage scaling are also applied to reduce the power consumption. The ESP consumes 1.26-μW at 0.7V, while providing real time signal processing.

[2] J. W. Schleifer and K. Srivathsan

The management of ventricular tachycardia and ventricular fibrillation in the cardiac intensive care unit can be complex. These arrhythmias have many triggers, including ischemia, sympathetic stimulation, and medication toxicities, as well as many different substrates, ranging from ischemic and nonischemic cardiomyopathies to rare genetic conditions such as Brugada syndrome and long QT syndrome. Different settings, such as congenital heart disease, postoperative ventricular arrhythmias, and ventricular assist devices, increase the complexity of management. This article reviews the variety of situations and cardiac conditions that give rise to ventricular arrhythmias, focusing on inpatient management strategies.

[3] N. Ellouze, S. Rekhis, N. Boudriga, and M. Allouche,"Cardiac implantable medical devices forensics

Cardiac Implantable Medical devices (IMD) are increasingly being used by patients to benefit from their therapeutic and life-saving functions. These medical devices are surgically implanted into patient's bodies and wirelessly configured by prescribing physicians and healthcare professionals using external programmers.

A digital investigation system for the postmortem analysis of lethal attack scenarios on cardiac IMDs. After developing a set of techniques allowing the secure storage of digital evidence logs which track the executed sensitive events, we implement an in-depth security solution allowing the protection of cardiac IMDs. An inference system integrating a library of medical rules is proposed to automatically infer potential medical scenarios that caused the patient's death, or that created heart-related emergency situations (through the occurrence of ventricular tachycardia for example). The results obtained by the two proposed reasoning techniques (i.e., the inference system and the Model Checking based algorithm) are correlated to prove whether a potential attack scenario is responsible of the occurrence of heart-related emergency situations or the death of a patient. Based on the proposed techniques, we design a decision-support system that reconciles in the same framework the medical and technical investigation aspects.

V. Wi-Fi MODULE - ESP8266

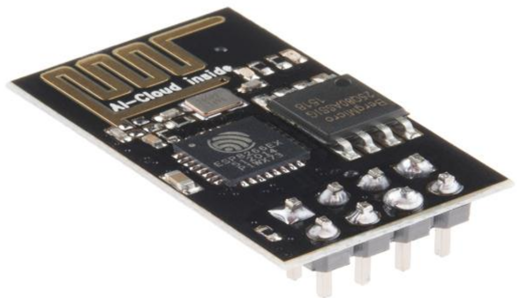


Fig 4 **Wi-Fi MODULE - ESP8266**

The ESP8266 WiFi Module is integrated TCP/IP protocol. it is used to upload the data to the arduino. that can give any microcontroller access to your WiFi network. The ESP8266 module is cost effective board with a huge, and ever growing, community. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and RF requires no external parts.

VI. TEMPERATURE SENSOR

Fig 5 Temperature sensor

Temperature sensor senses the heat energy generated by a system or an object. it is used to detect accurate centigrade temperature. IC LM35 is used as a temperature sensor. The sensor output changes linearity.

The output voltage of the IC sensor is linearly proportional to the Celsius temperature. LM35 is operated over a range of -55˚ to +150˚C and it has low-self heating. It is operated under 4 to 30 volts. Temperature sensor circuit has two inputs: non-inverting (+) and inverting (-) and only one output pin. IC741 is used as a non-inverting amplifier. The difference between the input terminals amplifies the circuit.

6.1 Types Of Temperature Sensors

6.1.1 Contact Temperature Sensor

This contact temperature sensor can be used to detect liquids, solids or gases over a wide range. The temperature sensor is required to be in contact with the object physically and it uses conduction for monitoring the changes in temperature.

6.1.2 Non-contact Temperature Sensor

This temperature sensor uses radiation and convection for monitoring the changes in the temperature. The non-contact temperature sensor can be used to detect the gases and liquids that emit radiant energy, which is transmitted in the form of infra-red radiation.

VII. HUMIDITY SENSORS

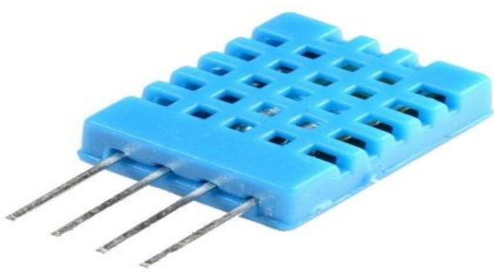


Fig 6 Diagram of Humidity sensor

The humidity sensor (or hygrometer) is used to senses and measures the relative humidity in the air. It measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.

The warmer air temperature is more moisture . Humidity sensors are use capacitive measurement.. Electrical capacity is used to create an electrical field between them. This sensor is composed of two metal plates and forms a non-conductive polymer film between them. This film collects moisture from the air, which produces the voltage between the two plates to change. These voltage changes are converted into digital readings showing the level of moisture in the air.

VIII. HEARTBEAT SENSOR

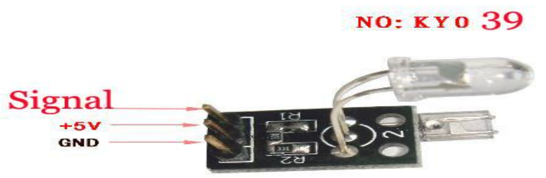


Fig 7 Diagram of heart beat sensor

8.1 Two Ways to Measure a Heartbeat

Manual Way: Heart beat can be checked manually by checking pulses at two locations- wrist (the **radial pulse**) and the neck (**carotid pulse**). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.
Using a sensor: Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

8.2 Principle of Heartbeat Sensor

The heartbeat sensor based on the principle of photo phlethysmography. It measures the volume of blood passes through the organ of the body which causes a change in the light intensity through that organ (a vascular region). The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

The heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body.

The light is emitted by the light emitting diode, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the

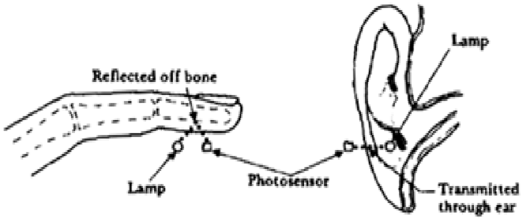


Fig 8 Working of Heartbeat Sensor

Transmitted or the reflected light is received by the light detector. The amount of light absorbed is depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.

IX. RESPIRATORY SENSOR

Fig 9 Diagram of respiratory sensor

The respiration sensor is used to detects chest or abdominal expansion/contraction and outputs the respiration waveform.

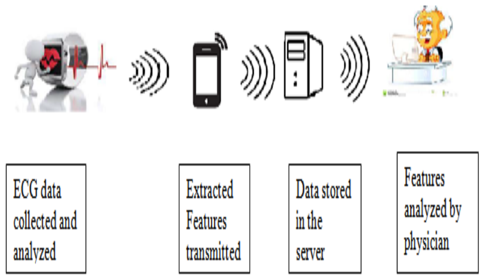


Fig 10 Block diagram for predicting ECG signal

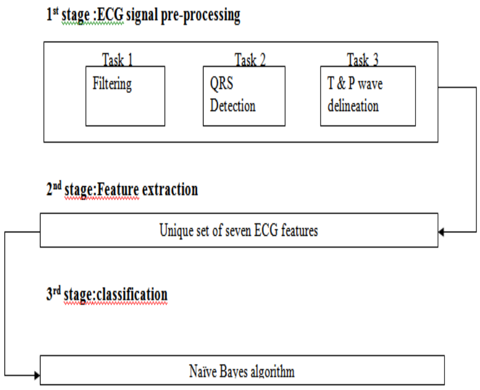
The proposed *VA processor/SoC is used to* predicting VT/VF events up to 3 hours before the onset. With the prediction of these events in advance, there is sufficient time to alert the patient and provide them with the required medical care. The ECG data is collected and processed on-chip, and only the relevant features are sent to the medical facility through the intermediate "programmer" device.

X. VA PROCESSOR ARCHITECTURE

The baseline VA processor presented in consists of three main stages: ECG pre-processing, feature extraction and classification. In the ECG pre-processing stage all the ECG wave features such as QRS complex, T-wave and P-wave are extracted. Prior to ECG delineation, filtering is performed because ECG could be corrupted by baseline drift, power line interference, and high frequency noise.

After filtering, QRS detection is performed based on the Pan and Tompkins technique. Along with the QRS peak detection, the QRS onset and offset are also delineated. Finally, T and P waves are delineated, and the corresponding fiducial points (P onset, P peak, P offset, T onset, T peak, and T offset) are extracted. Three major modifications were carried out to lower the power consumption: 1) Elimination of the SRAM block in QRS detection, and thus, reducing RAM requirements from **8KB** down to **4KB**. 2) Decreasing the **operating frequency to 250 Hz equal to the ECG sampling frequency.**3) The use of High Threshold Voltage (HVT) cells to reduce the leakage power.

Schematic representation of the proposed VA predicting system



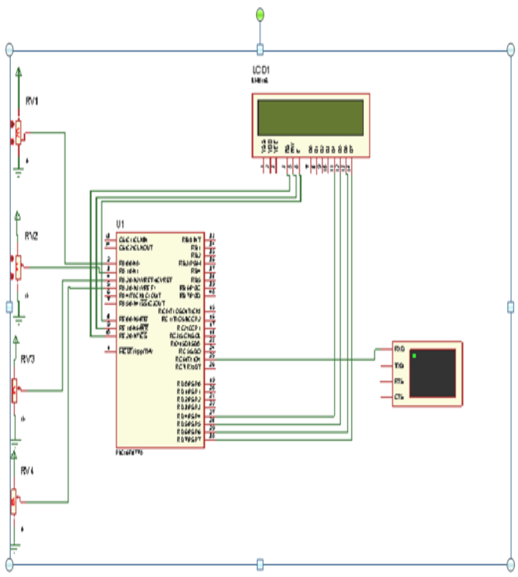


Fig 11 Simulation module

XI. CONCLUSION

The ultra-low power, secure, fully integrated IoT platform for prediction of ventricular arrhythmia using ECG signals and also sensing body temperature, humidity and respiratory problems. The proposed architecture was implemented using an ASIC design flow in 65nm LPe technology.

The VA processor attained a reduction of 62.2%inpower consumption and a 16.0% reduction in area when compared to similar state-of-the-art processors and reducing the size of the required RAM for ECG signal processing from 8KB to 4KB. Moreover, operating on the ECG signal directly enables the proposed VA processor to operate at the same frequency as the sampling frequency of 250Hz, further reducing dynamic power consumption.

The hardware kit is used to predict the heart beat rate and also sensing body temperature, humidity and respiratory problems using corresponding devices and display the output in hardware kit.

Include a low-powered wireless transceiver module to transmit the biomedical signals. Add protection against other forms of hardware attacks such as side-channel attacks on cryptographic algorithms.

REFERENCE

[1] H. Kim, R. F. Yazicioglu, P. Merken, C. Van Hoof, and H.-J. Yoo, "ECGsignal compression and classification algorithm with quad level vector for ECG holter system," *IEEE Trans. Inf. Technol. Biomed.*, vol. 14,no. 1, pp. 93–100, Jan. 2010.

[2] N. Ellouze, S. Rekhis, N. Boudriga, and M. Allouche,"Cardiac implantable medical devices forensics: Postmortem analysis of lethal attacks scenarios," *Digit. Investigat.*, to be published. [Online]. Available: http://www.sciencedirect.com/ science/article/pii/S1742287616301426

[3] N. Karimian, Z. Guo, M. Tehranipoor, and D. Forte, "Highly reliable key generation from electrocardiogram (ECG)," *IEEE Trans. Biomed. Eng.*, to be published.

[4] M. Rostami, A. Juels, and F. Koushanfar, "Heart-to-heart (H2H): Authentication for implanted medical devices," in *Proc. ACM SIGSAC Conf. Comput. Commun. Secur.*, Sep. 2013, pp. 1099–1112.

[5] ECRI. (2008). *American Heart Association ECG Database DVD.* accessed Dec. 10, 2016. [Online]. Available:http://www.ecri.org/components/Pages/AHA_ECG_DVD.aspx

[6] Y.-P. Chen *et al.*, "An injectable 64 nW ECG mixed-signal SoC in 65 nmfor arrhythmia monitoring," *IEEE J. Solid-State Circuits*, vol. 50, no. 1,pp. 375–390, Jan. 2015.M. Yasin, B. Mazumdar, J. J. V. Rajendran, and O. Sinanoglu, "SARLock:SAT attack resistant logic locking," in *Proc. IEEE Int. Symp.Hardw. Oriented Secur. Trust*, Apr. 2016, pp. 236–241.

[7] R. M. Nor *et al.*, "Electrocardiogram identification: Use a simple set of features in QRS complex to identify individuals," in *Recent Advancesin Information and Communication Technology*. Cham, Switzerland: Springer, 2016, pp. 139–148.