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IMPLEMENTATION OF SECURE WIRELESS ECG USING LABVIEW

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Abstract: In hospital the healthcare systems use various wireless sensors which are different from the existing systems. In recent times there is a drastic change in which human have worked in leading various type of lifestyles. Changes in food intake of a human being has changed where the healthy food items is supplemented by junk food items which has led to the rise of pressure in humans, that has led to many heart diseases which is more noticeable in all growing countries. Most of the people are prone to many kinds of heart problems. This Electro cardio gram type of device can used as a medical measuring device that records the functioning of the heart. The existing ECG instrument is energized using main electricity, which don't seem to be energy efficient. By the use of transformers in the circuit it makes the device expensive and bulkier. Optimum isolation amplifiers is a must which is included, by these instruments for the patient's wellbeing, in addition to the price, heavy circuits this work is done. Wireless ECG method is put forward in our project.

Index Terms- Sensor, ECG monitoring, Amplifier, Portable systems.

1. INTRODUCTION

The Electro cardio gram is a quantification which determines the functionality of the heart overtime that is represented, apparently recorded by the measurement of electrodes that is placed on the skin. The signal displays the general heart beat of the guts, fragility in numerous areas in the muscles of the heart. The approach is effective, measurement and diagnosis of abnormality in rhythm of the heart and is often employed in the hospitals and everywhere in the planet. These are utilized in military and sports environments for the latest indication of fit people.

In these days, the invesgative communities are operative in chasing the technologies for a "Wireless ECG" the patient need not required to stay longer at the hospital attached to an oversized halted device for continuous monitoring of the heart rate signals. According to the current situation that is to decrease the cost for the patients for real time monitoring system. People can stay at their home instead of taking a bed. Many systems are entitled to accomplish this attainment, with various approaches and goals. The wireless Electro Cardio Gram systems may be used for more than ten sensors, which is progressively complete data for heart specialist. Information which will be gathered and seen in the system, the data transmitted using wireless technology to the nearby receiver's device. The system is very easy and small in nature as compared to all the oversized instruments that are present in the hospital.

The wirelesses ECG are classified as two types, one is using wired sensor and another is with wireless sensor. The first type of system uses wires, for assembling of all the components. The second group of system uses wires in the transmitter side and receives the signals wirelessly at the receiver side.

2. LITERATURE REVIEW

Thirrunavukkarasu .R et al. [1] in 2021, In this paper, for the design of FIR filters KB window was used in the circuit. For the noise cancellation in the Electro Cardio Gram wave form, noise occurs from the external layer of the heat and EM field, for the design of KF filter FPGA is used, blocks are arranged with the help of wires using verilog, the result obtained of the step value is in the form of analog. The design of circuit is made using ISIS feature.

Ahmed M Rateb [2] in 2020, in this paper, CS method is used for less complex ECG data reduction, for smart watches and sensor based devices. Decrypting of CS is distinguishing using convolution technique. By the consequence of the energy resources used by the network which creates a burden. The objective of the paper is to address the Compressive Electrocardiography (FCE) technique. Decryption of CS is found in by using WRLS method instead of using a regular approach that is one normal reduction. Hence FCE can increase the efficiency of all the real time monitoring system.

Nilanjan Dey et al. [3] in 2017, Due to the convenience and cost effectiveness of wireless technology compared to wired applications, especially in light of the advantages provided by Wireless Sensor Network (WSN) based applications, the development of wireless technology has expanded alarmingly. These types of applications are noticed in various kinds of industries. A Zigbee-based home-based wireless ECG monitoring system is taken into account in the current study. These systems can be used to monitor people in their own homes or places, as well as for routine doctor visits to ensure proper healthcare, allowing people to stay in their homes for longer periods of time. Systems for real-time monitoring capture, quantify, and keep track of the electrical activity of the heart while maintaining the user's comfort. Zigbee technology can offer low-power, compact design.

Lianxi Liu et al. [4] in 2019, This study makes a suggestion for an intelligent system with connected audio transmission and a battery-free electrocardiogram (ECG) monitoring chip that can be used for extended and real-time ECG monitoring. The front-end chip modulates and boosts the ECG signal before transmitting it via the microphone channel of the 3.5mm headphone connection. The front-end device transforms the sine wave signals from the right and left channels into a DC supply and local oscillator signal. The exactness of signals that is converted to Analog-to-Digital converter (ADC) in the device and then the signals are processed by inner software. Therefore, in this system, there is no need for an external battery, a local oscillator, or any complicated modules.

Md. Hafizul Islam et al. [5] in 2018,This study makes a suggestion for an intelligent system with connected audio transmission and a battery-free electrocardiogram (ECG) monitoring chip that can be used for extended and real-time ECG monitoring. The front-end chip modulates and boosts the ECG signal before transmitting it via the microphone channel of the 3.5mm headphone connection. The front-end device transforms the sine wave signals from the right and left channels into a DC supply and local oscillator signal. The exactness of signals that is converted to Analog-to-Digital converter (ADC) in the device and then the signals are processed by inner software. Therefore, in this system, there is no need for an external battery, a local oscillator, or any complicated modules.

3. EXISTINGSYSTEM

Electrocardiograms are captured by devices with a number of electrodes coupled to a central unit for recording. The signal was driven to a motor in the earliest analogue ECG devices, which printed the signal on a piece of paper. The electrical activity of the heart is converted into a digital signal by electrocardiographs today using analog-to-digital converters. Today's ECG devices are frequently small and mounted on a little low wheel cart with a screen, keyboard, and printer. Recent developments in electrocardiography include the creation of even smaller devices for integration into smart watches and fitness trackers. To provide one lead, these portable devices frequently require two electrodes. There are also easily accessible portable six-lead devices.

Taking down an ECG reading may be a safe and effortless procedure. The instruments are provided with high input power, but these are planned with various security measures which includes earthing. ECG voltages across the body are extensively low. A low noise circuit, instrumentation amplifiers, and electromagnetic shielding are all essential because of the low voltage. Concurrent lead recording: earlier designs recorded each lead at a time, whereas modern versions record numerous leads at once. Automated explanation algorithms are inclusive in most current ECG equipment. The PR interval, QT interval, PR axis, QRS axis, rhythm, and other attributes are calculated in this analysis. These automatic algorithms' results are deemed "transitional" unless they are verified and/or updated by expert exposition.

4. PROPOSED SYSTEM

Software and Hardware components used in our project are
PC with LabVIEW, USB Client Driver, Arduino UNO software, Ag-AgCl electrodes,Arduino UNO, AD8232Heartbeatsensor, CC-2500transceiver, RF receiver with USB port, Jumper wires.

4.1 Arduino UNO

Arduino is a free source model platform that is completely based for easily operated hardware and software. Arduino which can look over inputs, such as light sensor and many more and then finally to output, such as beginning a motor, on an LED etc. Sending a stringent command to the board's microcontroller will instruct the board what to do. Arduino Software based mainly on processing, and the Arduino Programme which is purely based on connectivity of the wires. A seamless tool for quick prototyping, Arduino was created at the Ivrea Interaction Design Institute with college students without a background in electronics or programming in mind. The Arduino board started evolving as soon as it attracted a larger audience, shifting from simple 8-bit forums to products for Internet of Things (IoT) applications, wearable technology, 3-D printing, and embedded settings. Every Arduino platform is fully free source, allows end-users to create their own and finely customized them to suit their single needs.

Figure 4.1: Pin configuration of Arduino UNO

4.2 AD8232

The AD8232 is a planned sign trim block for ECG and other bio-likely signals inside seeing loud conditions, for instance, those made by the development or distant anode course of action. This container considers an ultralow power easy to cutting edge converter (ADC) or an embedded microcontroller to easily obtain the outcome signal. To additionally foster natural mode excusal of the line frequencies in the structure and other undesired hindrances, the AD8232 consolidates an enhancer for driven lead applications.

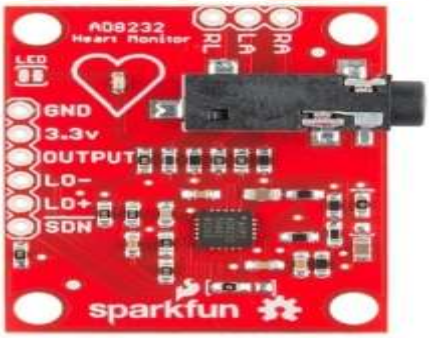

Figure 4.2: AD8232 Heart beat Sensor

4.3 CC25002.4GHztransceiver

The CC2500 is a low cost, single-chip, 2.4GHz transceiver intended for extremely weak Wi-Fi applications. The operation of the circuit takes between 2.4 and 2.483 GHz in the ISM (Industrial, Scientific, and Medical) and SRD (Short Range Device) frequency bands. The baseband modem is paired with the RF transceiver and is reasonably customizable.

Multiple modulation codes are supported by the modem, and its customizable statistics rate can reach 500 kbps. By turning on the modem's built-in Forward Error Correction option, you can increase the message variety. For data buffering packet handling, the CC2500 offers little hardware support. The 0.18 m CMOS generation served as the foundation for Chipcon's 4th generation platform. The least strength nature of the transceiver displays modern consumption of 13.3 mA in receiving mode, 11.1 mA in transmission mode, and 400 nA in sleep mode.

4.4 LabVIEW

The LabVIEW software It can be challenging to provide an accurate response because so many different programmes and industries use NI LabVIEW software. LabVIEW is a very effective development environment for creating custom programmes that interact with real-world data or indicators in disciplines like technology and engineering. The net outcome of using a tool combined with LabVIEW is that superior jobs can be finished in much less time with fewer humans engaged.

Programming model for data flow that is intuitive. Decreased learning curve compared to traditional text-based programming. Naturally uses timing and parallelism to depict records-pushed packages. The G programming language is extremely useful for LabVIEW; in fact, it's sometimes referred to as "LabVIEW programming." It allows you to quickly connect data collecting, analysis, and logical processes and see how data is being changed. Technically speaking, G is a graphical data flow language that uses nodes (operations or functions) to operate on records as they become available, as opposed to typical programming languages' sequential line-by-line approach.

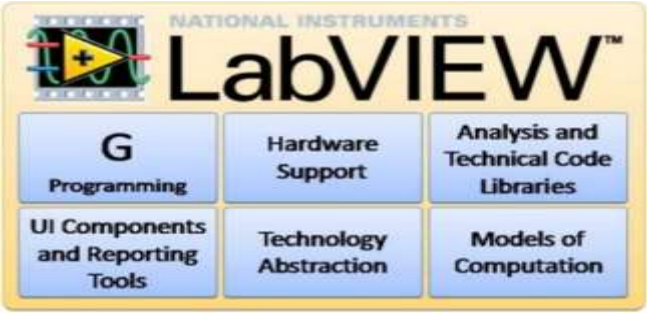

Figure 4.3: LabVIEW Description

4.5 System Flowchart

The analogue signal component of the ECG capture has been kept straightforward to conserve board space. With the use of disposable electrodes linked to wires using standard clips, the raw signal—a noisy ECG signal—is obtained. Bio-electric potentials produced by muscle and nerve cells are found using electrodes. Direct-contact electrodes, such as Ag-AgCl electrodes, are frequently used for electrocardiograms (ECG). They serve as transducers, converting the body's ionic movement through an electrolyte into electron current and, as a result, an electric potential that the ECG system's front end can measure. These transducers are made of a metal, such as Ag, and are referred to as bare metal or recessed electrodes.

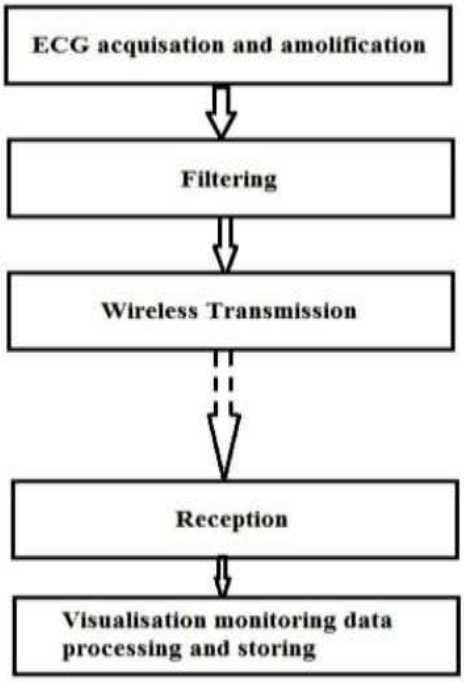

Figure 4.4: System Flowchart

4.6 PQRS Complex

The major spike in a conventional ECG is the QRS complex. It's the most noticeable aspect of the ECG because it's clearly visible. The depolarization of ventricles is represented by the QRS complex. It depicts the start of systole and the contraction of the ventricles.

The QRS complex or wave begins with a little downward deflection, symbolized by the point Q. It moves in lockstep with the P wave. Following Q, there comes a steep peak R, which is followed by a downward deflection S. We can calculate a person's heartbeat rate by counting the number of QRS complexes in a minute. When the heart is working normally, the QRS complex lasts 80 to 120 milliseconds.

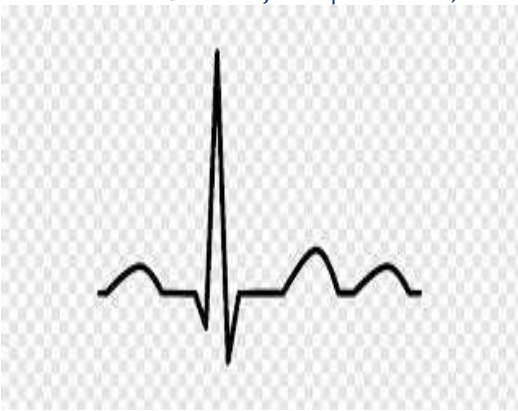

Figure 4.5: PQRS Complex

P-wave
Atrial contraction is represented by the P-wave this describes the de-polarization of the atria. It comes before the complex.

Q-wave
The de-polarization in the inter ventricular septum is represented by the Q wave. Little downward deflection is used to indicate it. A Q-wave occurs immediately after the P-wave. Infraction is indicated by abnormalities in the Q-wave.

R-wave
The R-wave comes after the Q-wave. This wave is characterized by an upward deflection. After the R, there occurs an S-wave. Left ventricular hypertrophy is indicated by large R and S wave amplitudes.

S-wave
The R wave is followed by a downward deflection, denoted by S. The J-point intersection is the complex with ST segment. This point is also known as first point of inflection of the S-upstroke wave.

5. METHODOLOGY

ECG signal acquisition:-To reduce the space consumption in the board, the portion of the analog signal is made simple. The raw data of the signal noisy ECG signal are taken through disposable electrodes; the electrodes are attached to a pair of normal clips through cables. The analog signals taken into the filter circuit and then to the module for wireless transmission.

Wireless Transmission and Reception: - The module is used for wireless transmission and receiving the signal. The circuit is connected to ECG part with the wireless module as base station. PC is inter phased with the receiver module at the base station. The signal acquired from the sensors is further transmitted wirelessly with the use of CC2500 radio equipment which is a low cost module.

At the receiver end similar type of radio equipment is used for receiving wireless ECG signals transmitted by the transmitter which was extracted from sensors used at transmitter end. That is given as the input to PC via com port for further analysis and processing of the ECG signal. Display of ECG signal on the screen can be done on LabVIEW.

Security System:-An encryption and decryption security system are added to the device so onto keep the medical documents safe from any external source, attacker, or hacker who can use the record for bad intentions or purposes.

The most common ECG for recording a 24-hour reading is a 3-lead ECG. A 24-hour reading is a common diagnostic technique for heart issues that is reimbursed as a long-term reading.

Place the three leads on your patient's chest in the following order:-

RED:- R Arm (right arm), immediately below the right clavicle.

GREEN: - Just below the left collarbone is the LA (left arm).

YELLOW: -On the lower chest, slightly above and to the left of the umbilicus, LL (left leg).

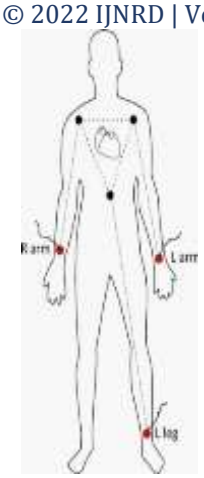

Figure 5.1: 3-Pin Lead Connection

5.1 Working

The ECG signals which are collected from the body are taken by the electrodes (Ag-AgCl electrodes), the signals which are collected from the body are very weak so that it is given to the amplifier. The signal acquisition system which is the front-end for is an instrumentation amplifier.

Common Mode Rejection Ratio (CMRR) is very more and i/p impedance is also more which is taken by the system for capturing of the ECG signals which are taken from the human body, with the ECG signal the signal to noise ratio also gets amplified, this type of noise is removed by the use of band pass filter. The signals extracted from the system are weak in nature hence that is given as the input to the buffer amplifier. The signals are transformed in digital manner using Analog-Digital Converter (ADC).The set of tools such as acquisition, analyzing, display, and data storage.

Arduino board is used for the connection of the transmitter module and the heart beat sensor, Electrodes are mainly used for knowing the sensitivity of bio-electric potentials which is occurred by the contraction and the relaxation of the muscles cells. ECG the electrodes used are Silver-Silver chloride of direct contact type.

They function as transducers, transforming the body's ionic ensure through an electrolyte into an electrical potential that can be measured by the EKG system. The transducers are generally made up of silver or chromium coated steel are called bare metal or recessed electrodes, it carries with a jelly electrolyte that contains chloride and other ions.

At the receiver end the USB port connected with CC2500 receiver module at the other end of the PC the distance can be maximum up to 2 meter if there is no noise or the users in the particular location does not use the same range of transmission of the data. Further if the distance is 1 meter and the noise is minimal we can obtain a proper ECG of a person without any disturbance and that can be viewed on LabVIEW display.

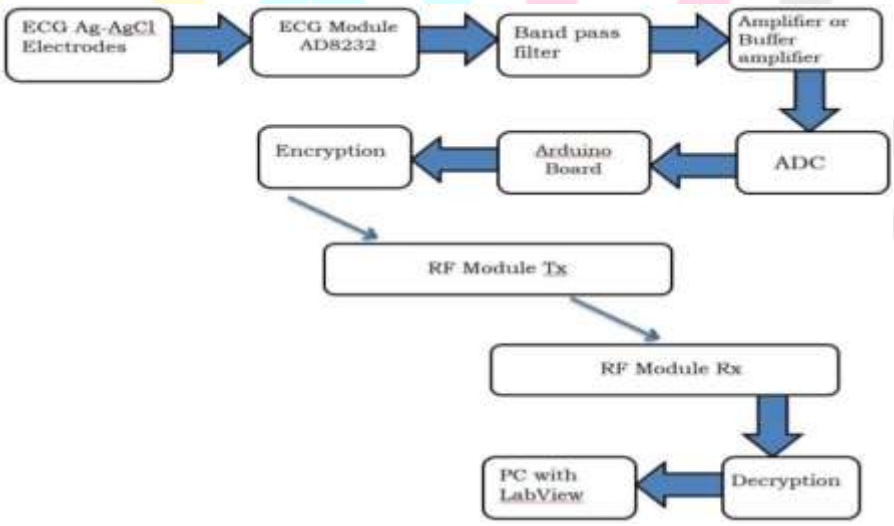

Figure 5.2: Block Diagram

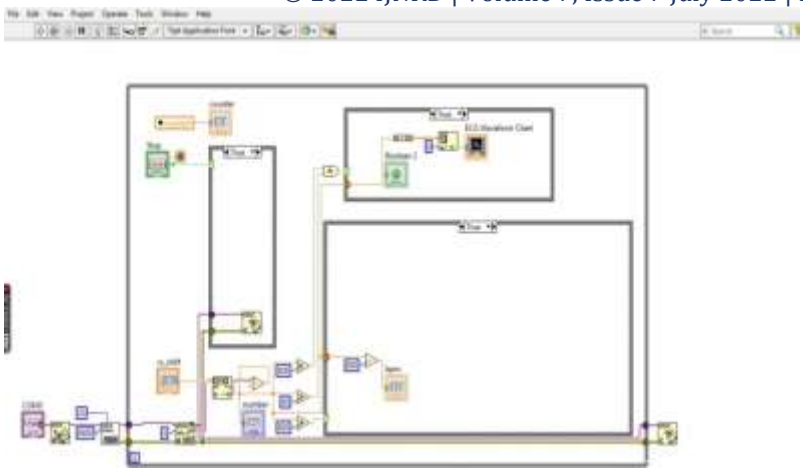

Figure 5.3: Block Diagram of LabVIEW

6. RESULTS and DISCUSSION

In this system, Caesar shift as a security protocol have been implemented. Random bits are generated for the encryption of the data. Random bits are generated within a given limit. Every time when the user view the ECG signal the bits are generated random manner.

Figure 6.1: Circuit connections

LabVIEW is used for creating a wireless ECG sensor that shows its results on a PC. The device that uses effective remote monitoring in providing real time data, continuous, and accurate heart information.

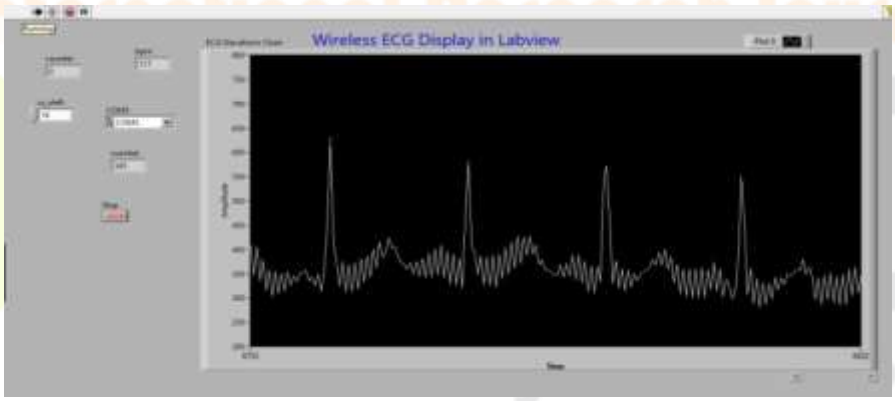

Figure 6.2: Final ECG display on LabVIEW

7. CONCLUSION

As for a conclusion, the goals for this effort have been met. A circuit for recording electrocardiograms has been created. The primary stage of the system's second stage wirelessly received the ECG signal. It has been successfully transferred without losing the crucial aspect (PQRST wave). Using LabVIEW software, the ECG signal is successfully presented at the graph chart as well.By using wireless technology it reduces the minimal desk clutter and reiterates the strong marketplace for technology that permit for inclucating easy and simple method in hospitals and within the house. Additionally to the present, a tool which employs efficient method of remote monitoring for real time, continuous, and accurate information of the heart rate condition have been executed. The future scope we can add mobile application for direct communication between the patient and doctor for the exchange of reports of the patient. If we use high end module like Rasberry pie and many other we can increase the transmiter and receiver distance for communication.

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