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A Review on an Integrated Digital Stethoscope and ECG Acquisition System

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***Abstract:** This paper presents a review on an integrated digital stethoscope and ECG acquisition system. Development of science n knowledge based on wireless technology is increasing day by day in health care environment. Problematic situation is faced by the patient because of unpredicted death due to the some heart problem and heart attack. This is due to the nonexistence of quality medical feeding for patients in needful time. The primary focus of integrated health care systems is to provide higher quality of care as well as better health outcomes for patients. As per the review there is no integrated healthcare system which includes Stethoscope, ECG and detection of arrhythmia. So it specifies the methodology to implement the integrated system which analyzes the heart sound. If the heart sound is abnormal then it checks for cardiac electrical activity by checking arrhythmia conditions and displays the heart rate. Then all the necessary data will be sent to the doctor through wireless module. Heat sound and ECG test can be done in a single portable device so that the cost and time of the patient is reduced and also it helps in eliminating the distance barrier. In future blood pressure and respiration rate can also be integrated in same portable device.*

***Keywords:** Integrated health care system, Stethoscope, ECG, Arrhythmia, Respiration rate, Blood pressure, Portable device.*

I. INTRODUCTION

Heart disease is main cause of death globally. World Health Organization (WHO) discloses that CVDs (Cardiovascular Diseases) are the number one cause of death worldwide [1]. More people die yearly from CVDs than from any other cause. Nationally, 735,000 people have heart attacks every year, and 610,000 people die of heart attacks and heart diseases [2].

Heart auscultation, is one of the most fundamental process of interpreting the sounds produced by heart to diagnose various cardiac disease. It works as the most frequently used technique in primary medical care and in the situation, where sophisticated medical equipment is not available. Detecting the heart sound or murmur using the traditional stethoscope is key problem that always arise for doctors medical physicians [4]. Doctor mainly diagnose based on their experience and hearing, and there are not able to make timely diagnose [2]. The heart murmur may not be detected during regular checkup due to many reasons like the quality of the equipment used, due to lack of training or expertise of the doctors and the severity the condition. Because of this reason there is a need of digital stethoscope so that it can replace the existing acoustic stethoscope [4]. In some adverse circumstances like noise from ambulance scene of accident and busy energy room, it is very different to make an effective diagnosis by using the traditional stethoscope accuracy which may misjudge or misled by subjective factors [2]. Especially in rural area most frequently employed technique in primary health care is served stethoscope. Due to low amplitude and frequency signals the heart sound and murmur heard from the patient using stethoscope may lead to false diagnose. Also this technique requires lots of expertise and skills which is decreased over a period of time [4]. The sound level is very low and that is a problem with the acoustic stethoscope. It is very difficult for the medical doctor to diagnose and it is hard to analyze the heart sound. This is the reason why many forms of digital electronic stethoscope are developed so that it can replace the conventional acoustic stethoscope [8]. In Indonesia the ECG devices are mostly situated in only big hospitals. The patient suffering from the heart attack should wait for ambulance to come and escort them to hospital. So there may be a loss of some important signals associated with heart attack when the patient is waiting for the ambulance. The patients usually don't do regular check up for ECG unless and until something wrong happen in their heart. ECG checkup is bothersome. Therefore it is important to have a portable ECG device. This portable device can be done or it can even be placed in community health centre. So that diagnose will be much cheaper and easier. The special condition such as patient with heart attack will also be accommodated with portable ECG Homecare device [6]. Hearing to heart sounds is a primary part of any physical health examination. The heart and lung sound can be listened by using the stethoscope. The first indication or symptoms of heart problems are usually determines with a stethoscope. If there is any heart related problem present then the physician will get to know by listening to these sounds. Suspected patients having heart problem is then referred to specialist for an ECG (electrocardiogram) or an echocardiogram, or nuclear magnetic resonance imaging. Since these techniques are very high cost, it is preferable to have a reliable and low-prize screening tool for making a right primary diagnosis [10].

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The prime goal is to develop an integrated portable device so that the health care system is going to monitor the patient's status, who are either hospitalized or in remote place, executing their regular life activities. So that it changes traditional approach and lead to a modernized patient approach [5].

II. RELATED WORKS

Different methods have been used to develop a stethoscope over a year. Acoustic stethoscope only has listening function with no visual function [2]. The main limitation of this type of stethoscopes is that the doctor cannot hear the intensity of sounds, if it is below the threshold of audibility. Assessments by human ear are too subjective and prone to preference. It is preferred to evaluate the stethoscope using a more quantitative measure [14]. This limitation can be overcome by the using electronic stethoscope where the body sound can be electrically amplified. The electronic stethoscopes have more advantages but there is noise because the detection of sound is achieved by the microphone and the microphone is sensitive to body. The external noise is a main reason for body sounds and difficult to hear [15]. This limitation overcomes by digital stethoscope. From the literature survey of previous paper, the method that was used to develop a stethoscope is by using acoustic signal which is acquired by the condenser microphone and the signal is amplified through amplification module. Aurdino UNO Microcontroller was used for the conversion of signal from analog to digital data and it is sent through Bluetooth wirelessly [3]. In another method fabrication of stethoscope is done by 3D printer, where chest piece consists of microphone embedded into the drum of 3D printed chest piece. For differentiating cardiac murmurs algorithm is developed [7]. Through data logging application the heart sound signal can be recorded and it can be sent to the medical person for the further analysis. A second order active filter is then used to remove high frequency background noise [11]. Further data can be transmitted through IoT [13].

12 lead electrode systems is the tradition way to detect the arrhythmia condition and to collect ECG data [4]. The recent paper shows that the ECG readings can be even collected using 4 electrodes and 3 electrodes. But the main disadvantage in using few electrodes for collecting ECG data is many complicated arrhythmia can't be found [12]. By using 10 electrodes it's easy to collect the data and different arrhythmia can also be detected [9]. Integration of both stethoscope and ECG system is going to check irregular or abnormal sound. If there is an abnormal sound then it detects in the stethoscope and then the physician will direct the patient to ECG test, this both test can be done in a single portable device so that the cost and time of the patient is reduced and later data can sent through wireless module.

III. PROPOSED METHODOLOGY

The block diagram the proposed system is shown in the figure1 and implementation of stethoscope and ECG system is explained below:

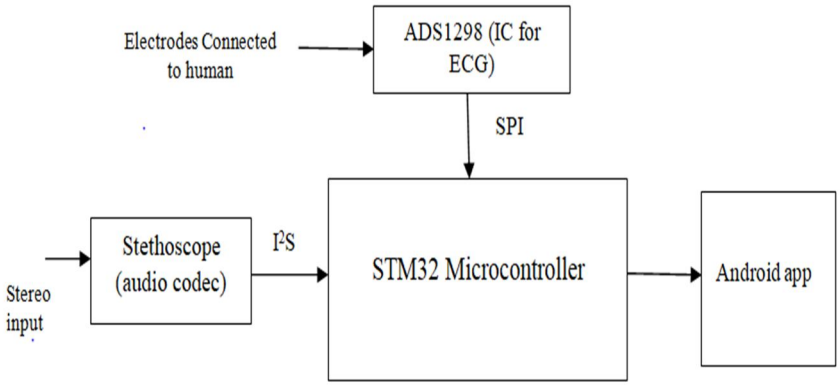

Figure 1: Block diagram of proposed system

A. Implementation of Stethoscope

It consists of signal acquisition system and signal processing module. To acquire the heart sound electrets microphone and traditional stethoscope in fitted together. To perform any analysis, the signal should be in digital format but that the amplified heart sound signal is acquired in the analog form. The main function of signal processing is converting analog signal to digital signal and this can be done by using audio codec of DSP kit. Through I^2S bus the data is sent to the processor and the signal again converted into analog signal. Headphone connected to the headphone pin in audio codec can be used to hear the heart sound.

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B. Implementation of ECG

The onboard pin is placed so that it can be connected to the ECG electrode cable, which helps in the collection of 8 channel data. Micro USB of type C is included so that it can either connected for charging or it can be used for displaying ECG data on computer using USB cable. SPI communication is done to communicate between ADS1298 analog front end and STM microcontroller. Once the SPI communication is established by configuring the registers, then the ECG data will be acquired. The acquired ECG data can be viewed with the help of teraterm by establishing UART communication. The data in teraterm can be stored by saving the file in .csv and the data is plotted in the excel sheet. Pins are available on the board for programming and ST-link debugger is used to program the STM32 microcontroller. Once the data of heart sound and ECG is collected it can be sent to the concerned person or doctor through wireless module.

IV. CONCLUSION

From the review it concludes that there is no device which integrates stethoscope and ECG. The stethoscope is integrated with the ECG acquisition system so that if any abnormality is detected in primary test, then ECG signals can be acquired in the same portable device. Since both ECG and stethoscope is integrated in the single portable device, it reduces the cost and time of patient and as it is portable it can easily fit inside the ambulance. For efficient implementation of the telemedicine the portable device can be developed which can treat wide range of diseases [16]. In future along with Stethoscope and ECG, respiration and Blood pressure parameter can also be integrated so that the device becomes more effective. In single stretch heartbeat, cardiac activity, blood pressure, respiration rate and heart rate can be detected. This will give potable and quality health care system at low cost.

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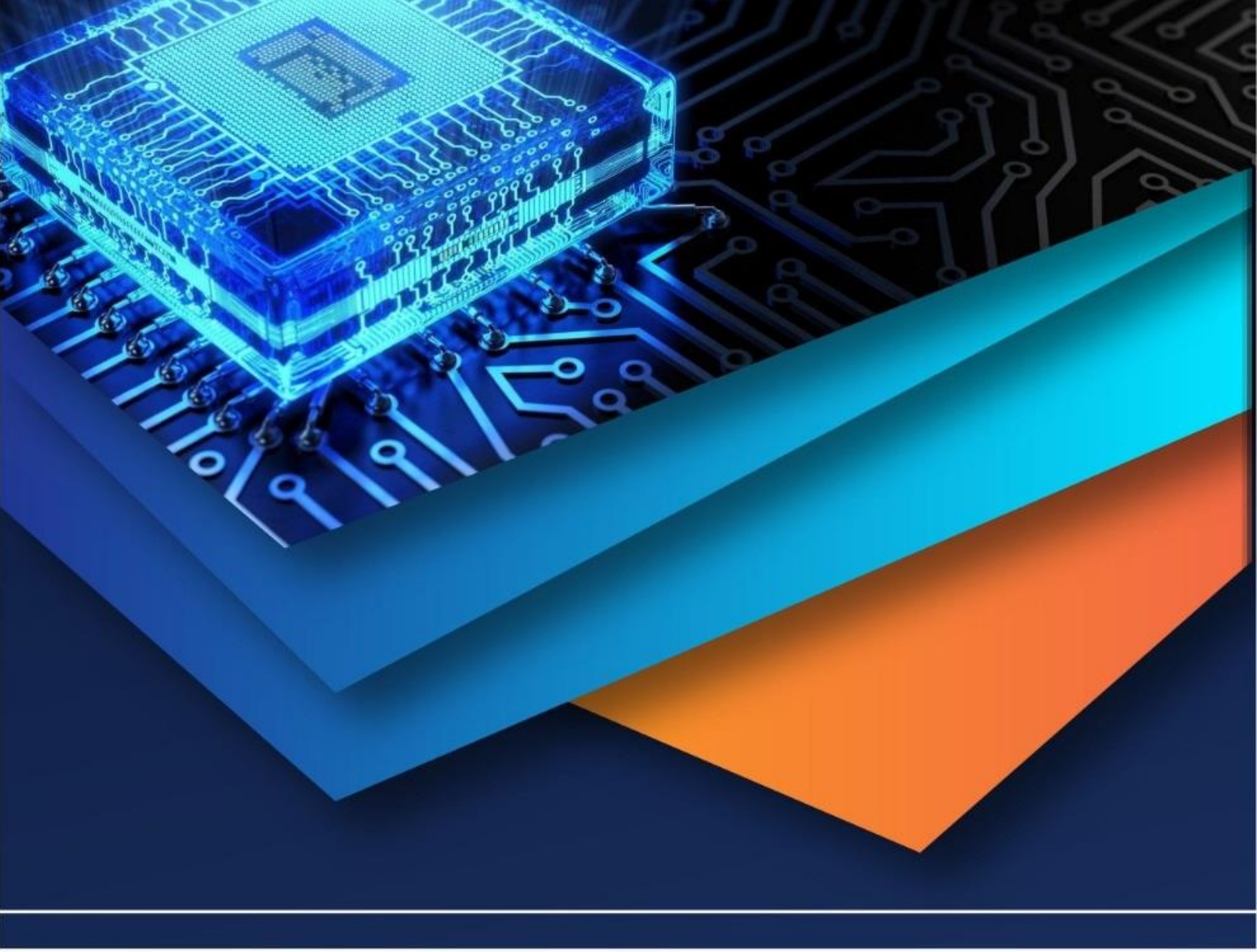

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