Electrocardıography Devıce Desıgn And Applıcatıon

Rüştü GÜNTÜRKÜN

Department of Electrical and Electronics Engineering, Simav Technology Faculty, Dumlupinar University, 43500 Simav, Kütahya, Turkey

SUMMARY
With this study designed and applied, the electrical signals produced by the heart with the help of the electrodes placed in the body are raised with the INA128 instrumentation amplifier, and thanks to ARDUINO UNO R3, ECG signals are displayed on the LCD screen. A 2x16 pixel graphic LCD was used to display the signal. The right and left arm electrodes used in the measurement provide differential inputs for the instrumentation amplifier. ECG signals, which can be measured using electrodes from the skin surface, have frequency values of approximately 1mV amplitude and 0.1-150 Hz bandwidth. These signals, which have very low amplitude values, are quite difficult to display without raising them. In this study, the gain was set to 1000 using the instrumentation amplifier called INA128. This gain was supported using the LM741 amplifier. Unwanted signals are suppressed by filtering in order to process the obtained biological signals.
With this study, which is designed and applied, the electrical signals produced by the heart are raised with the help of the electrodes placed on the body, and the ECG signals are displayed on the LCD screen thanks to the ARDUINO UNO R3.
KEYWORDS: *ECG, ARDUINO UNO R3, INA128 instrumentation, LM741*

I.   INTR0DUCTION

Electroencephalography is a medical imaging technique that reads scalp electrical activity generated by brain structures. The electroencephalogram (EEG) is defined as electrical activity of an alternating type recorded from the scalp surface after being picked up by metal electrodes and conductive media [1]. The human brain electric activity starts around the 17-23 week of prenatal development. Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are pumped through channels in neuron membranes in the direction governed by membrane potential [2]. It is assumed that at birth the full number of neural cells is already developed, roughly 1011 neurons [3]. Later in 1934 Adrian and Matthews published the paper verifying concept of "human brain waves" and identified regular oscillations around 10 to 12 Hz which they termed "alpha rhythm" [4]. In [8], Researchers have studied Brain activation during judgments of Positive emotions: Pride and Joy. They have used fMRI images for this purpose. However, recording fMRI of a brain is comparatively costly affair as compared to recording of EEG. Researchers Arman Savran et al. [5] have also developed a technique for multimodal emotion detection. They have used the modalities like fNIRS, face video and EEG signal. The electroencephalogram (EEG) recording is a useful tool for studying the functional state of the brain and for diagnosing certain disorders.[6]

In this study, the application of an ECG measurement system, which has theoretically determined properties, was implemented. In the designed system, ECG signals are raised from the biological signals obtained from the skin surface with three electrodes, and these signals are displayed on the graphic LCD. ECG signals, which can be measured using electrodes from the skin surface, have frequency values of approximately 1mV amplitude and 0.1-150 Hz bandwidth. Electricity should not be taken directly from the city grid to power the circuit. Since the electrodes easily pass the electric current, it is extremely dangerous to get the energy directly from the city network and it may harm the patient. An external power supply has been used to prevent this.

II. DESIGN AND IMPLEMENTATION CIRCUIT

Instrumentation amplifiers are high performance voltage amplifiers. At the same time, these amplifiers are differential amplifiers with high gain, high input impedance and low output impedance [7]. The most important feature of the instrumentation amplifier is the pushing of common signals known as the common mode suppression ratio (CMRR-common mode rejection ratio). CMRR is generally defined as follows:

"CMRR = Name / Ac ………………………………………………………………… .." (2.1)

Here, Ad is differential gain and Ac is common gain. The higher the CMRR, the better the performance of the amplifier.
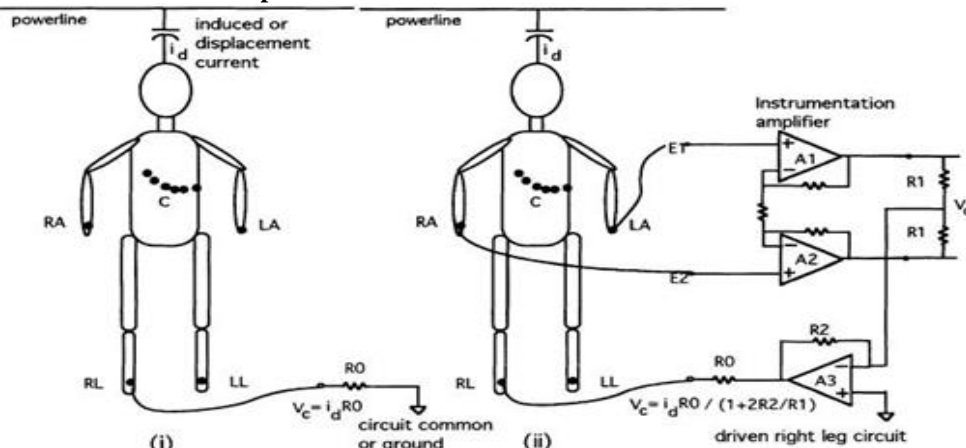
2.1. INA128 Instrumentation amplifier

Figure 2.1 Difference marks and instrumentation amplifier application [5]

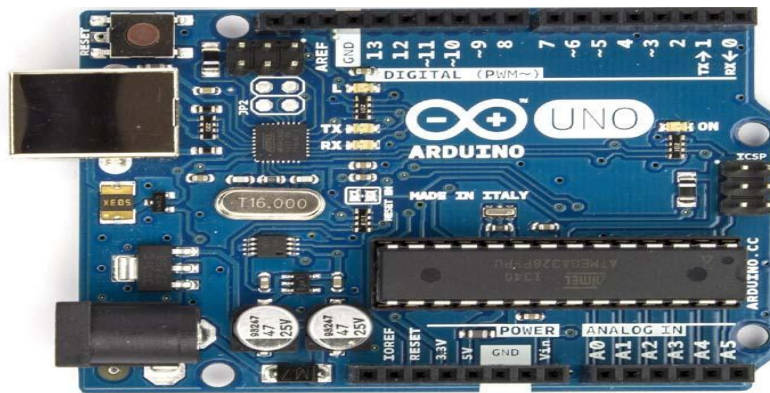### 2.2 Introduction of Arduino Used in Data Processing Department

Figure 2.2.1. Arduino UNO R3 [6]

2.3. Programming

To program Arduino Uno, the Arduino program must be downloaded here. After downloading and opening the program, Arduino Uno is selected from the Tools> Board menu. A bootloader must be installed in the ATmega328 on the Arduino Uno. Thanks to this bootloader, no external programmer hardware is required to program the Arduino. Communication was provided using the original STK500 program [6].
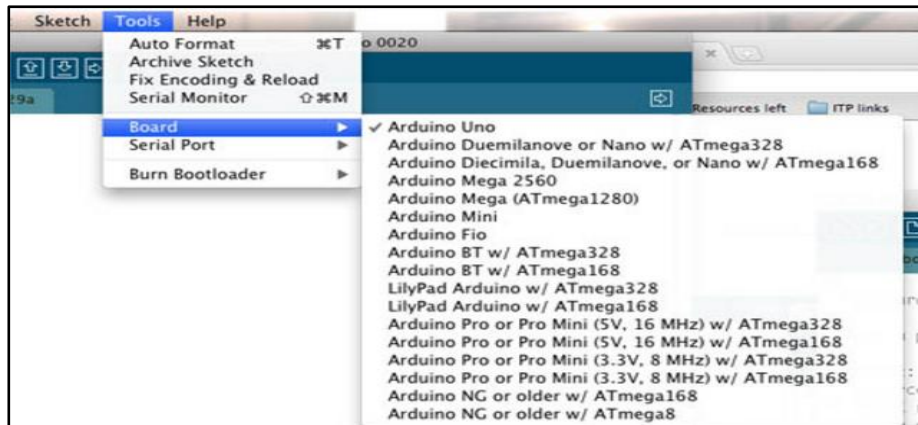
Figure 2.3.1. Arduino UNO R3 Selection [8]

III. EQUIPMENT OF ELECTROCARDIOGRAPHY EQUIPMENT

In this project, a device that detects the ECG signal and displays it on the graphic display has been designed. The block diagram of the device designed in Figure 4.1 is shown.
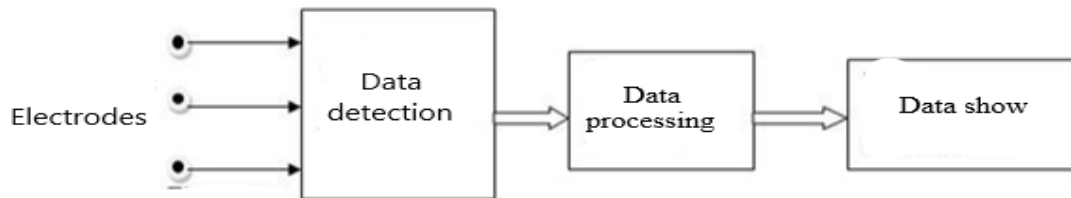

Figure 3.1: Block diagram of the device

The analog heart signal detected by the electrodes is given to the data detection section. Here, the electrical noise is separated from the signal using the filter and the signal is amplified several thousand times. The signal is then transmitted to the data processing department. Here, the analog signal is converted to digital and transferred to the data display section after necessary operations. In the data display section, 2x16 pixel graphic LCD and ECG signal is displayed on this LCD.
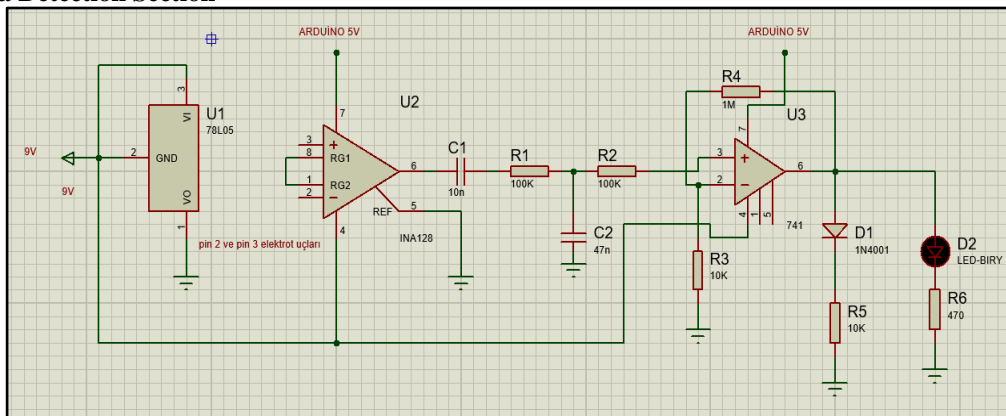
3.1. Data Detection Section

Figure 3.1.1. Circuit diagram of the data detection section

Two electrodes are connected to the input of the circuit. The received signals are amplified with the instrumentation amplifier (INA128) to amplify very small signals mixed with noise. The INA128 amplifier gain is connected to 1000. This gain was supported by using the LM741 amplifier. The scheme of the data detection section is shown in Figure 3.1.1.
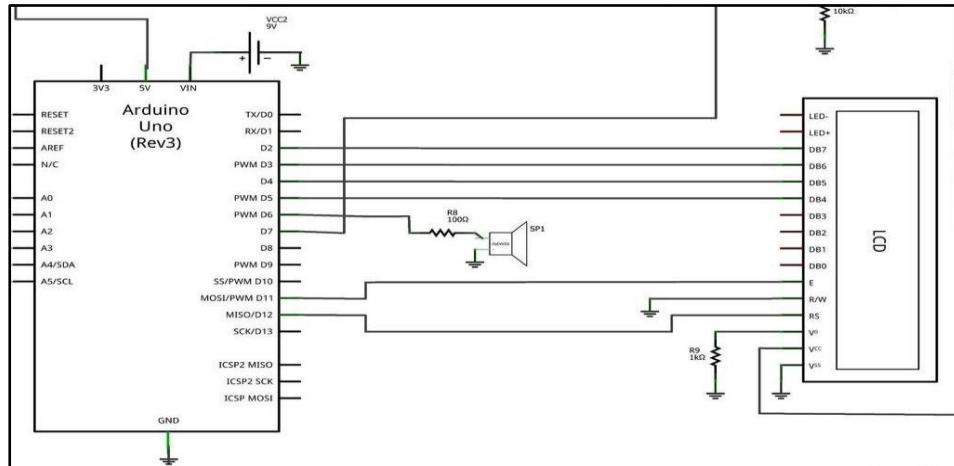
3.2. Data Processing and Demonstration

Figure 3.2.1: Arduino and graphic LCD connections

The scheme of data processing and display sections is shown in Figure 3.2.1. An Arduino model of UNO R3 was used in the circuit. It is powered by Arduino 9V battery. The circuit of the data processing and display sections is shown in the figure above. After passing the ECG signal through the data detection section, it is connected to the digital end of the Arduino, D7. A 2x16 pixel graphic LCD was used to display the signal.

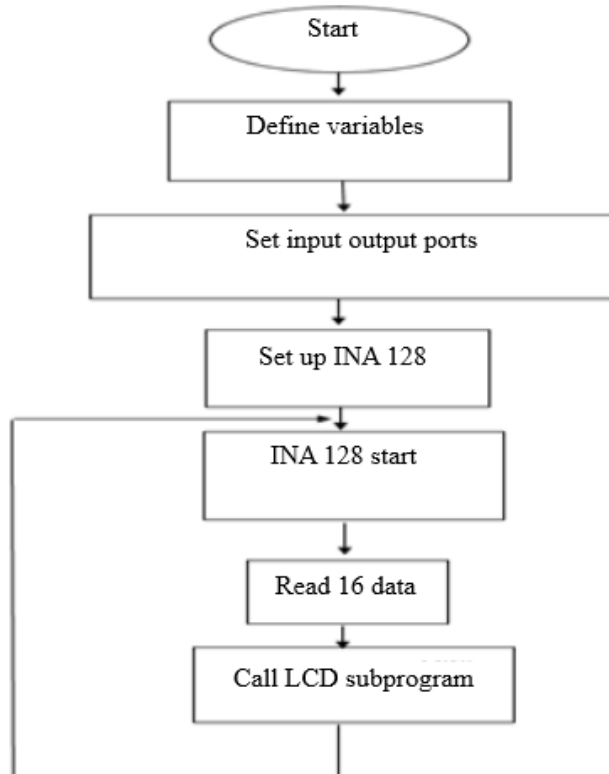## IV. ELECTROCARDİOGRAPH DEVİCE SOFTWARE

Figure 4.1 Flow chart of ECG Device

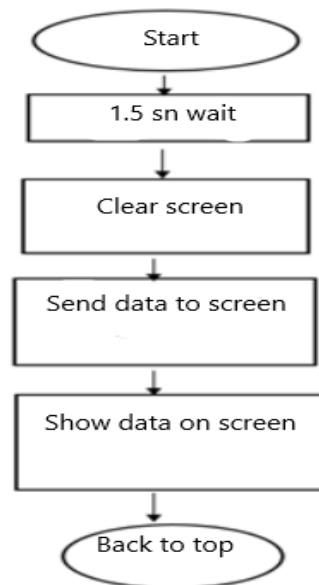ECG LCD Subprogram flow diagram is shown in Figure 4.2.

Figure 4.2: Program flow chart

V. CONCLUSION

With this study, which is designed and applied, the electrical signals produced by the heart are raised with the help of the electrodes placed on the body, and the ECG signals are displayed on the LCD screen thanks to the ARDUINO UNO R3. The ECG signal is as small as a few millivolts and generally these signals are confused with electrical noise. It is necessary to separate such a small signal from noise and amplify it a few thousand times. Therefore, the analog heart signal detected by the electrodes is given to the data detection section. As it is seen in Figure 5.1, the information obtained from the heart is obtained by taking the heart beat and you are alive on the screen.

Figure 5.1. Displaying ECG signals on the LCD screen

REFERNCES

[1]. E. Niedermeyer, F. H. Lopes da Silva. 1993. Electroencephalography: Basic principles, clinical applications and related fields, 3rd edition, Lippincott, Williams & Wilkins, Philadelphia.
[2]. H. L. Atwood, W. A. MacKay. 1989. Essentials of neurophysiology, B.C. Decker, Hamilton, Canada.
[3]. P. L. Nunez. 1995. Neocortical Dynamics and Human EEG Rhythms, Oxford University Press, New York.
[4]. J. D. Bronzino. 1995. Principles of Electroencephalography. In: J.D. Bronzino ed. The Biomedical Engeneering Handbook, pp. 201-212, CRC Press, Florida.
[5]. Brain Activation during Judgments of Positive Self-conscious emotion and Positive Basic Emotion: Pride and Joy : by Hidehiko Takahashi, Masato Matsuura et al in Cerebral Cortex April 2008; 18; 898-903.
[6]. Emotion Detection in Loop from Brain signals and Facial Images by Arman Savran, Koray Ciftci,etc.: Enterface'06, July17th , Dubrovnik, Croatia.
[7]. Kostas Michalopolous, Vasiliki Iordanidou, Giorgos A Giannakakis, Konstantina S Nikita and Michalis Zervakis (2011)"Characterization of evoked and induced activity in eeg and assessment of intertrail variability" ", IEEE research paper, page 978.
[8]. http://www.robotiksistem.com/
[9]. http://engineerslabs.com/2012/01/ecg-circuit-analysis-and-design-simulation-by-multisim/