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CONTINUOUS NON-INVASIVE BLOOD PRESSURE MONITORING WITHOUT USING CUFF

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Abstract: In the Worldwide, raised blood pressure is estimated to cause 7.5 million deaths, about 12.8% of the total of all deaths. High blood pressure (BP), or hypertension, is a common, long-term health condition, particularly among older adults. Non-invasive blood pressure (BP) monitors based on cuff occlusion are used widely in and outside of care facilities. These devices measure systolic (SBP) and diastolic blood pressure (DBP). Cuff- based methods for measuring blood pressure (BP) have shown some limitations. Moreover, the inflation of the cuff can cause discomfort to the patient, inaccurate reading, and does take continuous measurement. The system consists of a finger and three ECG leads, connected to a control unit.PPG makes uses of low-intensity infrared (IR) light to measure the changes in the blood volume. ECG waveforms are obtained from ECG leads. By comparing the ECG waveform and volume of blood changed we can find blood pressure of that person

INTRODUCTION

Normal blood pressure is vital to life. Without the pressure that forces our blood to flow around the circulatory system, no oxygen or nutrients would be delivered through our arteries to the tissues and organs. However, blood pressure can become dangerously high, and it can also get too low. Nowadays, the device used to measure blood pressure is a sphygmomanometer by ausculatory method, it consists of a rubber armband the cuff that is inflated by hand or machine pump.

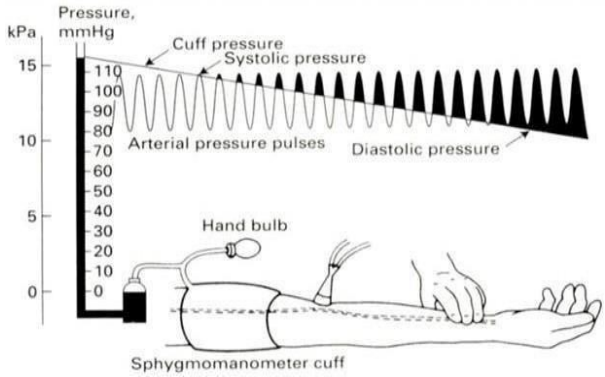

Figure 1: Ausculatory Method

Once the cuff is inflated enough to stop the pulse, a reading is taken, either electronically or on an analogue dial. A stethoscope identifies the precise point when the pulse sound returns and the pressure off the cuff are slowly released. Using the stethoscope enables the person measuring the blood pressure to listen out for two specific points. Blood pressure readings consist of two figures - the systolic pressure first and the diastolic pressure second.

Figure 1: shows a blood pressure monitoring using sphygmomanometer by ausculatory method. However, these cuff-based methods have some disadvantages, which limit their use in certain clinical or home settings, especially during certain a certain physical activity in which the cardiac output increases. A continuous BP cannot be measured using cuff- based methods because a pause of at least 1–2 minutes between two BP measurements is necessary to reduce errors in the measurement. Further, the patient may be disturbed by the inflation of the cuff and this disturbance may cause a sudden elevation of the BP.

It has been reported that the pulse transit time (PTT), the interval between the peak of the R-wave in electrocardiogram (ECG) and the fingertip photoplethysmogram (PPG), is related to arterial stiffness, and can be used to estimate the systolic blood pressure (SBP) and diastolic blood pressure (DBP). This phenomenon has been used as the basis to design portable systems for continuously cuff-less blood pressure measurement, benefiting numerous people with heart conditions. However, the PTT- based blood pressure estimation may not be sufficiently accurate because the regulation of blood pressure within the human body is a complex, multivariate physiological process. Considering the negative feedback mechanism in the blood pressure control, we introduce the heart rate (HR) and the blood pressure estimate in the previous step to obtain the current estimate.

COMPONENTS USED:

ECG ELECTRODES:

The ECG Electrode is used to obtain ECG waveform. Electrocardiography is the process of producing an electrocardiogram (ECG or EKG [), a recording– a graph of voltage versus time – of the electrical activity of the heart[4] using electrodes placed on the skin. These electrodes detect the small electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat). Changes in the normal ECG pattern occur in numerous cardiac abnormalities, including cardiac rhythm disturbances(such as atrial fibrillation and ventricular tachycardia), inadequate coronary artery blood flow (such asmyocardial ischemia and myocardial infarction), and electrolyte disturbances.

Figure 2 : ECG Electrode

There are three main components to an ECG: the P wave, which represents the depolarization of the atria; the QRS complex, which represents the depolarization of the ventricles; and the T wave, which represents the repolarization of the ventricles.

PHOTOPLETHYSMOGRAM (PPG):

A photoplethysmogram (PPG) is an optically obtained plethysmogram that can be used to detect blood volume changes in the microvascular bed of tissue. A PPG is often obtained by using a pulse oximeter which illuminates the skin and measures changes in light absorption. A conventional pulse oximeter monitors the perfusion of blood to the dermis and subcutaneous tissue of the skin. With each cardiac cycle the heart pumps blood to the periphery. Even though this pressure pulse is somewhat damped by the time it reaches the skin, it is enough to distend the arteries and arterioles in the subcutaneous tissue. If the pulse oximeter is attached without compressing the skin, a pressure pulse can also be seen from the venous plexus, as a small secondary peak. The change in volume caused by the pressure pulse is detected by illuminating the skin with the light from a light-emitting diode (LED) and then measuring the amount of light either transmitted or reflected to a photodiode.

PIC CONTROLLER:

The term PIC stands for Peripheral Interface Controller. Initially this was developed for supporting PDP computers to control its peripheral devices, and therefore, named as a peripheral interface device. These controllers are very fast and easy to execute a program compared with other microcontrollers

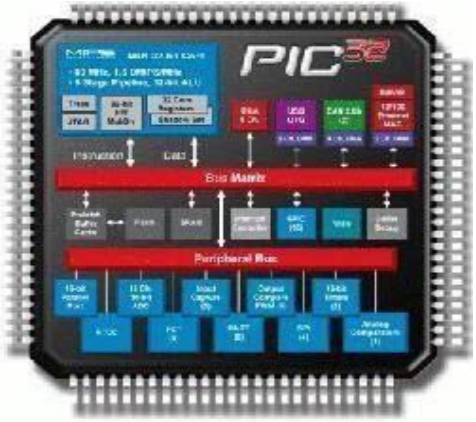

Figure 3: PIC Microcontroller

It consists of EEPROM memory based memory unit. It is cost efficient and easy to handle compared with other controllers. Instruction set of the PIC controller is very small and it's capable of working at 20Mhz frequency. Operating voltage of the unit about 4.2- 5.5V. Communication between the units is very easy as it has both serial and parallel communication protocol.

WORKING PROCESS:

The system mainly depends on the above explained three components. the ECG lead are used to obtain the ECG waveform. From the obtained waveform we can calculate the heart which is a well described process i.e it's calculated by dividing the number of large boxes between two successive QRS complex into 300. The PPG sensor consists of both the transmitter and receiver unit. The transmitter unit consists of low intensity IR light (140- 400nm). These light travels through the biological tissue are absorbed by bones, skin pigments and both venous and arterial blood vessels. Even small changes in the blood volume can be detected by using this method, though it cannot be used to quantify the amount of blood. The incident IR ray get reflected and received by photo diode by we can detect the blood volume of the person. The PIC microcontrollers are used to interface they obtained data from the ECG electrodes and the PPG sensor. By comparing these two values we can obtain the systolic and diastolic blood pressure of the patient.

CONCLUSION:

This paper presented the implementation of the system for continuously and non- invasively estimating the blood pressure. The estimation method uses the pulse arrival time (PAT) derived from photoplethymography (PPG) and electrocadiographic (ECG) sensor. The PAT is measured by means of a wireless body sensor network (WBSN) comprising of PPG and ECG sensor nodes. Blood pressure is estimated within the ECG sensor node and the LCD could be only needed to visualize the blood pressure values in application that demand it. This feature enables reducing both power consumption and system cost, and also providing with free movement to the user. Thanks to the proposed locations of the nodes, the user can perform daily activities, eliminating the discomfort produced by the system that requires installation of sensor in the finger. In future works, more sensor nodes could be included to achieve the more accurate result. The development of the blood pressure estimation system was guided by the reduction in energy consumption. However, further power consumption optimization is possible.

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