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# Human Health Monitoring System At Home Based on Cortex-m3

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**ABSTRACT:** This paper presents the human health monitoring system at home based on cortex-m3, which deals with study and analysis of physiological signals and it achieves the simultaneous monitoring of physiological signals and real-time storage and transmission of data. The system uses memory card for data storage and USB for data transmission, which achieves storage and display. So it reduces the operating frequency to achieve the goal of low power consumption. The experimental results show that the system having high-capacity, low-power and high accuracy, which meets the user's requirements for physiological signal monitoring.

**KEYWORDS:** Cortex-m3, physiological signals, storage, transmission.

## 1. INTRODUCTION

ECG, EEG and PULSE are vital sign's in our body. These signals having an important value in the monitoring of human health. It is necessary to access these physiological signals timely and accurately and it is also important to find the disease and take effective measures. So it is important to monitoring the patient's physical condition properly to maintaining the patient's health. The traditional multi-parameter monitoring system having the speed of data transmission is slow and the accuracy of measured physiological signal is low [1]. We therefore designed the human health monitoring system at home based on cortex-m3, which achieves the simultaneous monitoring of physiological signals which is characterized by the low power, high precision and high-capacity. The system can obtain ECG, EEG, EMG, and, Pulse signal at low operating frequency. At the same time, it also store the data in SD card and USB for data transmission.

## II. SYSTEM DESIGN

The system can monitor the human physiological signals based on the cortex-m3. It uses a SD card as a data storage memory and uses the USB interface to achieve real-time communication. The structural frame of the system is shown in Figure l.

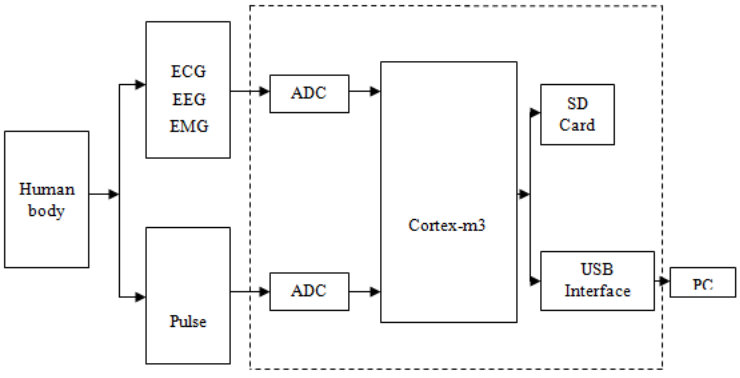


Fig 1. Diagram of the system

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2.1 ARM Cortex- M3 processor

Medical sensor acquisition is consisting of ARM Cortex-M3 processor. The LPC1788 is based on ARM Cortex-M3 microcontrollers for embedded applications. It's featuring a high level of integration and Enhanced determinism, low power consumption. The ARM Cortex-M3 is a after that generation core. The LPC1788 drive at CPU frequencies of up to 72 MHz's. The ARM Cortex-M3 CPU incorporates a 3-stage pipeline with branch speculation and uses a Harvard

The physiological signals acquired in the system includes: ECG, EMG, and EEG. The system uses two 24-bit analog-to-digital converters to collect the analog signals after the copula between electrode and electrical signal. By placing the electrodes on our body first, the signal in each channel is amplified by a differential amplifier inside the instrument, then the analog signal is converted into digital signal, finally the data are transmitted to Cortex-m3 by the serial communication.

The extraction method of finger pulse signal is based on Photo Plethysmo Graphy: The system uses Cortex-m3 to drive red light and infrared light. After the analog signal from photodiode is amplified, it is inputted into analog to digital converter (ADS8344).

The changes in respiratory is monitored by restraining the human thorax. The system can get the differential signal from the sensor based on this method. After passing the instrumentation amplifier, the active lowpass and secondary amplification the signal is inputted into analog to digital converter. Cortex-m3 reads the converted data from analog to digital converter (ADS8344) through the Serial to Peripheral Interface bus. Thereby the system gets the pulse and respiration signals.

## III. SOFTWARE DESIGN

IAR Systems is the tools provider of choice for mixed-signal control processors from Analog Devices. So the system achieves the data collection, storage and transmission based on cortex-m3 (LPC1788). The system takes multiple signals and generates a large amount of data, these data can be stored in SD card and the time the system needs to work, at the sampling rate of EMG, ECG and EEG are set at 512Hz, the sampling rate of respiratory signal and pulse signal are set at 256Hz.

The system has to deal with multi-tasking functions such as data storage in the SD card, real-time transmission by USB and so on. Completing multiple tasks at low operating frequency is not only an important task to the system, but also an important way to achieve low power consumption.

3.1 Data acquisition.

Electrocardiography (ECG), electromyography (EMG), and electroencephalography (EEG) systems measure heart, muscle, and brain activity over time by measuring electric potentials on the surface of living tissue [2][3]. An electrocardiogram (ECG or EKG), is a measurement of the electrical activity of the heart. Normally at rest, as the electrical impulse moves through the heart, the heart contracts about 60 to 100 times a minute. Each contraction of the ventricles represents one heartbeat.

Electroencephalogram detects abnormalities in the brain waves or electrical activity of the brain. It records patterns of brain activity among the basic waveforms are the alpha, beta, theta, and delta rhythms. Electromyography (EMG) measures muscle response or electrical activity in response to a nerve's stimulation of the muscle. The test is used to help detect neuromuscular abnormalities.

Nervous stimuli and muscle contractions can be detected by measuring the ionic current flow in the body. This is accomplished using a bio potential electrode. A chemical reaction occurs at the interface between the electrolyte and the electrode. A voltage known as the half-cell potential develops across the interface due to an uneven distribution of anions and cations. It appears as a dc offset in ECG, EMG, and EEG signals.

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The pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute. The pulse signal is obtained by the principle of using alternating red light and infrared light to through the pulsatory artery in the measurement site [4][6]. To get the oxygen saturation, the system needs light red LED and extinguish the infrared LED once, so it can collect the value from sensor. It also need light the infrared LED and extinguish red LED once, so it can collect value from sensor. In addition, the system needs to get the value twice when the red LED and infrared LED are off. Based on this principle, the system sets the frequency of timer interrupt up to 2 KHz to control the red light and infrared light flashing alternately.

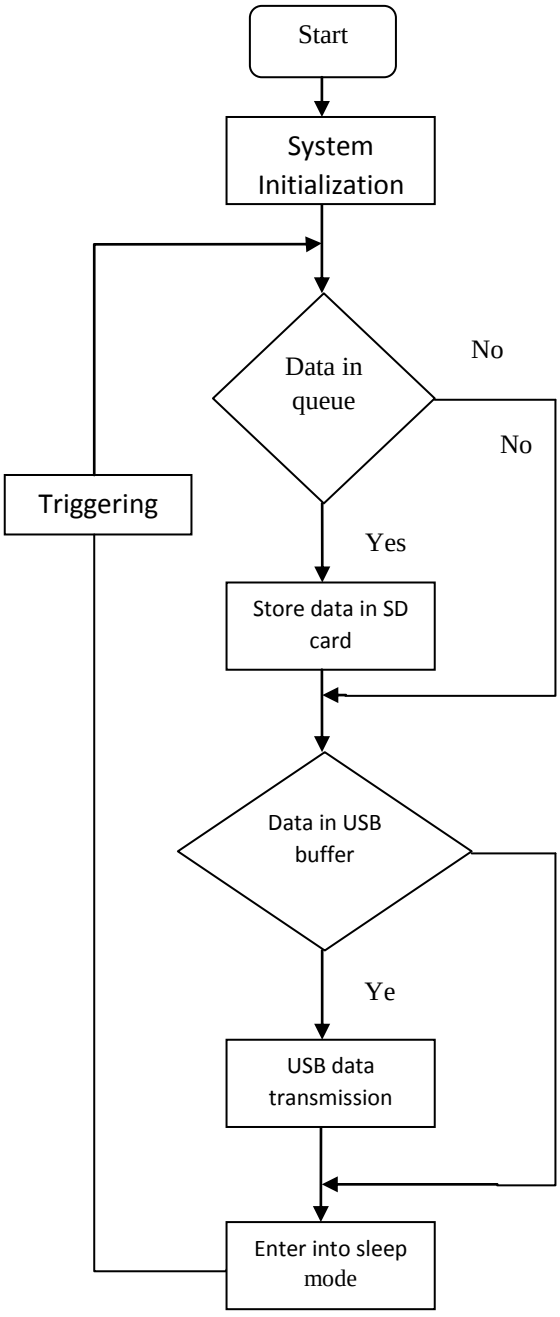


Fig 2. Flow chart of the system

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3.2 Data transmission

When the data in the SD card is sufficient, the system will transfer the data to the computer by USB bus. The USB interface used by the system supports hot-swappable and dynamic configuration, It has the advantage of high-speed and stabilization. The specific processes of data transmission is that the PC checks whether there is a USB device firstly, if it finds a USB device, it will send an instruction to the system, if it does not find the device, the PC will continue to check for the USB device. After receiving the communications instruction, the system begins to transfer SD card information or it directly access the data. The system checks the USB buffer whether the data frames are adequate at the same time, if the data are enough, the data will be issued ,if not, the system will check the buffer in the next cycle.

3.3 Data storage

The SD card interface provided by Cortex-m3 has all the specific features of Storage Device memory card. It has the advantage of safety, high-speed storage and so on, which meets the requirements of storing large quantities of data in the system. Different from the USB data frames, the data frame stored in the SD card consists of 512 bytes. It and is necessary to format the SD card and create new files to store data patient information before working. When the SD card is full, the system will automatically stop storing and open the corresponding indicator. Storing the data into SD card synchronously contributes to a more detailed health care diagnosis.

## IV. RESULTS AND DISCUSSIONS

The whole system can be designed and tested. The physiological signal can accessed and displayed.

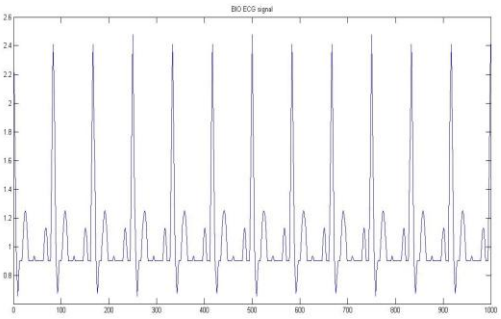

Fig 3. ECG waveform

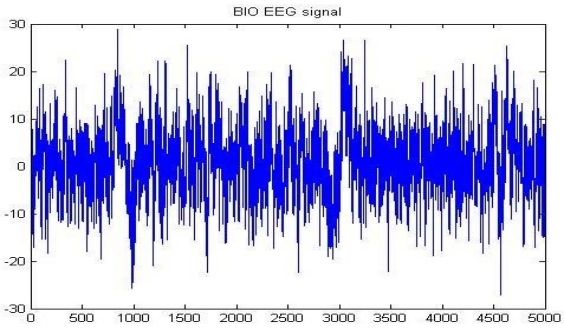


Fig 4. EMG waveform

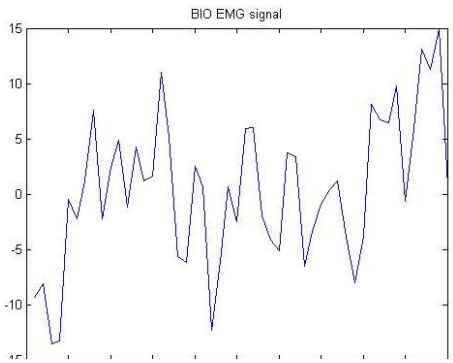


Fig 5. EEG waveform

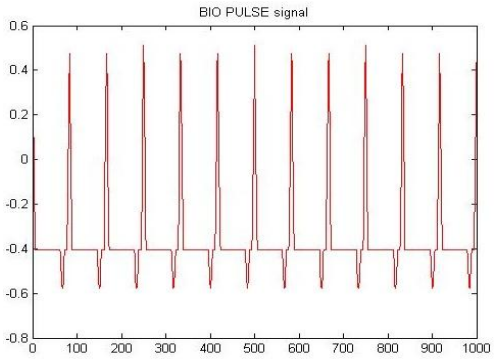


Fig 6. Pulse waveform

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The waveforms shows that state of art of wearable physiological signal monitoring system, by placing the electrodes on our body and acquiring and transmitting the physiological data using wearable data acquisition hardware.

Sample recording of ECG is shown in fig 3, the significant features of waveform are the P, Q, R, S waves, the duration of each wave and time intervals such as P-R, S-T and Q-T intervals. When there was a problem in heart, the rhythms of heart was too slow or too fast or irregular rhythms. A heartbeat that is too fast is known as tachycardia. A heartbeat that is too slow is known as bradycardia.
Fig 4 represents EMG waveform, when the person in relaxed position the negative peak was appeared and there was a muscle movements or contraction it shows the positive peak, any disorders in muscle shows that strait line.

Fig 5 shows the brain activity among alpha, beta, theta, delta waveforms. When the person awaking feeling anxiety or depression the beta waveforms occur at the frequency of 13-30Hzs per cycle as shown in fig 5, based on human physiological condition the waveforms are occurred.
Fig 6 shows the pulse rate or heart rate, the pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute. The normal pulse for healthy adults ranges from 70 to 80 beats per minute. The pulse rate may fluctuate and increase with exercise, illness, injury, and emotions.

## V. CONCLUSION

The human health monitoring system at home based on Cortex-M3 achieves the simultaneous monitoring of multiple physiological signals and completes the storage and real-time transmission of data. The system has the advantage of high storage capacity, low-power consumption and high speed of data transmission.

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