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HealthComm – Your Doctor on the Go!

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Abstract. A tiny electronic widget in your pocket sufficient enough to spare you from clinical visits and keep you updated on some of the statistics that dominate your health profile, warns you on deteriorating health and sends emergency messages in crisis. A low power, multifunctional, intelligence embedded health analyzer-HealthComm.

Keywords: EEG, oximeter, pattern analyzer, GSM, GPS, heart rate monitor, blood pressure monitor, stress and temperature monitor.

1. Introduction

One of the acute problems confronted by present day society in health care and medicine is the sheer dearth of skilled physicians and doctors. However with technology advancing day by day, we present a smart solution, HealthComm, a virtual doctor, available to diagnose and partially cure commonly encountered health problems.

The vital health parameters for any person are his **heart beat** rate, **blood pressure**, the **oxygen saturation** of his blood, his body **temperature**, his physical **stress** and the most versatile of them all-**Electroencephalogram** of his brain which can itself help in diagnosing several neural and mental diseases. It's a State of art design having all these on a board that plugs into your phone!

The project aims at creating a virtual doctor that can track your all these, log the measured data into the memory, and then use it to produce a pattern of the body's performance (in pertinence to that parameter) over a period of time and finally function to precaution the user of his degrading health. It also broadcasts emergency messages to preselected doctors, family members, and emergency services similar to that of 911.

The innovation comprises of six modules that share a logic using time division multiplexing to optimize the area and minimize power consumption. It also generates patterns based on logged data which are be statistically analyzed to display warnings if the recorded performance is below the threshold for a reasonably long period of time.

The user has power option with the three power saving modes-the Sleep mode which has only half the device ON, the Power Saver mode which samples output at 10 minute intervals and a Turbo mode for intense operations.

2. Building Blocks

The architecture of the entire design is divided into the following sub-units:

1. Tracking systems
2. Memory for data logging
3. Pattern Analyzer
4. Alarm Subsystem
5. Communication Subsystem

6. System control

3. Concept and Features

The concept can best explained by considering the signal flow.

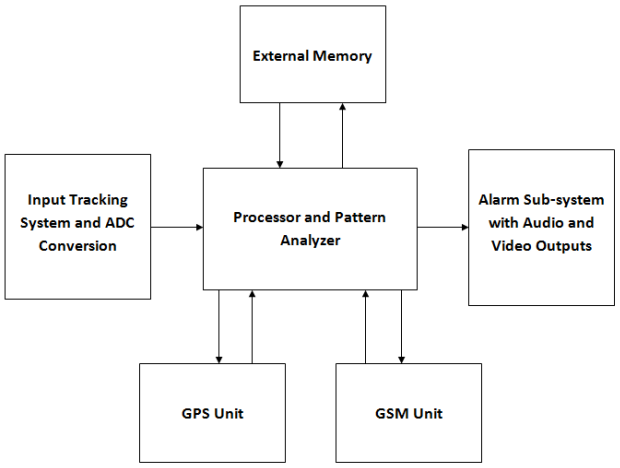
The tracking system comprises of six distinct sensors whose output is converted to digital values by a precision Analog to Digital Converter. These values are then sent to the processor.

The processor assigns an identity bit to each data coming in and then compares it with a test bench. The test benches are predesigned set of values.

Each of the sensors measures a body parameter or its performance and over the years, several medical institutes have set certain parameters to judge this performance. By making use of such pre-defined values, we design a test bench that is compared with the incoming data and inference is drawn.

Now this compared data, called offset is used by the pattern analyzer, which is just a part of the processor designed to act in way it does. It takes the values and makes a virtual graph of the incoming data. The time axis guided by the clock signals and the magnitude axis being a representation of the offset values, we get a near perfect graphical representation of the parameter being measured. Now by analyzing the parameters of the graph more inferences can be drawn.

The alarm sub-system is used to alarm the user about any possible threats. It gives the output graphically as well as in audio. It doesn't wait for the patient to reach the worst case and alarms him just in time to take reactive or even proactive measures to avoid the calamity, courtesy the pattern analyzer.



The communication system communicates with the outside world. The GSM module is used for sending relevant data to the doctors or medical practitioners. It's also use to alarm the emergency services in case of any calamity.

The GPS module can be used to guide the patient to the nearest hospital or track down the user in case he is unable to reach the place of treatment.

Every HealthComm devices has a unique tag that it carries along with it. It's like the identity of the user. Whenever communication occurs over the GSM module, this tag plays an important role to identify the user. Also, such tags can be used to store user's data to be later retrieved over the cloud incase the GSM services provider makes provision for a cloud connectivity.

4. Tracking Systems

A total of 6 distinct tracking modules have been used. They are optimized by simulating a single component they share and then using that component on a time division multiplexing basis for all of them. This shall effectively reduce the overall size of the chip. A detailed description of the modules will follow:

- **Heart- beat rate meter**: A sensor provided stream of pulses are compared with an empirically accepted threshold. The beats well above the threshold are counted by a counter leaving the weaker ones. Counters are used to give away the rate.

- **Blood-pressure meter**: The inputs from a hand-cuffed sensor cum transducer provides two different electrical voltages (in the range of 12mV to 36 mV) - one for the systolic pressure and other for the diastolic pressure. Both these incoming voltages are passed through a high pass filter and then amplified to get the blood pressure of the user.
- **Oximeter**: The oxygen saturation in the blood carried in capillaries near a finger tip or around an ear-lobe is precisely determined by efficiently utilizing the property that oxidized hemoglobin (HbO_2) and reduced Hemoglobin (Hb) have significantly different optical spectra in the range of 500nm(Visible Red Color) to 1000nm(Infra Red). The outputs from the photodiode are converted to voltage, sampled and then filtered to get the comparable signal. An algorithm follows which gives the actual value of oxygen saturation.
- **EEG meter**: Signals are obtained from 2 to 26 electrodes placed on the user's brain. These are fed to a filter matrix to separate the alpha, beta, gamma, delta, and mu waves by frequency. These are further tested for their amplitudes to diagnose diseases, if any.
- **Stress Measurement**: The skin conductivity of humans vary depending on the level of physical stress he endures. The design prototype intends to represent this tracking system by simulating a variable resistor.
- **Body Temperature Measurement**: A heat measuring sensor coupled with a transducer will provide inputs which would indicate the body temperature of the user. A comparative threshold is set to let the user know of temperature related issues like fever.

5. Memory and Data Logging

The memory organization is done such that it effectively interfaces with various subsystems. The digital values from respective counters or A/D converters are fed into the respective memory blocks after comparison with the threshold. The blocks are so designed that memory logging occurs in a loop by erasing the previous bits whenever the upper limit of data holding capacity is reached. The stored data is fed to the pattern analyzer. The pattern analyzer also uses the memory for its operation.

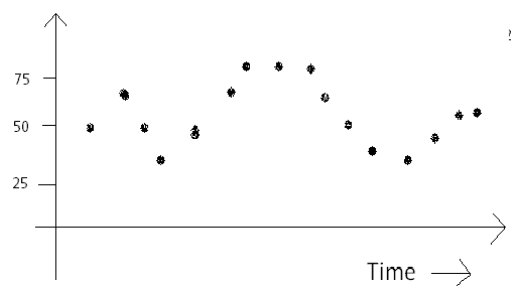
Moreover, data traffic over GSM and GPS modules also makes use of the memory. Important numbers and frequently needed data, such as user tags too are logged into it.

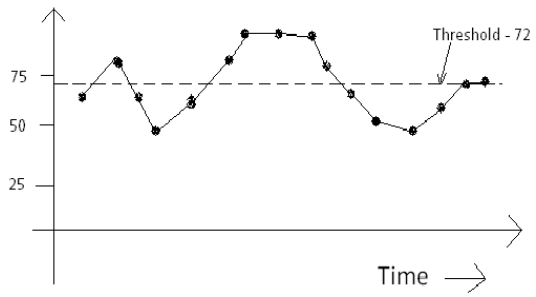
6. Pattern Analyzer

It is not a different block but a part of the processor itself. The data logged into each of the memory blocks is forwarded continuously to the pattern analyzer unit which is customized for each of the input tracking systems.

For instance, in the heart beat rate measurement unit, 100 successively loaded data entries just prior to the latest recorded one are to be plotted on the Y-axis(as the magnitude) as shown.

The pattern analyzer shall create a continuous graph, by using various mathematical techniques that extends for those 100 instances. The resulting waveform can be displayed along with a threshold level to serve as a performance chart of the user pertaining to his heart beat. For example, from the graph shown here, several of the recorded instances depict heart rate reasonably below the normal human threshold of 72 beats per minute. This being an anomaly is brought to the attention of the user by using the alarm sub-system.





7. Alarm Sub-system

The pattern analyzer intelligently, through an inbuilt algorithm, comprehends the performance of the user, relative to the corresponding parameter, over a period of time (which is dependent on the kind of mode the user uses his HealthComm in) and issues warnings in the form of messages which are prerecorded. In the case of crucial situations like the user getting unconscious due to suffocation in crowded places, then his oxygen saturation may suddenly decrease, or his blood pressure may suddenly decrease, then in such an emergency the pattern analyzer recognizes this sudden slump (or possibly even a sudden surge) from the normal value as a 'crisis' situation and broadcasts messages to preselected doctors, family members or emergency services like 911 through the communication module.

The alarm subsystem has exclusive access to the output unit in terms of LCD and loudspeakers. It not only alarms the user in emergency situations but also gives him timely inputs when the health's deteriorating gradually.

Without staying true to its name, it applauds when the health is normal and congratulates a recovering body.

The only user interface in the whole system, there lays a responsibility on it to satisfy the user every bit.

8. Communication Sub-system

The communication subsystem comprises of a GSM and a GPS module.

The GSM module is the HealthComm's gateway to the outside world. It is used to communicate with doctors as well as the emergency services.

Not only that, a regular link between the doctor and patient can be established successfully through this system. The readings from the tracking system are sent to respective doctors and specialists for examination and comments received by the doctors are made visible to the user.

In case of a crisis situation, the emergency services are alarmed by a high priority call which curbs any other ongoing process and makes way for this alarm to go off.

Also, in such cases, the GPS system is used to tell the user the shortest possible way to hospital and/or giving the emergency services a guide to reach the user.

All this can be done with help of a unique tag that defines the user.

If the service provider allows for cloud connectivity, even better use of the resources is possible. Now, important data of the user can be recorded straight on the cloud and act as a history for the patient. Also, dynamic update of the threshold can be made possible. Similarly, doctors can change the threshold as they change the prescription and make HealthComm customized for a patient.

Adding onto the already existing plethora of features to this buddy of yours, it can very well advise you have control on your food intake. Say for instance, a low Blood Pressure patient is not allowed to have too much salt in his diet. Then whenever such a person is about to intake such a dish having primarily salty taste then, if he just lets the system know that he's onto relishing a salty delicacy then the system can maturely advise him to refrain taking that. This requires pre-programming of the module to suggest opinions for different tastes given a certain critical bodily state of the patient.

9. System Control

All the multiplexing operations are exclusively controlled by the System Control Unit.

This unit accepts input as the mode selection from the user. The chip is designed to work in 3 modes:

1. Sleep mode: When the user rests, then variations in parameters like oxygen saturation, stress level, body temp are hardly changing. So, we can shut the performance of those units temporarily and thereby save power. Only the heart beat and blood pressure measurement unit along with the EEG are active in this mode.

2. Power saving mode: When the user is performing everyday tasks like reading, eating, watching TV, talking on the phone or is simply at his word desk, then the power saving mode can be activated. Here the

inputs are activated at regular instances, say 10 minutes and the data is logged in. This saves on power as this is the state user would be in for most of the day.

3. Turbo mode: When the user is exercising, travelling or doing any strenuous task, almost all of his health parameters tend to move away reasonably from the threshold. Here it is the duty of HealthComm to trace variations in all such parameters and alert the user whenever required. So in this mode, all the units are working continuously monitoring the user.

10. Conclusion

As the manuscript suggests, the ultimate aim is to develop a health monitoring device which tracks your body parameters, analyzes them and warns you every time you cross the danger-line. Implementation of several essential devices on a single chip to ensure a good overall health and a communication module acting as a warning device makes it your doctor on the go

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