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# DETECTING VITAL SIGNS OF CHF PATIENTS WITH WEARABLE SENSORS

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## ABSTRACT

*Nowadays, chronic heart failure affects an ever-growing segment of population, and it is among the major causes of hospitalizat ion for elder citizens. Based on periodic visits, The actual out-of- hospital treatment model, has a low capability to detect signs of destabilization and leads to a high rehospitalization rate.*

*In this paper, a complete and integrated Information and Communication Technology system is described enabling the CHF patients to daily collect vital signs at home and automatically send them to the Hospital Information System, allowing In case of necessity the physicians to monitor their patients at distance and take timely actions. All signals are processed upon acquisition in order to assert if both accurate values and extracted trends lay in a safety zone established by thresholds. Per-patient personalized thresholds, required measurements and transmission policy are allowed.*

## I. INTRODUCTION

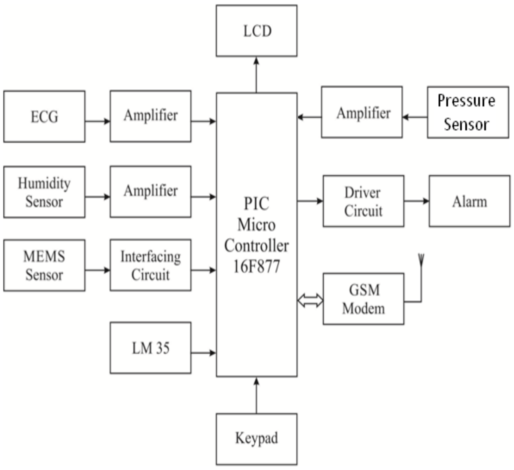
Chronic Heart Failure (CHF) represents one of the most relevant chronicdisease in all industrialized countries, affecting approximately 15 million people in Europe and more than 5 million in the U.S., with a prevalence range from 1% to 2% and an incidence of 3.6 million new cases each year in Europe and 550 000 cases in U.S.

It is the leading cause of hospital admission particularly for old adults reaching a prevalence of 1.3%, 1.5%, and 8.4% in 55–64 years old, 65– 74 years, and 75 years or older segments, respectively.

Admission to hospital with heart failure has more than doubled in last 20 years, and it is expected that CHF patients will double in 2030.

The current healthcare model is mostly in-hospital based and consists of periodic visits. Previous studies point out in patients with a discharge diagnosis of heart failure; the probability of a readmission in the following 30 days isabout 0.25, with the readmission rate that approaches 45% within 6 months.

## II. BLOCK DIAGRAM




The microcontroller is a general purpose device. which integrates a number of components of a microprocessor system on to single chip. It has input CPU, memory and peripheral to make it is a mini computer. A microcontroller combines on the same microchip:

- The CPU core
- Memory(both ROM and RAM)
- Some parallel digital i/o

Microcontrollers will combine other devices such as:
The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS that uses separate bus for instruction and data allowing simultaneous access of program.

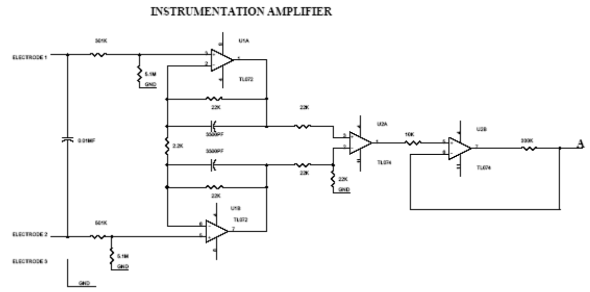
## III. PIC 16F877

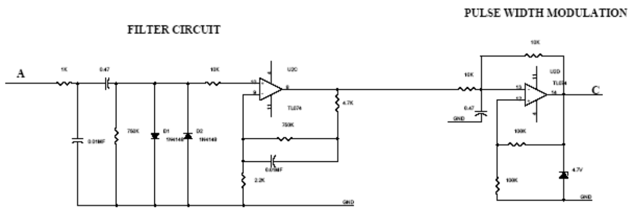
In Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. There are some of the memories technology. In which FLASH is the most recently developed.

Technology that is used in pic16F877 microcontroller is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

## IV. ECG

An electrocardiogram (ECG or EKG, abbreviated from the German Electroc ardiogramm) is a graphic produced by an electrocardiograph, which records the electrical activity of the heart over time. Analysis of the various waves and normal vectors of repolarization and depolarization yields important diagnostic information.




The sensor for pulse oximetry and plethysmographic measurements is a classical finger clip reader type to be applied at patient’s first finger. In accordance with the physicians, the Einthoven’s 3 leads ECG configuration is considered sufficient for our purposes ( e.g., detection of heart rate (HR) and rhythm) and not excessively dependent on the transducer positioning. All such signals are conditioned, digitalized and then packetized, and finally transmitted via Bluetooth protocol.

The ECG device outputs digitalized waveforms of two standard limb leads, the oxygen saturation in the blood, the plethysmographic waveform, and the battery level.

Integrating ECG functionalities in a novel single device reduces the number of sensing devices in the final system and also enables to acquire synchronized ECG plethysmogram traces.

As reported the ECG module is realized assembling its building blocks on a single printed circuit board. All communications within the board take place under the coordination of a dedicated firmware running on the MSP430F2418 Ultra-Low Power Mixed Signal Controller, responsible for mixing raw data before passing them to the Bluetooth interface. The core of the ECG block is an adhoc developed application-specific integrated circuit (ASIC), very compact and high configurable, able to integrate the ECG functionality into portable and wearable devices.

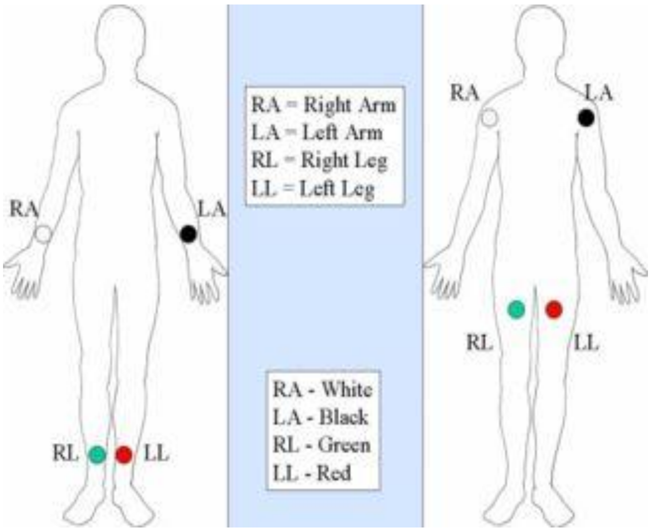
The electrocardiogram does not access the contractility of the heart. However, it can give a rough indication of increased or decreased contractility.

## V. LIMB LEADS

Leads I, II and III are the called limb leads because at one time, the subjects of electrocardiography had to literally place their arms and legs in buckets of salt water in order to obtain signals for Einthoven's string galvanometer.

They form the basis of which is known as Einthoven's triangle. Eventually, electrodes were invented that could be placed directly on the patient's skin. They remain the first three leads of the modern 12 lead ECG.

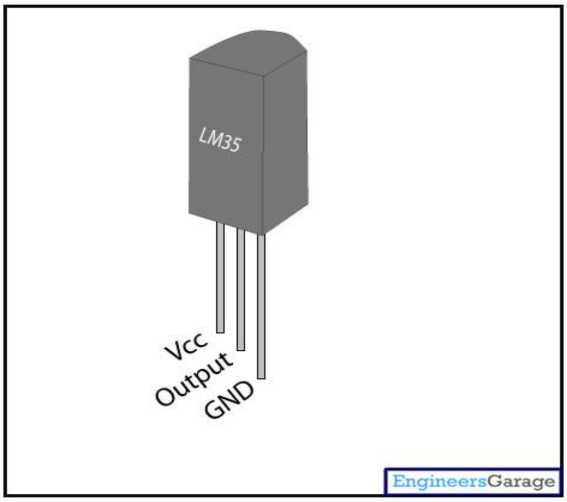
Leads aVR, aVL, and aVF are augmented limb leads. They are derived from the same three electrodes as leads I, II, and III. However, they view the heart from different angles because the negative electrode for these leads is a modification of Wilson's central terminal, which is derived by adding leads I, II, and III together and plugging them into the negative terminal of the EKG machine.




This zero out the negative electrode and allows the positive electrode to become the "exploring electrode" or a unipolar lead.

## VI. TEMPRATURE SENSOR

LM35 is a precision IC temperature sensor it is output proportional to the temperature. The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than thermistor. It also possess low self heating and does not cause more than 0.1 $^{o}$C temperature rise in still air.




The operating temperature range is from -55°C to 150°C. The output voltage variesby 10mV in response to every oC rise/fall in ambient temperature, i.e., its scalefactor is 0.01V/ oC.

## VII. HUMANITY SENSOR

A humidity sensor, also called as hygrometer, measures and regularly reports the relative humidity in the air. This may be used in the home for people with illnesses affected by humidity; as the part of home heating, ventilating, and air conditioning systems; and in humidors or wine cellars.

Humidity sensors can also be used in cars, office and industrial HVAC systems, and in meteorology stations to the report and predict weather.

A humidity sensor senses relative humidity. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.

## VIII. PRESSOR SENSOR

A pressure sensor measures pressure, typically of gases or liquids. Pressure is expression of the force required to a stop fluid from expanding, and is usually stated in terms of force

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per unit area. A pressure sensor usually acts as a transducer; its generates a signal as a function of the pressure imposed. For the purposes of this article, such as a signal is electrical.

Pressure sensors are used for control and the monitoring in thousands of everyday applications. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensors can alternatively be called pressure transducers.

## IX. ACCELEROMETERS

An accelerometer is an electromechanical device that will used to measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer.


Since the charge is proportional to the force, and the mass is a constant, then the charge is also proportional to the acceleration.

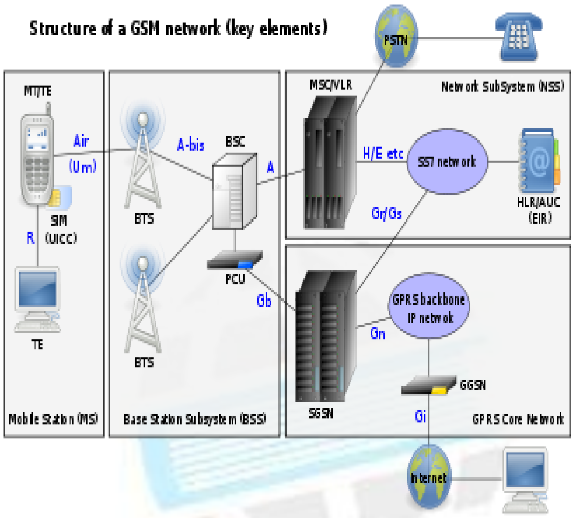
## X. GSM

Global System for Mobile Communications is one of the most popular standards for mobile telephony systems in the world. The GSM Association, its promoting industry trade organization of mobile phone carriers and manufacturers, estimates 80% of the global mobile market uses the standard.[1] GSM is used by over 1.5 billion people[2] across more than 212 countries.[3] Its ubiquity enables international roaming arrangements between the mobile network operators, providing subscribers the use of their phones in many parts of the world.

GSM differs from its technologies in that both signaling and speech channels are digital, and GSM is considered a second generation for mobile phone system.

This also facilitates the wide-spread implementation of data communication applications into the system.

## XI. NETWORK STRUCTURE




Structure of a GSM network

The network is structured into a number of discrete sections. The sections are :

The Base Station Subsystem (the base stations and their controllers).

The Network and Switching Subsystem (the part of the network most similar to a fixed network). This is also called core network.

The GPRS Core Network (the optional part which allows packet based Internet connections).

The Operations support system (OSS) for maintenance of the network.

## XII. CONCLUSION

The Health at Home system proposes an innovative home care model in order to support in integrated and coordinated fashion the whole process of the patient treatment, connecting in-hospital care with out-of-hospital follow up.

One of the main system novelties is represented by the home gateway which embeds, through the so-called OP, the medical prescription for any given patient. Moreover, it locally performs all the sensor signal processing and alarm detection. The OP is configurable according to the patient's needs and remotely updatable if required via the server platform.

The basic sensors kit established by physicians includes two commercial devices for temperature and humidity and a new developed module for acquiring synchronized ECG and pulse.

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