

# Monitoring of Health @ Home using Sensing Devices

E. Nagabhooshanam, Y. Gayathri, G.Praveen, K. Deepak, D. Sireesha

**Abstract:** *The current healthcare model is mostly in-hospital based and consists of periodic visits. Nowadays, chronic heart failure (CHF) affects an ever-growing segment of population, and it is among the major causes of hospitalization for elderly citizens. The actual out-of hospital treatment model, based on periodic visits, has a low capability to detect signs of destabilization and leads to a high re-hospitalization rate. To this aim, 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 the physicians to monitor their patients at distance and take timely actions in case of necessity. A minimum set of vital parameters has been identified, consisting of electrocardiogram, SpO<sub>2</sub>, blood pressure, and weight, measured through a pool of wireless, non-invasive biomedical sensors. A multi-channel front-end IC for cardiac sensor interfacing has been also developed. Sensor data acquisition and signal processing are in charge of an additional device, the home gateway. All signals are processed upon acquisition in order to assert if both punctual values and extracted trends lay in a safety zone established by thresholds. Per-patient personalized thresholds, required measurements and transmission policy are allowed. As proved by first medical tests, the proposed telemedicine platform represents a valid support to early detect the alterations in vital signs that precede the acute syndromes, allowing early home interventions thus reducing the number of subsequent hospitalizations.*

**Keywords:** *Biomedical instrumentation, chronic heart failure, e-health, sensor signal processing, tele-monitoring, vital signs sensors.*

## I. INTRODUCTION

Chronic Heart failure (CHF) represents one of the most relevant chronic disease in all industrialized countries, affecting approximately 15 million people in Europe and more than 5 million in the U.S., with a prevalence ranging from 1% to 2% and an incidence of 3.6million new cases each year in Europe and 550 000 cases in U.S. [1]–[3]. It is the leading cause of hospital admission particularly for older 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 [2].

Admission to hospital with heart failure has more than doubled in the last 20 years [1], and it is expected that CHF patients will double in 2030. Hospital admissions caused by CHF result in a large societal and economical issue, Accounting for 2% of all hospitalizations [4]. The CHF management accounts for 2% of the total healthcare expenditure [5], [6] and hospitalizations represent more than two thirds of such expenditure [3]. The current healthcare model is mostly in-hospital based and consists of periodic visits. Previous studies pointed out that in patients with a discharge diagnosis of heart failure, the probability of a readmission in the following 30 days is about 0.25, with the readmission rate that approaches 45% within 6 months [7]. It is acknowledged that changes in vital signs often precede symptom worsening and clinical destabilization: indeed, a daily monitoring of some biological parameters would ensure an early recognition of heart failure de-compensation signs, allowing appropriate and timely interventions, likely leading to a reduction in the number of re-hospitalizations. Due to lack of resources at medical facilities to support this kind of follow-up, the use of Information and Communication Technologies (ICT) has been identified by physicians and administrator as a possible valid support to overcome this limit. There is in literature some evidence that a multidisciplinary management program [8], [9] including a home-based followup strategy can improve outcome of heart failure patients, including a reduction in mortality, hospital readmissions, and lengths of hospital stays, and increase patient satisfaction [10]–[12].

This paper represents an extension of [13] in which the same authors provide an overview of a flexible and high configurable platform for domestic vital signs acquisition and processing, integrated with the Hospital Information System (HIS). This work has been developed within the Health at Home project (H@H) of the Ambient Assisted Living Program (AAL). It takes into account the recent AAL Roadmap guidelines [14], the future challenges in telecare [15], and some recent studies conducted on AAL solutions [16], [17]. The H@H platform aims at connecting in-hospital care of the acute syndrome with out-of-hospital follow-up by patient/ family caregiver, being directly integrated with the usual cardiology departmental HIS. Patients' signs, symptoms, and raised alarms can be received by healthcare providers, and aggravations can be quickly detected and acted upon. Thanks to the collection of vital parameters at home, the sensor data signal processing and the automatic data transmission to the medical center, a more frequent (usually daily) assessment of clinical status than in conventional practice is permitted [18].

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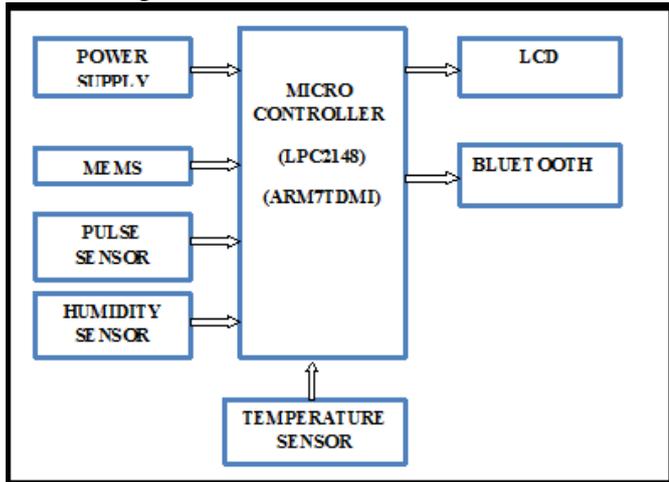
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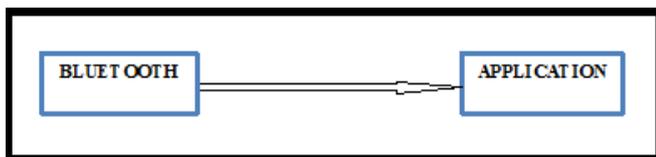
## II. SYSTEM DESIGN MODEL

This paper consists of two sections. They are the sensors sends the information with the help of Bluetooth we receive that information sections. The block diagrams of these sections are given below:



**Fig 1 Transmission Block Diagram.**

In this work, we propose an innovative adaptive recommendation mechanism for monitoring the vital parameters of the patients. The module will help to monitor the patient condition on regular intervals. In this project we use different modules to find out the condition of chronic heart failure patients. The chronic heart failure is a very serious problem in present scenario so due to lack of hospitality we cannot save the person's life to overcome those problems here we find a solution with the help of these modules the physician can monitor the patient continuously. By using pulse sensor we can know the pulse oximetry of the patient it represents the condition of the heart-beat. With the help of the humidity sensor we can know the blood pressure of the patient. The Temperature sensor can monitor the patient temperature. MEMS can help to find out the postures of the patients. In this when the controller can receive all the data from all different sensors, that information can be monitored by physician for that here we add a Bluetooth device. With the help of Bluetooth the physician can monitor the patient condition at any time.



**Fig 2 Receiver section.**

We can overcome the disadvantage of the existing method by monitoring the patient from home which is called Health at Home. Due to lack of resources at medical facilities to support this kind of follow-up, the use of Information and Communication Technologies (ICT) has been identified by physicians and administrator as a possible valid support to overcome this limit. Patients' signs, symptoms, and raised alarms and information by wireless can be received by healthcare providers, and aggravations can be quickly detected and acted upon. By using sensors like

accelerometer, thermistor, humidity and pulse, we monitor the patient's vital parameters. These vital parameters can be seen by using Ethernet or Bluetooth. The android app is used to monitor these parameters on the android device.

**MEMS:** The ADXL345 is a small, thin, ultralow power 3-axis accelerometer with high resolution (13-bit) measurement at up to  $\pm 16$  g. Digital output data is formatted as 16-bit two's complement and is accessible through either a SPI (3- or 4-wire) or I2C digital interface. The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (3.9 mg/LSB) enables measurement of inclination changes less than  $1.0^\circ$ . Several special sensing functions are provided. Activity and inactivity sensing detect the presence or lack of motion by comparing the acceleration on any axis with user-set thresholds. Tap sensing detects single and double taps in any direction. Free-fall sensing detects if the device is falling.

**Temperature sensor:** A sensor (also called detectors) is a device that measures a measurable attribute and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury-in-glass thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. Temperature Sensor which converts temperature value into electrical signals. We used IC called LM 35 as a temperature sensor. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature.

**Pulse sensor:** A sensor is placed on a thin part of the patient's anatomy, usually a fingertip or earlobe, or in the case of a neonate, across a foot, and a light containing both red and infrared wavelengths is passed from one side to the other. Pulse oximetry data is necessary whenever a patient's oxygenation may be unstable, including intensive care, critical care, and emergency department areas of a hospital.

**Bluetooth:** This module enables you to wirelessly transmit & receive serial data. It is a drop-in replacement for wired serial connections allowing transparent two-way data communication. You can simply use it for serial port replacement to establish connection between MCU or embedded project and PC for data transfer. Bluetooth Core V2.0 compliant module with SPP. The module is designed to be embedded in a host system which requires cable replacement function. Typically the module could interface with a host through the UART port.

**Firmware integration:** This is an Operating System (OS) on which all the software applications required for our design are going to be run. This OS is flexible to any user to operate and easy to understand. Accessing the software and using them is very convenient to user. Or-CAD is a proprietary software tool suite used primarily for electronic design automation.

The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics. The  $\mu$ Vision development platform is easy-to-use and it helps you quickly create embedded programs that work. The  $\mu$ Vision IDE (Integrated Development Environment) from Keil combines design management, source code editing, program debugging, and complete simulation in one powerful environment. Code written in 'EMBEDDED C'.

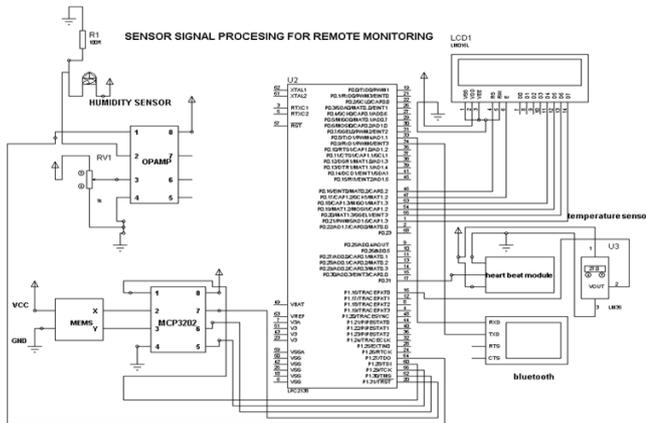


Fig 3: schematic design of the experiment by using ORCAD.

The  $\mu$ Vision3 IDE is a Windows-based software development platform that combines a robust editor, design manager, and makes facility.  $\mu$ Vision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator.

### III. EXPERIMENTAL RESULTS

In this project initially we need to download a Bluetooth application that is S2 terminal from Google play and we need to pair it with the HC-05 module.

**STEP1:** In this step we need to switch on the power supply and the LCD display the title as "H@H using sensing devices" and then we need to reset the system by pressing the reset. Then the process moves to the next step i.e. step 2

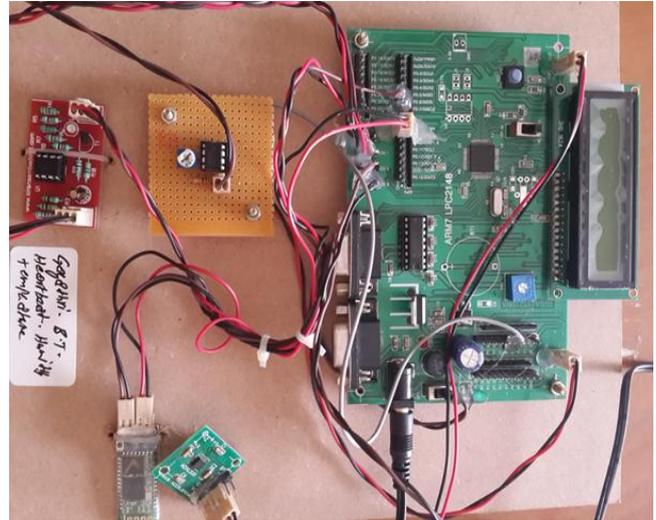
**STEP2:** In this step we need to sense the each parameter by using the modules. First we need to calculate the pulse sensor. In this case we need to put the clip to the finger whenever the pulse was sensed by the sensor it will be indicated by the led and we can see the output in the LCD and the same output is received in the S2 terminal by using Bluetooth module. Then the process moves to the next step i.e. step3.

**STEP3:** In this step after the heart beat module we need to calculate the posture of the person by using the MEMS. Here we can find two posture i.e. one is normal and the second one is tilt depending upon the Mems position and the same information we can see in LCD and S2 terminal continuously and then the process moves to the next step i.e. step4.

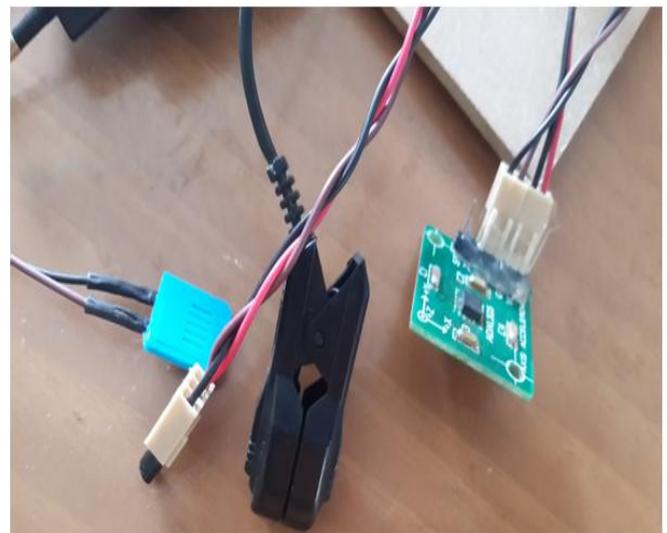
**STEP 4:** In this step we can find the moisture of the person by using humidity sensor. We can know the condition of humidity i.e. whether it is on or off by blow air. That

information we can get in LCD as well as in S2 terminal. Then the process moves to the next step i.e. step 5.

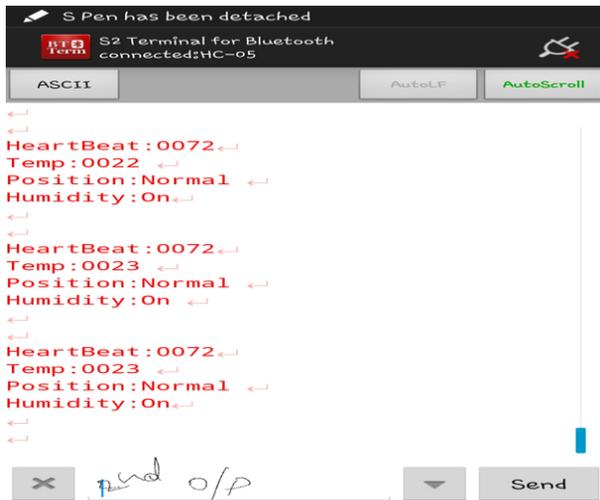
**STEP5:** In this step we need to find the temperature of the person by using temperature sensor. Whenever the temperature sensor senses the temperature, the temperature value changes according to the information and the same information will be received by LCD and S2 terminal. This process repeats continuously.



Here we can see the hardware of Monitoring of health @ home using devices. Here we can see an ARM board with LCD, Bluetooth i.e. HC-05, MEM sensor, Heartbeat Sensor and Temperature sensor.



Here we can observe the different modules i.e. Mems, Temperature, Heartbeat, Humidity Sensors.



## IV. CONCLUSION

This work presents the requirements and the realization in terms of sensing devices and sensor data signal processing of a complete and integrated ICT platform to improve the provisioning of healthcare services for CHF patients. The H@H 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. With the remote monitoring, the medical staff can realize changes in the parameters of patients without frequently visiting them and consequently they can take concerned action to prevent possible aggravations. The benefits extend beyond the early detection of clinical exacerbation to optimizing specialized resources scheduling and to reduce unnecessary travels to hospital. The system definition was completely driven by the end-users resulting in a platform particularly effective and practical with respect to other telemonitoring trials and state-of-art products.

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