# The Development of a Ubiquitous Health House in South Korea

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**ABSTRACT**
This paper describes the development of comprehensive home health monitoring system (uHouse) in South Korea which monitors a patient's biosignals and activity. Several types of sensors and devices installed monitor biosignals, like bedside ECG, snoring, weight changes, and movement patterns. The developed system is unobtrusive, and leaves the patient free to conduct his/her daily life. We constructed the uHouse network using ADSL and Bluetooth, which is capable of transmitting monitored signals to a main server in a hospital through a home server. The uHouse system can monitor the patient's daily activities and state of health in a unconstraining manner.

**Author Keywords**
Ubiquitous health house, unobtrusive measurement.

## INTRODUCTION

During the last century, biosignal measurement technologies were developed on a wired basis. These wired, and therefore by definition, constraining systems have several limitations: 1) Patients are required to visit hospital to be tested; 2) An 'other than home' environment changes a patient's natural rhythm, and potentially could change, for example, blood pressure and heart rhythm; 3) Patients may have to travel long distances and wait to have measurements taken, and the travel itself can alter biorhythms. 4) In emergencies that occur at home, it can take some times for meeting the emergency. 5) The patient is constrained in his/her daily life by the measurement-taking.

The rapid development of telecommunication during the last decades has made it possible to transmit a great deal of data quickly. In addition, wireless communication technologies are now capable of replacing wired systems. Many studies have been undertaken on these wired/wireless biosignal measurement methods. Tamura et al. [1] developed an ECG monitoring method using conductive bed sheets, which has advantages by being unconstraining for the patient, who is not aware of any monitoring. The Health Integrated Smart Home Information System ($HIS^2$) was developed for activity monitoring [2], using numerous sensors, which are installed in the patient's home. This HIS2 system is controlled by the patient.

The objective of the uHouse project in South Korea was to develop a system that can monitor a patient's biosignals continuously without obtrusive additional devices or attachments. With this goal in mind, we developed a wireless system that can monitor a patient's biosignals and transmit biosignal data to a server. The uHouse system contains many devices and sensors linked to a Bluetooth network in the home area, and acquires many kinds of biosignals, ECG and snoring whilst sleeping, ECG and weight changes from the toilet, visual images form CCD cameras etc. The developed system can transfer monitored data in real time to a home PC, via a Bluetooth network. The data acquired by the home PC is then transmitted to a central data server in the Advanced Biometric Research Center (ABRC), at Seoul National University Hospital.

This system is used for patients who have mobility difficulties, such as the elderly, residents who live in rural areas, and those requesting such monitoring.

## INSTALLED SENSORS AND DEVICES

### uHouse Network

Using high-speed subscribe lines in Korea, installed many devices and sensors transmit a great deal of data to the home server via a Bluetooth network.

### Sensors and Devices

*Following represents the installed sensors and devices*

*Bed monitoring for ECG, respiration & weight change*

*Toilet Seat for ECG & Weight changes and Bathtub ECG monitoring*

*Monitoring Camera in the living room*

*Flame Sensor, CO2 sensor*

*Device for measuring blood glucose, blood pressure, body fat*

*Magnetic switch for monitoring door*

*Flame Sensor, Movement Detection Sensor etc.*

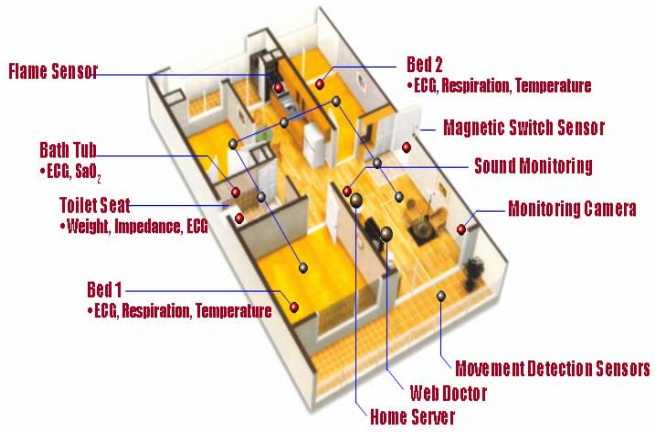


Figure 1. Implemented Sensors and Devices in uHouse.

## DISCUSSIONS

The uHouse project points towards the non-intrusive measurement of daily biosignals by using devices in the home. These technologies have many advantages over conventional biosignal measurements.

### Monitoring both biosignals and activies

In previous bio-monitoring systems, activity monitoring was a major issue. However, in the developed 'uHouse system', biosignals and patient activity can be measured. Therefore, an observer can almost immediately determine the patient's state of health.

### Detection of symptoms before disease onset

In general, patients do not visit hospital until they have recognized symptoms. However, we found that an illness can be detected before it develops recognized. Daily activities and biosignals are stored and analyzed by the ABRC server and if an abnormal condition arises, the ABRC server can inform the patient.

### No interruption to a patient's daily life

The objective of the uHouse project was 'to obtain quality data without interrupting the patient's daily life'. Most biosignals measurement systems require contact between electrodes or test strips and patients. However, the developed system is unconstraining. Biosignals are measured by adapting common devices for signal acquisition- i.e., beds, toilet seats, bathtubs etc. Signals are transferred without the patient being aware of the monitoring. For example, only lying on a bed is required for ECG and snore monitoring and only sitting on a toilet seat is required for weight-change and ECG monitoring.

## CONCLUSION

We implemented and tested 'Ubiquitous Health House.' In this house, a patient's biosignals and activities can be acquired in a non-intrusive manner. Our system incorporates many devices and sensors. There are three stages of measurement, transmission, and anlysis. The uHouse system is basically a continuous real-time system. This system seems to be helpful to both elderly people who lives alone and to rural residents.

We suggested that visits to hospital services and experts for health monitoring purposes can be overcome by this kind of system.

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