Web Based Measuring System for Health Monitoring at Home

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ABSTRACT
The aim of this study is to improve the design of a monitoring system for early dehospitalization of patients suffering from chronic diseases, excluding advanced stage conditions and those in death risk, and also ensuring continuous assistance at home with monitoring, interaction and intervention. We actually reached the goal of completely reproducing hospital visits at the household, moreover the system could be used at a hospital in the same way of standard "vital signs monitor" networks. The developed system integrates wired vital signs sensors, ad-hoc networking, video communication system and web portal technology to allow remote monitoring of patient's vital-sign status and intervention with therapies by activating medical equipment onboard. An important goal of this study is to monitor the effectiveness of the therapy applied on the patient. Furthermore the video – interaction channel will be an important instrument for early diagnosis of cognitive diseases in the elderly.

Author Keywords
Telemedicine, e-Health, vital signs monitor, health network, ageing, user interfaces, touch monitor.

ACM Classification Keywords
H.1.2 User/Machine Systems: Human factors, H.3.5 On-line Information Services: Web-based services, H.5.2 User Interfaces: Prototyping

INTRODUCTION
The H@H (Hospital at Home) Patient Monitoring System combines the proved power of video health assistance with remote patient monitoring. Some systems are already available on the market and have been described in many research projects [1], in this article we will discuss benefits that could be achieved thanks to innovative design solution.

The patient monitoring, coupled with interactive video, enables clinicians to monitor patient's health status, identify instability, provide real time remote clinical intervention in order to stabilize patients by activating the medical system available onboard, applying oxygen-therapy and medical-air and vacuum. The system offers all the advanced monitoring features of "patient vital signs monitor" in real-time with the additional ability to turn on an interactive video session when patient's condition demands it. When the patient's diagnosis, acuity level and condition changes it can create situations where a real-time interactive video visit is needed. The H@H patient monitoring system offers to the healthcare organizations the ability to implement new strategic capabilities. The application connected to a server station in dedicated hospitals or a clinician's office on one side and with a large number of H@H systems, in patient's homes on the other, using ordinary telephone lines or broadband connection.

The following will describe some of the most important aspects that were developed to improve usability of the system, reproduce visits and create *at-home measuring session*, like at a hospital.

SECTIONS
The device is really innovative compared to others already available on the market because it allows a continuous monitoring (24 hours on 24) as well as remote intervention. Doctors and health operators can administer therapies to the patient by activating medical equipments onboard. Before activating therapies it will be very important to ensure a correct control of the status of the patient.

Vital Sings Monitoring
The remote monitoring of a patient based at home involves the vital parameters control which represents the state of health and could be done in the same way in which it takes place in protected Hospitals. To fully implement the objective it is necessary to bring to the patient's home all

Figure 1. WEB based networks for early dehospitalization and patients monitoring.

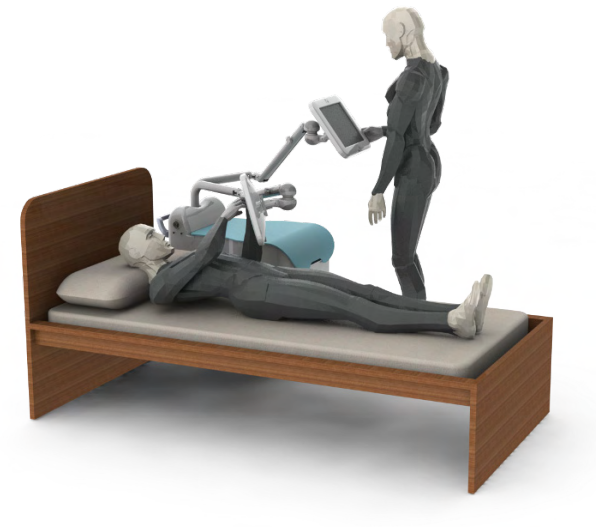

Figure 2. Arm positions for patient and caregivers.

the instruments necessary to measure his physical state, and all the technologies necessary to verify the outcome of the applied therapy, to command medical gases valves or to apply vacuum. All the system should be easy to use, effective in the monitoring of therapy and comfortable even for household installation [2]. For example, following some patients and healthcare suggestions, we decided to implement the vital signal status with wired sensors like at a hospital. This solution avoids recharging problems and would be more useful for in-hospital application besides allowing better sensors diagnosis in case of system's errors.

The entire project aims to examine, in terms of performance, how we can achieve a system for distance monitoring of patients with chronic disease but not in risk of death. With the designed system we would be able to define and create a new protocol of interaction between central hospitals and local hospitals and implement a solution that integrates hardware and software to respond to those needs. Doctors, Surgeons and Nurses in general can perform daily visits with remote access. Few health operators could follow several number of patients distributed on the territory.

Video-Communication for Patient Control

Thanks to the dedicated video-call system the H@H allows monitoring of the effectiveness of the therapy. The idea is to improve the quality of video-communication using High Quality cams, thus permitting a real "remote visit" into patient's homes. A good quality video-signal allows the doctor to see the details, to evidence problems and to better understand the emotional state of the patient. The patient is also advantaged by the better video-signal together with the use of a large monitor (15") making it possible for one to feel more involved in their care protocol as well as to interact with their doctor. Monitoring the patient during therapy is an application which can evidence problems and identify the ability and the independence of the patient in their self-care. The monitor will be connected to the system with articulated arm that allows the patient to feel like in real *on-bed visit*, the same monitor could also be used by caregivers.

In addition to cognitive decline, the video interaction channel can identify, by continuous monitoring and recording the evaluation of patient's status, at an early stage the signals for many elderly cognitive disease like: Dementia, Mild Cognitive Impairment, Alzheimer's Disease which are usually expressed by significant changes in personality and behavior [3] (e.g., apathy, disinhibition/social misconduct, mood changes, lack of empathy, poor judgment).

A future development of the system could include a test to monitor the cognitive disease also an exercise, some entertainment and games to improve memory and to slow the progress of the disease.

Easy-to-Use Graphic Interface

Interactive product design should be based not only on the interface graphic appearance but mostly on its usability. An excellent graphic interface should be essential in functionality as well as properly organized in each graphical element. All functionality should be placed as a result of defined visual perceptual hierarchy [4,5].

Figure 3. Touch screen interface.

Furthermore the touch screen technology involves all the problems related while the visual perception is not supported by tactile perception, simply reminding that "touch screen buttons" have no tactile feed-back. In order to obtain a high level of usability the project of the system is developed following the "Perceptibility Principle" that suggest highlighting, and making easy to perceive, all information that is necessary for product use [6].

To meet this principle we define commands and information's hierarchy through:

- Requirements analysis;
- Task analysis
- Scenarios identification
- Use of Conventions.

We finally designed the graphic interface thanks to a clear commands hierarchy definition, in-depth knowledge of different typology of users who will interact with the system and a clear definition of tasks and scenarios. Particularly the analysis of tasks has determined an important reduction of actions that users will have to play during the interaction, allowing an overall simplification of the structure. We actually believe that using constant users feed-back we can have an important improvement of the interface. The most interesting thing is that the feed-back is not only active (driven from the user), but can be monitored also thanks to health operators' collaboration. In that case the role of the video-signal will be fundamental for any future analysis of user actions.

CONCLUSION

With this new system it will be possible to reduce healthcare expenses and to improve patient quality of life, ensuring continuous assistance at home thanks to the active monitoring, interaction and intervention. The continuous measuring of vital signs correlated with video supervision of the activities and response of patients to the applied therapy can provide all the information that hospital personnel needs to achieve early diagnosis. Following a shared protocol, like the HL7 standard [7], the system provides continuous monitoring, executing the video-talks, by "administering therapies", requiring diagnostic tests and if necessary requiring intervention or hospitalization. All the data will be stored and can be easily exchanged with the Hospital Data System [8]. Furthermore the household workstation will be easy to install and to configure. The remote services offered will be differentiated according to the telematics infrastructure available guaranteeing the minimum system requirements in every situation.

The H@H bedside System is a product development project of Industrial Design and Information Technology departments of CETMA consortium [9]. The analysis of the feasibility and the implementation of the first prototype have been carried out by Item Oxygen S.r.l. [10].

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