

Kansei Design Applied on Hospital Beds: Medical Design for Patient and Caregiver

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Abstract—The paper proposes new design directions, using a Kansei Design approach, of the mechatronic hospital bed made by the Pontifical University Catholic of Peru, and analyzes the Kansei aspects of the overall user experience. Implementing a semi-autonomous, easy to use adjustable bed, not only facilitates the work of medical personnel, but may improve the recovery rate of patients by boosting their emotional state by enabling mobility. It is suggested to correlate the personality of the users with the impressions of this medical bed to find if using a mechatronic system is suitable for all patients.

Keywords—hospital bed; kansei design; rehabilitation; user experience; emotions.

I. INTRODUCTION

The technology developed in the past years has eased the advancement of automation in different areas, meaning that the quality of life of humans could arguably improve. In spite of that, there are concerns that automation will dehumanize certain procedures or could be misused and abused if not used correctly [1]. In response to this, researches and developers are starting to apply Kansei Design approaches to consider human factor, with a focus on human emotions, as the core when designing a product. The use of 'kansei' (a Japanese term that conveys the meaning of affection, emotion, aesthetics, and related terms) as the base for developing a product, aims to improve the synergy between humans and objects [2].

In health-care, automation aims to be beneficial for both patient and caregiver. In this regard, the evolution of adjustable beds, commonly known as hospital beds, plays a key role in any medical institution. From the traditional mechanical and electromechanical beds (controlled by handles or buttons that are cumbersome to operate), to the most advanced automated medical beds (embedded with sensors, actuators and a central processing unit), the goal has been to provide movement and comfort to bedridden patients.

Nevertheless, it is of the uttermost importance to take into account injuries caused by prolonged lack of movement, such as skin pressure ulcers, and reduce the risk of death by sleep disorders, like sleep apnea, while relieving caregivers of work-related stress. In this sense, the University of New Hampshire developed a medical bed [3] that monitors the patients' blood pressure and breath rates in real time to react to possible complications. Moreover, beds that monitor temperature and spatial location of the patient [4] can prevent skin injuries, while systems with pressure sensors [5] help for apnea sleep disorder. Following this trend, hospital beds as those produced by EPOSbed project [6] or Stryker [7] implement mechatronic

systems to ease the workload on the caregiver and yield more freedom to the patient.

In addition, to complete and complement the aforementioned researches and projects, the Pontifical Catholic University of Peru developed a mechatronic SmartBed [8] with these considerations in mind. However, most of these developments mainly focus on the technical features and usability of adjustable beds rather than the user experience and 'kansei' of the patient, the caregiver, and those members related to the bedridden person.

Therefore, based on this [8] previous research, this paper discusses the developed mechatronic hospital bed from a Kansei Design perspective and proposes improvements on its design. The structure of the document is as follows. In Section I, the State of the Art development of hospital beds are introduced. In Section II, the general characteristics of the SmartBed [8] are presented. Section III details the experimental procedure and obtained results, next to the analysis and discussion in Section IV. Finally, in Section V, the conclusions of this research are laid out.

II. MECHATRONIC SMARTBED

The following section briefly describes the characteristics of the mechatronic SmartBed show in Figure 1.

1) *Mechanical Specifications*: This hospital bed can be adjusted to seven standard medical positions, namely: trendelenburg, anti-trendelenburg, fowler, gatch, self-contour, lateral,



Figure 1. Mechatronic SmartBed.

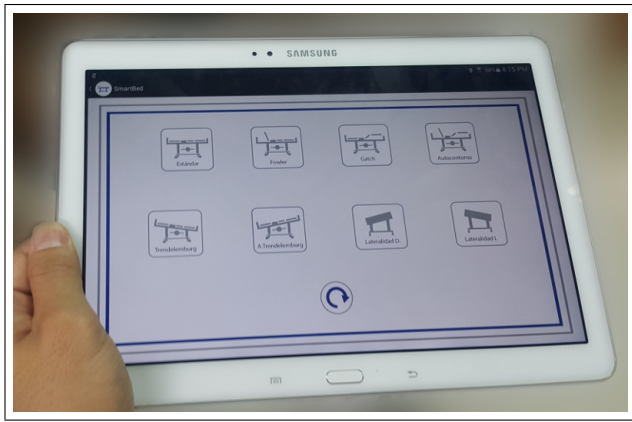


Figure 2. Smartbed User Interface

and flat. To achieve these shapes, four linear actuators act as pillars, while two linear actuators control the angle of the header and footer.

2) *Electronic Specifications:* Several sensors measure the weight, position and shape of the patient, while synchronizing these data to a web-based database. The bed itself communicates wireless to a tablet, where doctors and caregivers are able to manipulate the medical bed at ease.

3) *Interface Design:* All collected data is synchronized and stored on a web server in order to be accessible anywhere with an Internet connection. In this manner, family members, as well as medical personnel, can keep track of the patient’s condition in real time. The interface is presented on a tablet and uses icons to control all motor functions of the hospital bed, as shown in Figure 2, while providing processed data from sensors. The tablet can only control paired beds, so as to avoid misuse or hacking.

III. EXPERIMENT AND RESULTS

A. Experiment

As stated in [8], the carried out user study had two objectives: 1) confirm the functionality of the system, and 2) evaluate the users’ perception of the interface. In this regard, the focus of this paper will be to discuss the later. To accomplish the objectives, 20 participants from 17 to 28 years old tested the adjustable bed, as shown in Figure 3, and filled a survey that encouraged the participants to think of the system as a robot.

The procedure for the experiment went as follows:



Figure 3. SmartBed during the experiment

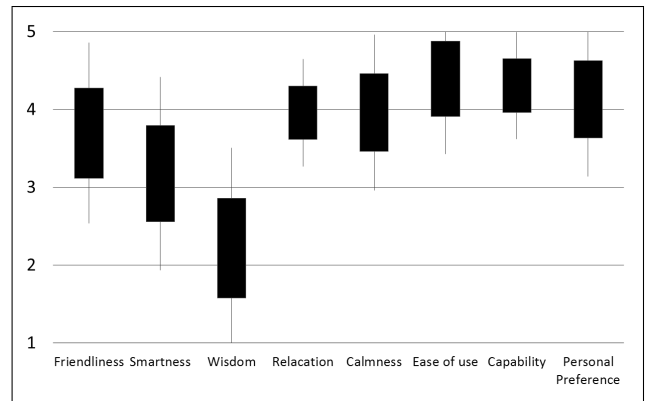


Figure 4. User Experience Survey

- 1) *Training (1 min)* - participants laid down on the bed and were given instruction on how to navigate the user interface.
- 2) *Predefined sequence (2 min)* - participants experienced automatic movement of the SmartBed.
- 3) *Free control (3 min)* - participants freely interacted with the interface.
- 4) *Questionnaire (4 min)* - participants filled out a questionnaire

For the survey, the following items were asked and answered with a scale from 1 (Not at all) to 5 (Of course), using a Godspeed style questionnaire [9]:

- *Friendliness:* how friendly the system feels.
- *Smartness:* how smart the system feels.
- *Wisdom:* how knowledgeable the system seems.
- *Relaxation:* how relaxed the system seems.
- *Calmness:* how calmed the system feels.
- *Ease of use:* ease of use of the interface.
- *Capability:* how capable the system feels for the task.
- *Personal Preference:* whether the subject would like to be catered by a robotic interface.

B. Results

The results of the survey presented in Figure 4 are as follows. Having an adjustable bed controlled by just a tablet seemed to be easy to use for the participants. Moreover, most subjects felt the bed to be calmed and relaxed. On the contrary, while some people thought the SmartBed was somewhat smart, the majority agreed that it did not infer wisdom.

C. Follow Up

A follow up of this experiment took place on an actual hospital environment, where a designated nurse and patient tested the bed for a week. From the care-giver’s perspective, the developed system proved to be functional and convenient, as they could control the hospital bed remotely, without any major effort. On the other hand, the patient reported that the movement of the bed was comfortable and felt secure while using the system.

Notwithstanding, this convenience of controlling the SmartBed remotely might distance the interaction between caregiver and patient, while the emotional state of the bedridden may not be conveyed promptly and correctly.

IV. KANSEI ANALYSIS AND DISCUSSION

In Kansei Design, user experience plays an important role in defining the direction of development for a product. The reaction of the final user is as important as solving the problem with the most optimal procedure, which is the reason why a constant feedback from the users is necessary to create a closed-loop like system that allows for a better design. Additionally, the environment where the product will be used must be taken into consideration, as that determines limitations and restrictions of the design.

Taking the aforementioned factors into account, the results presented on the previous section show that the overall feedback of the participants tends toward perceiving the bed as having seemingly human-like characteristics. Nonetheless, it is worth noting that the survey encouraged the subjects to think of the SmartBed as a robot, instead of an entirely controllable machine. Moreover, the subjects were around their twenties, which means that it is highly probable that they are used to interacting with technology.

In this sense, the general perception that this hospital bed is capable of doing what it is expected to do, but without having any knowledge or good judgment for its actions, namely wisdom, could mean that potential users (both patients and medical personnel), might think of the system as a slave machine rather than a companion throughout rehabilitation. Yet, this perception may give the patient the notion of freedom and independence, as the user will be able to control the system by itself, thus potentially increasing his/her motivation and mood, and improve the rehabilitation process.

Furthermore, as the SmartBed is projected to be used by people not familiar with technology, it is proposed to redesign the user interface. With the bed's ability to do biometric measurements of the patient, it is possible to process these data to present some of the emotional states of the user, as well as programming countermeasures to react to negative emotions. Also, Figure 5 shows a draft of the redesigned user interface: a cover and tablet which displays the face of the patient and caregiver, alongside simple inputs, to lessen the negative effect produced by remote controlling, and to make the bed both easier to use for general people, and a communication's channel.

On the other hand, a redesign of this medical device, considering the approach suggested by Lee, et al. [2] of creating a 3D model in clay before sketching, can be applied to obtain unconventional results to actual hospital beds in order to

circumvent the feeling of entrapment for bedridden patients. After that, the model must be adjusted with hospital safety standards to ensure its usability.

V. CONCLUSION AND FUTURE WORK

Although designing a hospital bed with only technical aspects in consideration may improve user experience, the 'kansei' of the user must be appraised to develop a medical device that feels and is safe.

Likewise, adding convenience to a system might improve usability, but could diminish patient-caregiver relationship. Thence, it is suggested to consider these factors on future designs.

Finally, further evaluations must be made on an actual hospital environment to assess the emotional and psychological response of target users. It is suggested to correlate the personality of the patient with the impressions of this SmartBed to find if using a mechatronic medical bed is suitable for all patients.

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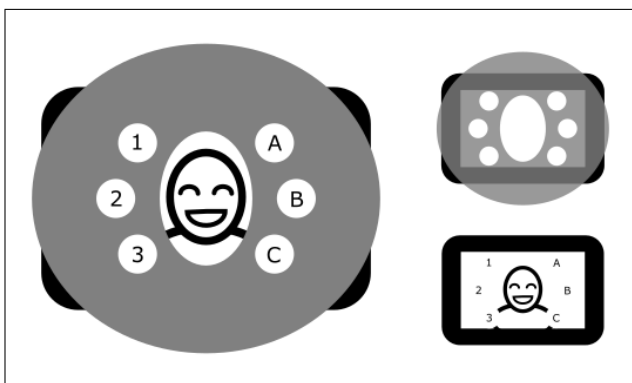


Figure 5. Proposed Interface Draft