Paindroid: A Mobile Tool for Pain Visualization and Management

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Abstract. This paper presents a tool that addresses self-management expression of pain, through an Android application based on multimodal and 3D. Our pilot evaluation highlighted a positive attitude towards the usability of PainDroid's novel functionality, as well as the potential of the application to open up new avenues of patient-clinician interaction with the use of an innovative user experience.

Keywords: Android, Pain Visualization, Tablet, HCI.

1 Introduction

Pain presents a significant challenge to citizens and the healthcare system of countries. Evidence from a pan-European consensus report [1], suggests that one in five Europeans is estimated to have some form of chronic pain. Efficient intervention seems to be limited in most cases, with studies indicating a partial success of current approaches in efficiently assessing the pain experience [2 - 6]. Typical intervention practices include the visualization of pain information by using a paper-based, 2-D representation of the human body. The "pain drawing", as this representation has been named, is considered to be a valuable and useful tool in describing certain aspects of pain, such as the pain location and sensation type [3, 4, 6, 7]. Nevertheless, the consensus of the pain literature seems to indicate that such studies rely on the 2-D representation of the pain drawing. Notwithstanding its advantages, the 2-D pain drawing has its limitations, as it does not capture the 3-D nature of the human body. Thus, patients are unable to visually express the pain that they are experiencing, as statements of the form —I have a pain on the inside of my thigh|| are not easily captured in a 2-D pain drawing, and the accuracy of the reported information can be often questioned. To date, however, the majority of efforts in the development of 3D pain applications have been focused on the management of pain in a clinical setting (i.e. hospitals). There is also only scarce research investigating the employment of the pain drawing for pain assessment on a *mobile* platform. Motivated by this situation we propose PainDroid: a mobile application for improved pain assessment visualization, which has been designed to run on handheld devices (i.e. a smartphone/tablet). Employing the benefits of 3D technology, the PainDroid application can provide the

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user with a 3-D visualization of the human body which aims to enable a user to improve their user experience and ability to report pain through a more realistic and interactive manner at any possible moment and place in time. The aim of this study is to tackle the issue of the small screen interface that normally a mobile device has. It is proposed that a VR component that is included would augment the small screen interface. While it could be argued that the solution to this issue could be to use a mobile device with the largest screen possible or bring the device at a comfortable self-chosen best viewing distance, this cannot always be the case with disabled users, who, in some occasions, due to their e.g. arm mobility problem might not be able to hold or move around a device that is bigger or weighs more. We therefore further investigate how to enhance the modes of interaction with a mobile solution to improve the experience of users that have mobility difficulties. Evidence from the literature seems to support the employment of additional modalities for interaction, for instance gesture input to effectively interaction [10].

2 Application Design

The PainDroid application has been developed on the Android platform. On the screen (Figure 1), the user is presented with five different pain types; *numbness, stabbing, pins & needles* (or tingling)*, burning, and stiffness* (or taut)*,* which were respectively color-coded. These types were chosen carefully after consultation with clinical staff, and are well documented in the pain literature [2, 7, 8, 9].

Fig. 1. PainDroid running on three different devices

In PainDroid user interaction is based both on direct touch and hand movement gesture input, in the anticipation that improving the interfacing modalities can make an important contribution to the interaction and usability of the relatively small-sized interface. As a result, touch gesture input in PainDroid is implemented as follows: first, the user selects an appropriate pain type by tapping on the predefined list presented on the left of the screen, and then the location of the pain is selected, again by tapping on the desired body part of the model. Each color represents a pain type and the model is colored at the selected location (Figure 2). To be able to see more details, pinch-to-zoom in/out, drag to move the model, and flipping of the model are implemented, so as to be able to position the model at an angle and zoom level sufficient for interaction. The data that are saved consist of information about the selected body part (s) and pain type (s), and a timestamp.

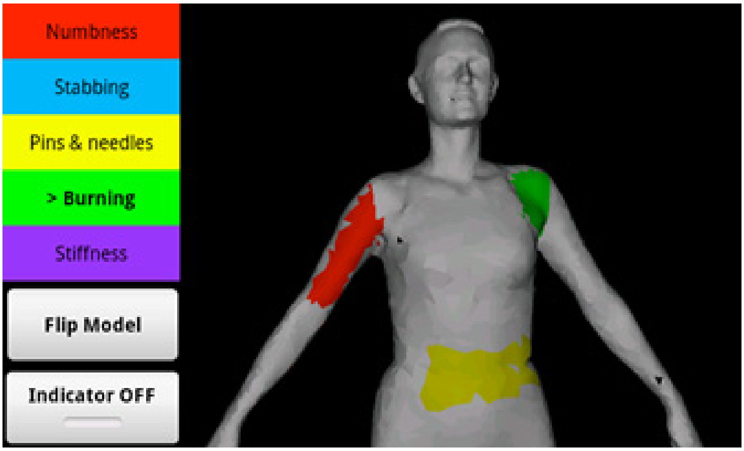

Fig. 2. Interaction with the 3-D PainDroid model using touch gesture input

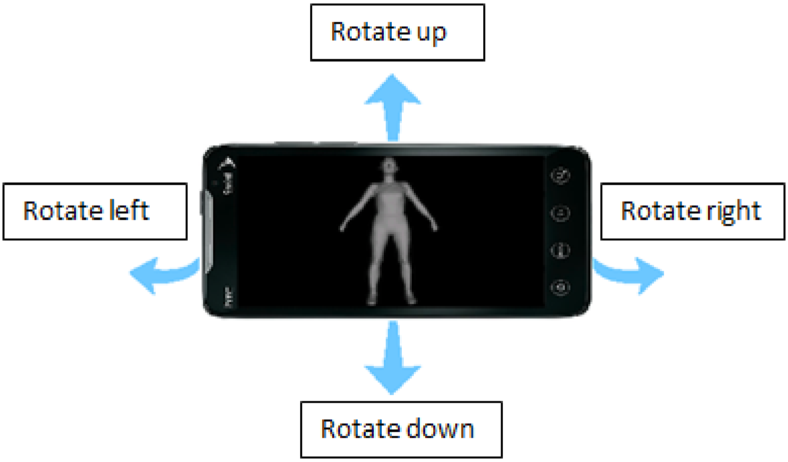

Fig. 3. Hand movement gestures

Specifically, the function between the data sampled by the accelerometer and the induced rotation of the 3-D model was implemented by directly mapping the angular deviation of the device from its initial position to the angular velocity at which the model is rotating. As such, the rotation of the 3-D model could stop by simply bringing the device back to its initial position.

3 Results & Discussion

The evaluation of PainDroid was performed with a group of seven wheelchair users (3 females; 4 males) ranging from 21 to 65 years old (Figure 4).

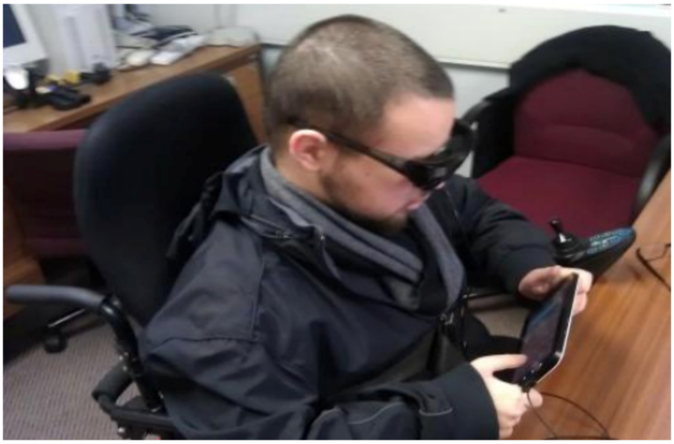

Fig. 4. User evaluation

The protocol centered on the evaluation of the participants' user experience and was examined via a questionnaire. On completion of the tasks, evaluators were asked to complete a 13-item questionnaire (Table 1) about the usability of PainDroid.

The first 13 questions asked users to indicate on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree) their (dis)agreement to a series of statements regarding PainDroid, which were grouped to four different dimensions of user perception. Reliability analysis of the responses received indicated a *Cronbach alpha coefficient of 0.890*, which underlies very good internal consistency. Accordingly, the participants' evaluation highlighted positive bias in respect of the application's usability and functionality. The evaluation demonstrated that participants generally felt confident that it would be easy for them to use PainDroid by themselves. It is therefore reassuring that participants further indicated that they would see themselves using PainDroid whenever available. These attitudes were also reinforced in comments targeting the best user perceived aspects of PainDroid, for instance:

"…the ease of use, the clarity of images and versatility of the program."

"…relatively intuitive and clear cut."

"…easy to use for people who have hard time writing by hand."

Table 1. User Evaluation of PainDroid

Dimension of User Perception	Question	Mean	SD
Ease of Use	Q1. I think that I would like to use this application frequently	3.85	1.46
	Q2. I felt very confident using the application	4.57	0.53
	Q3. I thought the application was easy to use	4	1
	Q4. I think that I would need the support of a technical person to be able to use this application	1.14	0.38
	Q5. I found the application very cumbersome to use	2.57	1.72
	Q6. I felt it difficult to recover after making a mistake	1.85	1.21
Consistency of Application	Q7. I found the various functions in this application were well integrated	4.29	0.49
	Q8. I thought there was too much inconsistency in this application	1.28	0.76
Required Learning	Q9. I would imagine that most people would learn to use this application very quickly	4.14	1.07
	Q10. I needed to learn a lot of things before I could get going with this application	1.14	0.38
Simplicity, clarity and helpfulness of UI	Q11. I found the application unnecessarily complex	2	1.15
	Q12. I liked using the interface of this application	3.85	1.07
	Q13. The information (e.g. menu) provided by the application was clear and helpful	4	1

Similar encouraging responses were finally received with regards to the simplicity, clarity and helpfulness of the PainDroid's user interface. Participants were generally satisfied with the level of simplicity that the application demonstrated, they thought that it was straightforward, and thus, they liked to use the functionality provided in the user interface.

4 Conclusion

There is a scarcity of tools that address self-expressed dimensions of pain. In this paper, we described PainDroid, a prototypical Android-based multimodal and 3D application for pain assessment. Our pilot evaluation highlighted a positive attitude towards the usability of PainDroid's novel functionality, as well as the potential of the application to open up new avenues of patient-clinician interaction through improved user interface design and user experience.

References

1. Baker, M., et al.: Improving the current and future management of chronic pain: A European Consensus Report, http://www.mijnpijn.nl/pdf/PainProposalEuropeanReport.pdf (accessed on: July 27, 2012)
2. Lee, S.J.: Pain measurement: Understanding existing tools and their application in the emergency department. Emerg. Med. 13, 279–287 (2001)
3. Mannion, A.F., Balague, F., Pellise, F., Cedraschi, C.: Pain measurement in patients with low back pain. Nat. Clin. Pract. Rheumatol. 3, 610–618 (2007)
4. Haefeli, M., Elfering, A.: Pain assessment. Eur. Spine. J. 15, 17–24 (2006)
5. Ohnmeiss, D.D.: Repeatability of Pain Drawings in a Low Back Pain Population. Spine 25, 980–988 (2000)
6. Jamison, R.N., Fanciullo, G.J., Baird, J.C.: Usefulness of Pain Drawings in Identifying Real or Imagined Pain: Accuracy of Pain Professionals, Non-professionals, and a Decision Model. J. Pain 5, 476–482 (2004)
7. Masferrer, R., Prendergast, V., Hagell, P.: Colored pain drawings: preliminary observations in neurosurgical practice. Eur. J. Pain. 7, 213–217 (2003)
8. Ohnmeiss, D.D., Vanharanta, H., Ekholm, J.: Relationship of pain drawings to invasive tests assessing intervertebral disc pathology. Europ. Spine. J. 8, 126–131 (1999)
9. Jacob, E., et al.: Usability Testing of a Smartphone for Accessing a Web-based e-Diary for Self-monitoring of Pain and Symptoms in Sickle Cell Disease. J. Pediatr. Hematol. Oncol. 34, 326–335 (2012)
10. Paggio, P., Jongejan, B.: Multimodal Communication in the Virtual Farm of the Staging Project. In: Proc. Int. Workshop Inf. Present Natural Multimod. Dialogue, Verona, pp. 41–45 (2001)