A Research on Persuasive Interaction Using Electrical Muscle Stimulation

- STEER: Strengthening Behavioral Self-Control for Healthcare -

5113E020-1 NING Jing Supervisor Prof. CHOU Ikuro

Abstract: The use of persuasive technologies to motivate behavior change for health care has been an active topic. In this research, we propose STEER, a just-in-time persuasive interaction system for wearable devices, using electrical muscle stimulation to actuate users arms, in order to strengthen behavioral self-control and avoid dangerous situations for health reasons. By collecting body data and ambient information via sensors, STEER allows objects to provide users a kinesthetic sense adapted to user's physical condition, such as preventing the user from grasping them, when users are beyond restraint or acting unconscious unhealthy behavior. Further, we developed and tested a low-fi prototype of STEER, and the results indicate that our design approach may fit the daily life and contribute to the enhancement of unhealthy behavior change.

Keywords: persuasive technology; behavioral self-control; electrical muscle stimulation; body data;

1 Introduction

In health care, self-care is any necessary human regulatory function, which is under individual control, deliberate and self-initiated [1]. Self-care includes exercising to maintain physical fitness and good mental health, as well as eating well, practicing good hygiene and avoiding health hazards such as smoking and drinking to prevent ill health. Self-care is also seen as a partial solution to the global rise in health care costs placed on governments. Meanwhile, self care is learned, purposeful and is continuous [2], which means people being lack of behavioral self-control may need supports to keep their motivation.

The use of persuasive technologies to motivate behavior change for self-care has been an active topic. Technology that can successfully motivate healthy decision-making could delay or even prevent the onset of medical problems such as obesity, thereby alleviating financial pressure on the traditional medical system [3]. With the latest advancements in Internet of Things, wearable computing and ambient intelligence play an important role in this field.

Despite this, a crucial problem of existing devices is the strong dependence on personal computer or mobile application to acquire information they need, which means the users suffering from a low level of cognitive capacity are pushed out. Furthermore, the visual or audio feedbacks are still inadequate, when the user is occupied with other primary tasks, such as listening to music, being engaged in a conversation.

In this research, we aim to motivate users' behavior change via a just-in-time persuasive interaction using Electrical Muscle Stimulation (EMS).

2 Previous Research

EMS is the elicitation of muscle contraction using electric impulses. The impulses are generated by a device and delivered through electrodes on the skin in direct proximity to the muscles to be stimulated. EMS is widely used in low-frequency therapeutic equipment and in devices used for ergo-therapy [4].

Prior research had already showed the advantage and potential of actuating user interface using EMS. Especially Affordance++ [5] allowed object to influence human behavior non-verbally using EMS. In our study, we aim to extend this interaction to the field of persuasive technology.

3 Proposal of STEER

In order to investigate and understand how did users recognize unhealthy behavior or self-control ability, we conducted a simple survey with 34 participant (20 male, 14 female) aged between 21 and 29 (M=24.2, SD=2.6). According to the answers, over 80% of

participants mentioned irregular eating habits and lifestyle. All participants think there might be some unhealthy behavior they haven't been aware of yet.

To solve these problems, we propose STEER, a just-in-time persuasive interaction system for wearable devices using EMS. By collecting body data and ambient information via sensors, STEER allows objects to provide users a kinesthetic sense adapted to user's physical condition and action, such as preventing the user from grasping them using EMS, when users are beyond restraint or acting unconscious unhealthy behavior. This process will help user to re-consider their behavior and make the decision afterwards. Furthermore, a conditioned response created by kinesthetic sense may contribute to the enhancement of unhealthy behavior change.

4 Prototype and Evaluation

For safety reasons, we developed a hardware prototype using an off-the-shelf electrical muscle stimulation unit[1] (TruTENS). The aboard is provided with two controllable output channels, each independent of each other. An electrode pair can be connected to each output channel. Aim to calibrate stimulation pulse, we asked 6 subjects to evaluate if the electrical muscle stimulation system can provide a visible hand motion and make sure it is pain-free. As the result, we set pulse frequency to 50Hz with a pulse-width of 200µs. Pulse amplitude is limited to 90mA.

And we developed a low-fi prototype, which prevent users from reaching and grasping items. In our calibration system, we used RFID to recognize items and user's motion. An Arduino Pro Mini board controls the system. We placed RFID tags on the table near the items, the EMS unit will be triggered and send electric impulses via electrodes, when users are approaching the item. The goal of this task was to investigate the interruption-task complexity and if

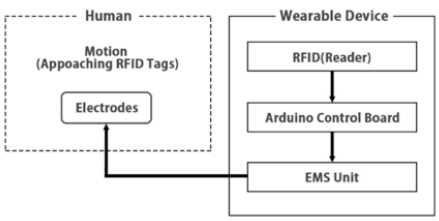

Figure 1: System architecture of prototype

participants can understand the kinesthetic sense created by EMS impulse. There are 7 participants (M=23.9 years old, SD=2.7 years). Each participant was asked to choice 2 from 3 cubes. Whichever they choose, system will prevent they grasping the second one they chose. We also asked participants to complete a questionnaire.

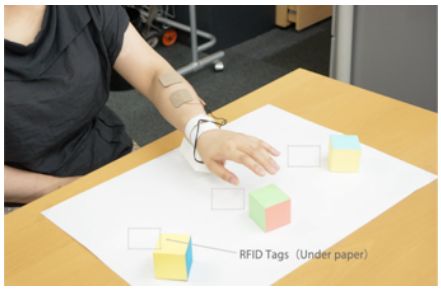

Figure 2: Lab study

5 Conclusions and Future Work

We conclude with results from the lab studies, which suggest the feedback using EMS can be more effective than traditional haptic feedback. And the results of questionnaire showed that our design is feasible and innovative. Further, we believe the unique properties of EMS technique can enable the design for human interface, and improving daily life.

As future work, we hope to optimize our calibration system, to reduce the uncomfortableness and inconvenient caused by EMS. And we expect our prototype could be becoming more lightweight, and equipped with more components, such as body sensors, or audio and visual feedback function. Finally, we expect that we could integrate this interaction with the rest of scenarios, such as child education, game interaction and universal design.

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