Universität des Saarlandes
Deutsches Forschungszentrum
für Künstliche Intelligenz

Immotion - Exergame for Warm Up Guidance and Motivation

Masterarbeit im Fach Informatik
Master's Thesis in Computer Science
von / by

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angefertigt unter der Leitung von / supervised by

begutachtet von / reviewers

Saarbrücken, November 2017

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Ich erkläre hiermit an Eides Statt, dass ich die vorliegende Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel verwendet habe.

Statement in Lieu of an Oath

I hereby confirm that I have written this thesis on my own and that I have not used any other media or materials than the ones referred to in this thesis.

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Ich bin damit einverstanden, dass meine (bestandene) Arbeit in beiden Versionen in die Bibliothek der Informatik aufgenommen und damit veröffentlicht wird.

Declaration of Consent

I agree to make both versions of my thesis (with a passing grade) accessible to the public by having them added to the library of the Computer Science Department.

Saarbrücken, November 2017 Marko Vujić

Abstract

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Chapter 1

Study Design

The main goals of this research were to develop an exergame which can be used for warm up routine before more strenuous physical activity and to evaluate its effectiveness in terms of guiding the user through the process of warming up. In this chapter we outline the research framework, detail the research methods and present the obtained results.

1.1 Description of the Experiment

This section describes the evaluation of the second version of the Immotion exergame. For this purpose, an approach was adopted that uses a mixture of different tools and user study methods. This period of testing of our gamified solution is known as pilot testing. During this period, data has been logged, surveys have been conducted and interviews undertaken. Similarly to the first evaluation, the obtained results are analyzed in order to determine to which level our proposed solution was effective in the context and whether it offered a solution to the problem. Based on the results from the exergame prototype evaluation (Chapter x) and a variety of flow research presented (Chapter x), guidelines were followed which influenced the design and development of the second version of the Immotion exergame.

1.1.1 Introduction and Goals

The primary goal of the second study was to investigate whether our exergame solution can be used as an interactive guide for individuals who do not know how to perform warm up routines. In addition, we examined if the exergame can be used as a solution that motivates individuals to warm up before physically more demanding exercises, and provides an enjoyable game experience.

Taking this into account, the research questions we address in this study are as follows:

1. **RQ1: Evaluation of effectiveness** - How effective our proposed solution is in guiding the user through the warm up routine compared to the guidance offered by classic (traditional) methods?
2. **RQ2: Evaluation of perceived usefulness and ease of use** - How useful and easy to use our proposed solution is?
3. **RQ3: Evaluation of the usability** - How usable our proposed solution is?
4. **RQ4: Evaluation of the game experience** - How enjoyable and entertaining our proposed solution is?

In order to evaluate the effectiveness, perceived user experience, usefulness and usability of our gamified solution in the given context, the user base is divided into two groups: *experimental group* and *control group*. The first, experimental group, is the one that interacts with the exergame directly. Contrarily, the control group is presented with the video of a coach (professional) who guides the participant through the warm up routine. This division allows us to infer the influence of our gamified solution, as well as, to assess the main differences in completing the required activities between the two user groups.

1.1.1.1 Hypotheses

Based on the research questions outlined in the previous section, the following hypotheses are established to be tested:

1. The exergame itself is sufficient for guiding the player through a proper warm up procedure with correct movements.
2. After the warm up routine is completed using the exergame, the player reached a significantly higher increase in ROM.
3. Participants had a more positive perceived warm up experience when using the exergame compared to the participants not using the exergame.

1.1.1.2 Apparatus

The experiment was conducted in the laboratory room in DFKI on (add date). Description of the room - measures to be added. The following equipment has been used:

- Kinect for Xbox One (2.0 2013) motion sensing input devices by Microsoft used for movement detection and controlling the exergame avatar.
- PC running the game engine.
- Projector used to display the game (video) on the wall in front of the participant.
- Microsoft Band used for gathering heart rate data.
- Goniometer used for measuring participants' ROM.

TODO: describe where and how is the equipment positioned.

1.1.2 Methods

In this section we outline the methodology adopted for the Immotion exergame evaluation. For this purpose we utilize the traditional (moderated) usability test since it gives direct input on how real users use the system.

1.1.2.1 Participants

Demographic details of the participants to be added when the study is completed.
Total of n = X individuals participated in the study that has been conducted DATE in DFKI. All participants were students from Saarland University. For recruiting participants, posters were distributed in print, and sent through social media and email (Appendix X). Each participant was given X euros for taking part in the study. All of the participants were amateur athletes who engage in some physical activity on average X times per week. For the study we particularly targeted individuals who exercise in gym or fitness centers and often avoid preforming warm up exercises before more strenuous physical activity. All participants were required to report to the laboratory in gym based clothing, preferably shorts and t-shirt, and all of them performed the required tests in the same location using the same equipment. Before the study, each participant signed a consent form (Appendix X). TODO: This should be updated later with real data.

1.1.2.2 Conditions

First x participant who applied for the experiment have been accepted. These participants were sent a a short questionnaire that needed to be completed before coming to the experiment. Based on the answers given, the participants were assigned to the control or the experiment group (Appendix X). Each assigned participant took part in a single test session one hour in duration. During this session, all the participants completed a preliminary questionnaire (Appendix X),

after which they performed one exercise session. At the end of the session the participants completed a post-test questionnaire (Appendix X). Two conditions were evaluated:

1. Exercising with the game guiding through the warm up procedure, projected on a wall in front of the participant.
2. Exercising with a video of a professional (coach) guiding through the exact same warm up procedure as induced by the game, projected on a wall in from of the participant.
3. TO DISCUSS: perhaps third condition participants who warm up without video or the exergame?

Depending on the group, each participant performed exercise that represent one of the conditions.

1.1.2.3 Control and Experiment Groups

The participants are assigned to each group based on the previously completed self-reported survey (Appendix X). This survey was sent to each participant and needed to be completed before the experiment. Based on the answers provided, each participant was assigned to either control or experiment group. The survey assessed participants' perceived fitness level and warm up preferences. TO DISCUSS: Decide how will the participant be divided into groups? Options: level of fitness, warm up preferences, gender, age?

1.1.2.4 Measures and Metrics

During the experiment, the following measures were collected from each participants:

- ROM measured before the warm up routine and after the warm up routine using goniometer. TODO: what kind of goniometer? To specify.
- Heart rate data measured using Microsoft Band.
- Distance during the warm up routine measured using Microsof Kinect.
- The warm up routine performed by the participant recorded using Canon XXX camera.

1.1.2.5 Tasks

In order to interact with the gamified system, the participants in the experiment group were required to perform a set of general movements. By performing these movements, the participant

controlled the game avatar and, by doing so, avoided obstacles and collected coins. Based on the data collected from the first survey, in order to successfully finish the game, only movements that are, first, detectable with high accuracy using only one Kinect device and, second, simplistic enough to be accomplished easily without no prior exercise knowledge or experience were required. The movements the participant needed to perform included:

- right hand movement up,
- left hand movement up,
- jump right,
- jump left,
- jump up,
- star jump, and
- squat.

Participants who were in the control group and did not interact with the gamified system were required to perform the same set of general movements. However, participants in this group had to follow a video that was projected on the wall in front of them. The video was a recording of a professional (coach) who guided the participants through the warm up routine. By following the video, and thus the coach, the participants were required to execute the same movements as the participant in the experiment group who interacted with the exergame.

1.1.2.6 Design

TO DISCUSS this section. Write the formal experimental design (e.g., a 2 x 3 mixed factorial design, more specifically a 2 levels of expertise (between subjects) x 3 interfaces (within subjects) design).

1.1.2.7 Procedure

Before the experiment, the lab environment is set up. The Kinect sensor is placed in a correct position and turned on. The PC running the software is started and the projector is enabled. In each session only one participant is present and guided by the researcher. The activities each participant followed are:

- The participant completes the preliminary survey.

- The researcher explains the sensors and tools that are required for the experiment, after which the participant puts them on.
- After the researcher confirms that the sensors are placed in a correct position, we start recording heart rate data.
- The researcher measures the participant's ROM before starting the warm up procedure for the following joints: TODO decide which joint will be measured.
- After the measurements are completed, the participant rests.
- The researcher gives a general explanation on the benefits of a proper warm up routine before physically more demanding exercise.
- The participant moves to the spot marked by the researcher.
- The researcher starts recording the session.
- The warm up procedure begins:
  - If this participant is part of the experimental group, the game starts with the start scene where the participant enters his or her name. After 5 seconds, the game proceeds with scenes in which the participant performs specific movements in order to avoid obstacles and collect coins. The duration of the game is not fixed and it is played up to the point when the participant feels warmed up enough.
  - In case the participant is part of the control group, the video that displays a coach who instructs the participants which movements need to be performed. As with with the sessions in the experiment group, the duration of the warm up is not fixed and the video is played up to the point when the participant feels warmed up enough.
- After finishing with the warm up routine, the participant takes a rest. During this period the researcher assesses the ROM of the participant.
- After taking the ROM measures, the sensors are removed.
- The participant completes the post-test survey together with the *RPE* (Rated Perceived Exertion) questionnaire.

1.1.2.8 Independent and Dependent Variables

Include exactly how you intend to measure each dependent variable. Independent variables are the things you manipulate or control for, such as design's you are testing or the ages of the respondents. Dependent variables are the things you measure, such as success rate, number of errors, user satisfaction, completion time, and many more. Have s clear idea what do you

manipulate - independent variables, and what do you want to measure - dependent variables. The most interesting is the intersection - is one design results in a higher task success rate than other.

Independent and dependent variables can be measured by 4 types of data: nominal, ordinal, interval, and ratio. Nominal (categorical) data: groups or categories. Mac vs Windows users, male vs female. These are independent variables, that allows you to segment data by these different groups. Nominal data also includes dependent variables like task success, number of users who clicked link A instead B... Ordinal: ordered data - imdb. In user studies this comes from self-reported data. User states if someone is good better worse... These are relative rankings. You report it by frequencies: for example 40 percent said it is good.

1.1.3 Problems/Limitations - Threats to Validity

Describe any problems/limitations encountered that will help other researchers avoid or account for them if they decide to replicate your experiment.

1.2 Results

This section is an objective report on what the numbers show. You should not try to interpret the meaning of the numbers in this section. Some of the things you may do here are: report means and standard deviations in neat tables indicate the statistics used and levels of significance include graphs, plots, histograms, etc that tell a story about the actual figures obtained Only critical raw data and summary statistics should be included in the actual report. However, you must keep all your raw data in a separate archival report, should anyone (a reviewer in the case of real scientific reporting) need more detail than is provided in the paper.

1.3 Discussion

Interpret the results. Although you should still try to be as objective as possible, the discussion section should illuminate your critical thinking about the results. Explain what the statistics mean, account for anomalies, and so on.

1.3.1 Interpretation of Results

Discuss what you believe the results really mean. For example, if you find a significant difference for some effect, what does that mean to the hypothesis? Is the different seen an important one?

1.3.2 Relation to other works

How do the results youve obtained relate to other research findings?

1.3.3 Impact for practitioners

As computer scientists, we are particularly concerned with the implications of our findings on practitioners. Should existing interface constructs be designed differently or used in a new context? Do you have suggestions for new designs? How can the findings be generalized?

1.3.4 Critical reflection

Critical reflection is one of the key foundations of science. You should criticize your work (constructively, if possible), indicate possible flaws, mitigating circumstances, the limits to generalization, conditions under which you would expect your findings to be reversed, and so on.

1.3.5 Research agenda

The best experiments suggest new avenues of exploration. In this section, you should reflect and refine your hypotheses, describe new hypotheses, and suggest future research, ie research that you would do if you continued along this path.

1.4 Conclusions

Summarize the report, and speculate on what is to come. Acknowledgements. This section should give thanks to the major people (supervisors, associates) and organizations (sponsoring agencies, funders) that helped you. For example, I would like to thank Ben Shneiderman, whose report framework was used to build this one.

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