Play4Physio: Supporting Physical Therapy of Children with Hemophilia

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ABSTRACT

Play4Physio is an Android mobile application that allows a player to control games with body movements, recognized through the mobile device camera. It has been specifically designed with the aim of increasing the adherence to the rehabilitation plan by children with hemophilia. Differently from existing exergames, which need to be specifically designed and developed, Play4Physio is compatible with most games that are already available on Google Play Store, effectively transforming them into exergames.

CCS CONCEPTS

• **Applied computing** → *Health informatics*; • **Human-centered computing** → *Mobile devices.*

KEYWORDS

Rehabilitation; Physical therapy; Interaction substitution.

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1 INTRODUCTION

For people with haemophilia, hemarthrosis (*i.e.*, bleeding into joints) is a common condition and one of the major causes of mobility impairment and disability [6]. Physical exercise can prevent articular damage but people with haemophilia are less physically active in comparison to their peers and maintaining adherence to training regimen was shown to be difficult, in particular for children [5]. As a means of promoting at-home exercises, prior works propose telerehabilitation through exergames [3, 4]. However, designing effective exergames for children with haemophilia is challenging because the exercises need to be suitable for different patients' conditions, and the games need to be age-appropriate, engaging and sufficiently numerous, so that, when a patient gets bored with a game, a different one can be used.

To address these challenges, we designed *Play4Physio*, a system that enables the patient to control existing games by substituting touchscreen interactions with body movements recognized with the device camera. Hence, unlike our previous solution, which required the patient to wear inertial sensors [1, 2], this approach does not require any additional hardware. The physical therapist configures *Play4Physio* for each patient, specifying the body movements and how they can be used to control the games. For example to control a game with four controls (e.g. up, down, left and right swipes) the physical therapist defines four movements (e.g. squat and raise left/right/both arms). Afterwards, the patients can continue to exercise while playing at home. While doing so, the physical therapist can remotely monitor the patient's physical activity, being notified in case the patient is not adhering to the training regimen.

2 SYSTEM DESIGN AND IMPLEMENTATION

Play4Physio is being developed with an iterative design approach. At the end on the first iteration, the system was composed of two Android components: a configuration application and an accessibility service for interacting with games through body gestures. After

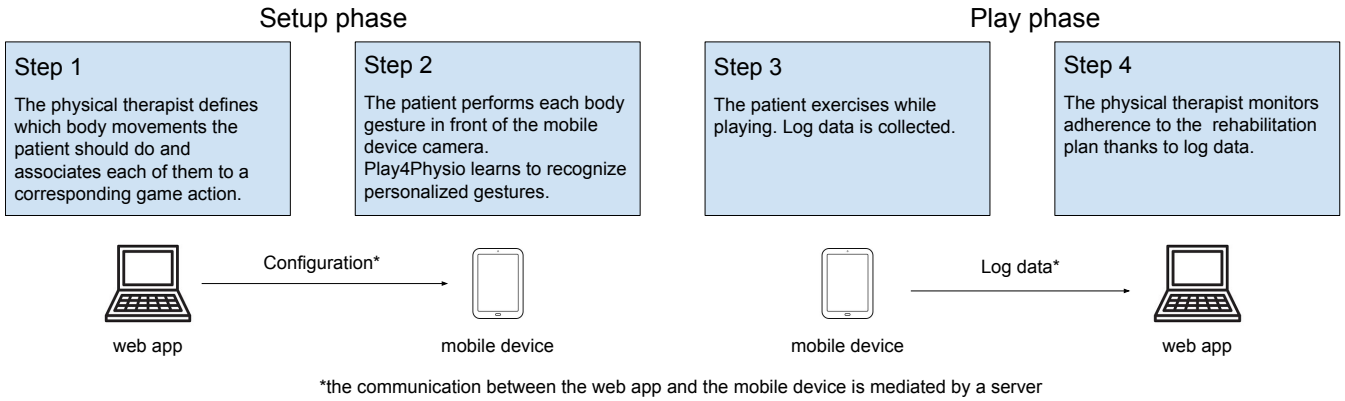

Figure 1: *Play4Physio* overview

the first round of tests, conducted with both physical therapists and patients, three main requirements emerged: a) to improve the visual feedback to support the patient, b) to ease the configuration phase, and c) to allow the physical therapists to remotely monitor adherence to the rehabilitation plan.

To address the first requirement, we designed an additional visual component that shows the patients body, as recognized by the system. This component is used to instruct the patients on how to position with respect to the camera, and to self-monitor during the exercises. To address the second requirement, we designed a web application that allows the physical therapists to configure the system for each patient starting from pre-defined templates (see Figure 1). To address the third requirement, while the patient practices with *Play4Physio*, a remote server collects usage logs that are processed to show a report to the physical therapists and to raise warnings when the patient is not adhering to the training regimen (see Figure 1).

Technically, the core component that makes it possible to play third party games with body gestures is an accessibility service that is an Android component that can run code in background and can generate simulated gesture events on the screen[1]. We implemented our own accessibility service that acquires the camera feed and uses the *BlazePose*[2] library to detect the body pose in the frames. Then, a k-nearest neighbors model, previously trained by our configuration app, is used to detect the movement and to trigger the corresponding gesture event, as specified in the configuration app.

Play4Physio is compatible with games that require screen interactions at fixed positions but not with those having moving targets. Body gestures are also longer to perform than screen gestures (e.g., raising an arm takes longer than tapping on the screen). Hence, games that do not require strict time constraints should be selected. Considering a sample of 418 free games published on Google Play Store we identified 131 that are suitable for playing with *Play4Physio*.

3 CONCLUSIONS & FUTURE WORK

A video demo of *Play4Physio* is available online[3], introducing the system and showing how it can be used to play. Currently, *Play4Physio* is designed for children with hemophilia, but the solution can be adapted to a number of different contexts, including training for children or adults, rehabilitation for other medical conditions (e.g., post surgical rehabilitation and cerebral conditions as palsy or ictus), soft training for the elderly. Using different inputs, *Play4Physio* can be adapted to different domains, including speech therapy (controlling games with mouth sounds) and accessibility to people with motion disabilities (e.g., by detecting head movements with the camera).

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