Slackliner — An Interactive Assistant for Slackline Training

Felix Kosmalla
DFKI, Saarland Informatics Campus
Saarbrücken, Germany
felix.kosmalla@dfki.de

Frederik Wiehr
DFKI, Saarland Informatics Campus
Saarbrücken, Germany
frederik.wiehr@dfki.de

Christian Murlowski
Saarland Informatics Campus
Saarbrücken, Germany
christianmurlowski@gmail.com

Antonio Krüger
DFKI, Saarland Informatics Campus
Saarbrücken, Germany
krueger@dfki.de

Florian Daiber
DFKI, Saarland Informatics Campus
Saarbrücken, Germany
florian.daiber@dfki.de

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Abstract
In this paper we present an interactive slackline assistant which features a life-size projection, skeleton tracking and real-time feedback. As in other sports, proper training leads to a faster buildup of skill and lessens the risk for injuries. We chose a set of exercises from slackline literature and implemented an interactive trainer which guides through the several exercises and gives feedback if the exercise was executed correctly. A post analysis gives the user feedback about her perfomance.

Author Keywords
Slackline, sports, tracking, real-time feedback.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction
Slacklining is a form of tightrope walking but as opposed to a tightrope a slackline is mounted with much less tension. This allows the material to stretch and bounce, resembling a very narrow trampoline which enables experienced athletes to jump and even do flips. For the hobbyist the usual way to exercise this sport is to go to a park, setup the slackline between two trees, and try to walk from one side to the other. This requires a substantial amount of balance, core

body strength [2], and focus. However, as in many other sports, proper training leads to a faster buildup of skill and lessens the risk for injuries. For beginners, it is difficult to walk or even stand on a slackline. The uncontrollable swift of the narrow line result in unfamiliar movements that cannot be handled at the very beginning. Therefore, beginners should learn to concentrate, build up motor basics, and trust into the line, as well as manage their body behavior. For this there are several exercises which focus on the individual aspects of successful slacklining [9, 14, 12]. In the best case these exercises are explained and supervised by an expert or trainer. However, such a trainer is not available for everyone.

To overcome this issue we present an interactive slackline assistant which can track the user's movements and give feedback whether the exercise was performed correctly.

Related Work

Interpretation of Movements

The use of technology in sports has given athletes and trainers new possibilities in training. Simple measures such as video recording and manual analysis is now good form for every professional athlete be it in running, swimming, or even rock-climbing. However, these practices which where reserved to professional athletes are, to some extend, are now possible for the hobbyist by using off-the-shelf hardware like smartphones and consumer 3D cameras like the Kinect. [13].

Other research projects have used the Kinect for rehabilitation [3, 5, 1] and balance training purposes [11]. Furthermore Estapa et al. [3] and Freitas et al. [4] collected data of execution from patients for medical reviews. Both developed a motor rehabilitation game. It is used to support therapeutic exercises and evaluate biomechanics of the patients. This allows subsequent analysis of the performance data for the therapist. This approach of data analysis was also integrated by Garrido Navarro et al. [5] but in addition they elaborated whether the Kinect can serve as a rehabilitation home assistant. Many patients are thrown out of their daily life environment for accessing traditional rehabilitation training in a medical center. Here the patients incorporate the system into their daily life and avoid those trips. The medical personal receives all relevant parameters via the transmission of the recordings from the exercises to the medical center.

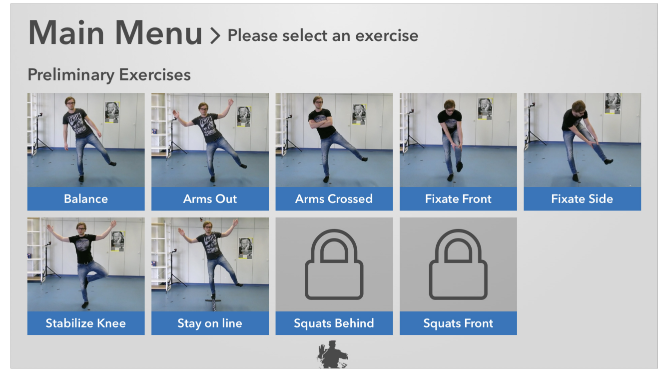

Figure 1: The user can select the exercise via hand gestures

Providing Feedback

Several technological advances like video feedback, virtual environments and auditive information can be applied for providing feedback in sport activities. Liebermann et al. [10] evaluated those feedback methods regarding their field of application. Hämäläinen [6] developed applications for a camera output in front of an athlete. An automated motion controlled approach starts and stops the recording if the motion exceeds a certain threshold. Holsti et al. [7] investi-

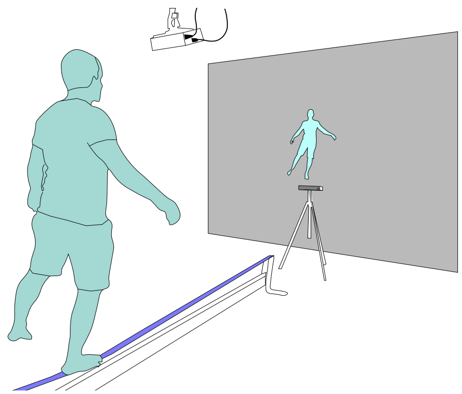

Figure 2: Setup of the prototype. The slackline is placed in front of a projected display. A Kinect facing the user tracks her movements.

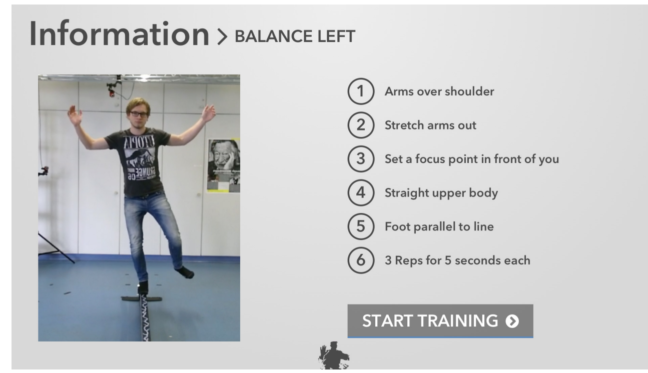

Figure 3: A selected exercise features a miniature preview of the movements, a description, and tips how to perform the exercise

gated delayed video feedback and a platform jumping game in trampoline sport. The former records the performance execution and shows it repetitive to the user. Kajastila and Hämäläinen [8] project graphics on an artificial climbing wall. A feasibility study showed that graphic information is best located near holds where the focus of the climber goes naturally. This can be adapted to slacklining since the athlete has to focus usually a specific point in front of her. It would be useful to provide information in the peripheral view.

Prototype

Setup

The current prototype consists of a self-supporting slackline, a Kinect v2, a projector, screen, and a desktop computer. While the slackline is standing in front of the screen, the Kinect is mounted on a tripod in front of the screen, facing the user (see Figure.

Usage

To start the training, the user steps in front of the screen and uses hand gestures to browse through the available exercises (see Figure 1). While the user is free to pick any exercise she wants, the order of exercises is designed in a way so that the user starts with easy movements which are based on the ground and later on transfer these movements to the slackline. Each exercise features a miniature preview of the movements, a description, and tips how to perform the exercise (see Figure 3). Usually an exercise consists of a number of repetitions of a certain movement. Upon selection of an exercise, the Kinect tracks the user's body, decides if the movement was executed correctly and counts the repetition. The user sees a mirrored image of herself which is captured by the camera and gives instant feedback about the duration of the current repetition, the repetition count, and whether the movement is performed correctly (see Figure 4).

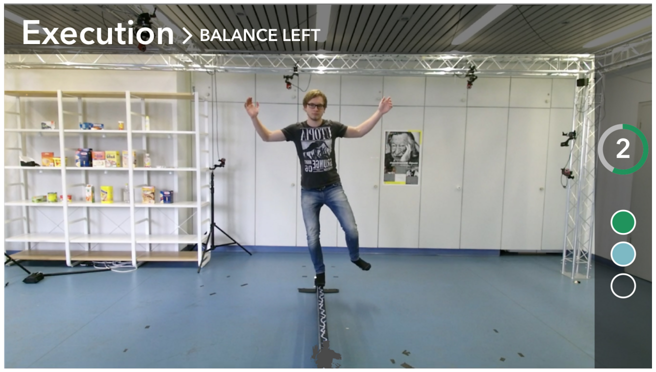

Figure 4: During the exercise the user receives instant feedback about his exercise and repetition count.

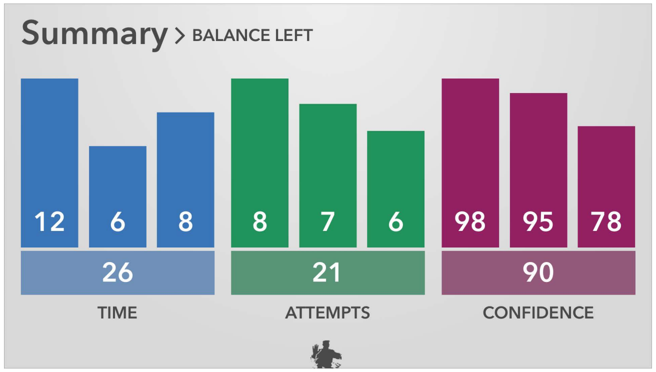

Figure 5: A selected exercise features a miniature preview of the movements, a description, and tips how to perform the exercise

After an exercise the user is shown a summary of her performance, including performing time, number of attempts and the precision of the execution (see Figure 4).

Implementation
The current prototype was implemented using Unity 3D. Currently the tracking of the movement is based on gestures recorded with the gesture builder for Kinect [1]. New exercises can be added to the system via JSON files which contain the name of the exercise, a description, tips, a video, and the gesture database obtained from the gesture builder. For this, an experienced athlete performs the exercise (e.g. standing on the slackline while raising one leg) which is recorded via the Kinect. The resulting movement is then converted to a gesture which can be later recognized in the training session.

[1]http://kinect.github.io/tutorial/lab12/index.html

Training Plan
Based on literature on slackline training, we developed a set of exercises which are suited for beginners to teach them how to slackline. The pool and order of exercises are based on literature for slackline training [9, 14, 12].

Future Work
A user study should investigate the differences in skill acquisition between training alone, training with an expert and training with our system. Ideally this would be a long term study. This bares the challenge of comparability since we can expect different motor skill levels between the participants.

Furthermore, it would be interesting to see if the integration of gamification in the system could lead to an increased use of the system and thus, a faster learning curve.

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