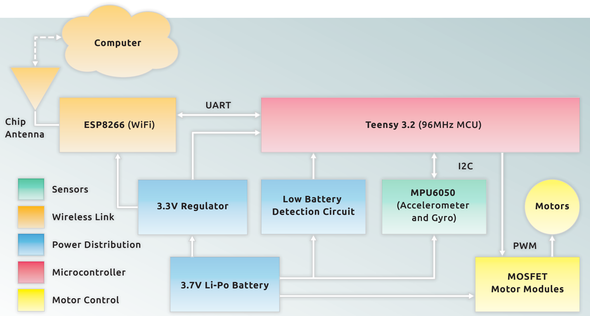
WAG

Wearable Action Guidance System

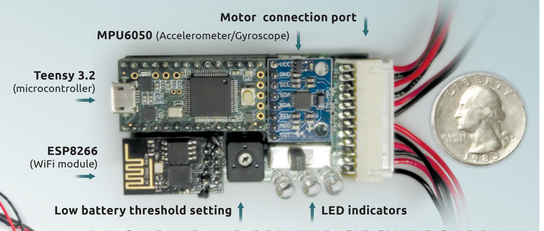
abstract

THE WEARABLE ACTION GUIDANCE (WAG) SYSTEM is a training tool designed to improve the efficiency and convenience of teaching and learning new physical skills, while matching or exceeding the quality of feedback received from an in-person trainer. The system consists of a computer application and a set of wearable bands; each band comprises a 3D printed case, an inertial measurement unit, a battery, a ring of vibration motors, and a secure strap. Trainers can use the WAG System to record and save motions for distribution to trainees, while trainees can use the system to play back those motions with directed vibratory feedback. Initial prototypes have attracted potential partners interested in introducing the technology to various markets including athletic training and physical rehabilitation.

wearables



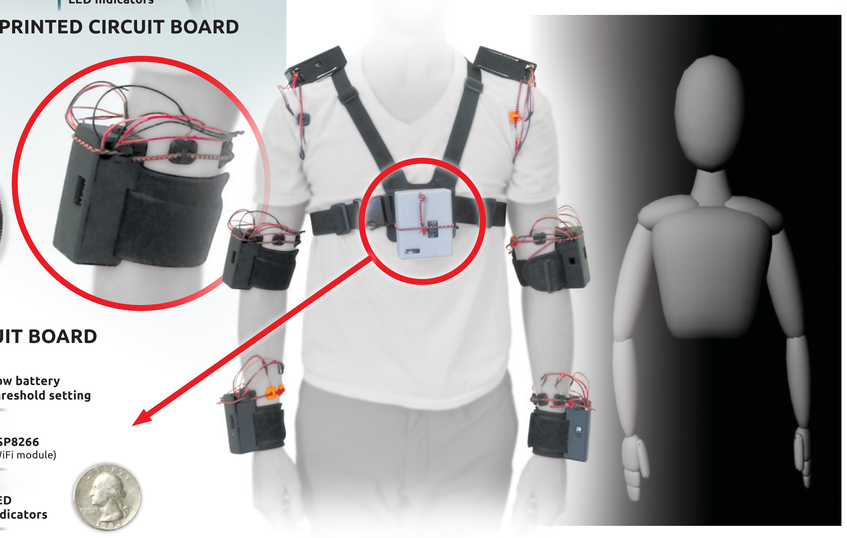
The WAG System includes a set of WAG Bands, which consists of seven wearable bands: one chest band, two shoulder bands, two upper-arm bands, and two forearm bands. Each band is securely affixed to a designated limb and tracks that limb's motion. The complete set of WAG Bands weighs just under 3.25 lbs.



WAG ARM BAND PRINTED CIRCUIT BOARD

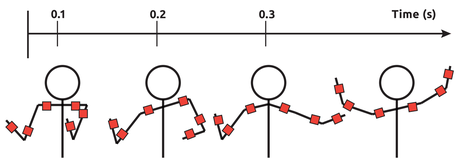
WAG system supports:

- Connecting and calibrating bands
- Enabling and disabling WAG Bands
- Displaying band disconnect notifications
- Monitoring band battery status
- Managing WiFi communications
- Saving 10 minutes of continuous movement in one motion file
- Cropping recorded motions
- Loading motion files for playback
- Maintaining and accessing a motion library
- Playing back motions in continuous or step-through modes
- Specifying motion playback speeds
- Visualizing user motion
- Indicating error via haptic feedback with under 0.1 seconds of latency
- Measuring 9 degrees of freedom per arm
- Playing back motion for up to 2 hours on battery power
- Recording motion for up to 6 hours on battery power
- Recharging internal batteries
- Adjusting the size of each band



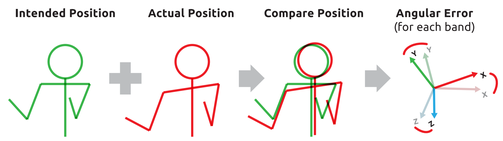
record

To record a user's motion, the application collects snapshots of position information from each of the 7 bands, at a regular time interval, over the recording period.



play

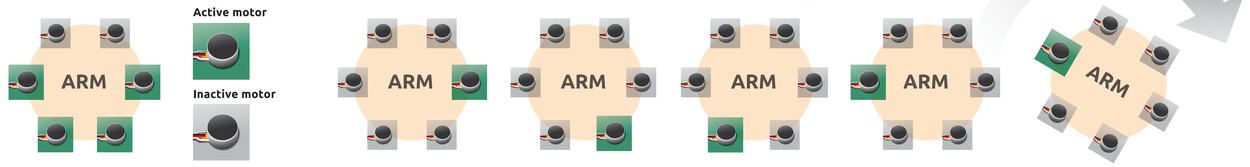
To play back a motion, the application compares the saved (intended) position snapshot to the live (actual) position snapshot taken from the WAG Bands worn by the user. Comparing these two positions results in an error for each band that is translated into directed haptic feedback to guide the user to correct their motion.



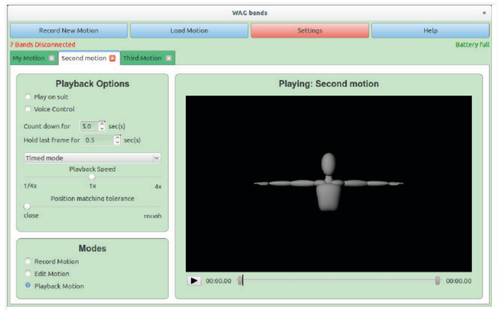
TRANSLATE

learn

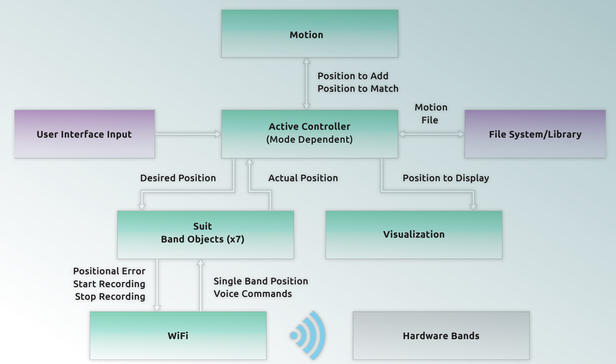
Each WAG Band generates a feedback signal consisting of a rotational component and a translational component. The band uses simultaneous vibrations for translational error and sequential vibrations for rotational error to apply the feedback signal to the six motors so the users can correct themselves in real time.



software



The WAG System also includes a software application with a graphical user interface, written in C++, which runs on the user's computer. The application is responsible for collecting and manipulating each band's orientation data and is the primary interface between the user and the WAG Bands.



user studies

The evaluation plan for the WAG System is in two parts:

(1) user studies for the software flow, and
(2) user studies on the complete system.

These studies, in progress as of April 14, 2016, will evaluate:

(1) The intuitiveness of navigating the software application while:
- Recording a new motion
- Editing a motion
- Opening a motion for playback

(2) The usefulness of vibration feedback for motion training

future improvements

This project offers numerous expansion opportunities, including:

- Adding hardware bands for the legs to include lower body motion training
- Visually overlaying real-time position onto recorded motion
- Enabling motion file synchronization across multiple WAG Systems
- Streaming motion data from a trainer to a trainee for real-time feedback
- Integrating respiration, blood-oxygen, and heart rate sensors
- Tracking user motion statistics to suggest improvements
- Analyzing the effectiveness of the WAG System as a training tool

WPI

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notes

A provisional patent was filed through WPI on March 11, 2016.
At this time, this project is competing as a finalist in the 2016 Intel Cornell Cup Competition.

acknowledgements

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