I-Ball: A Programmable Sporting Aid for Children with a Visual Impairment to Play Soccer

Surya P. N. Singh*, Paul E. I. Pounds, and Hanna Kurniawati

The Robotics Design Laboratory
School of Information Technology and Electrical Engineering
The University of Queensland, Australia 4072
http://robotics.itee.uq.edu.au

1 Extended Abstract

Team sports, such as soccer, are not only fun, but conducive to the development of interpersonal skills [1]. From a social perspective, it is important that the players with blindness or low vision have a normative experience and be able to play alongside their fully-sighted peers as team members [2]. Today, children with visual impairment participate by using special balls with conspicuous noise makers that engender alienation, and provide sparse feedback to the player.

This study presents a programmable sporting ball with an integrated inertial sensor module that provides motion information to players via a piezo beeper. It varies tones in response to motion and then focuses on how changes in the tone (pitch, frequency, volume) and action (the extent that various motions couple to output sounds) affect the interaction of both the players and their team members.

1.1 Design of a Programmable Sporting Ball

An interactive ball (which we term the I-Ball) has been developed to assist the people with a visual impairment play sports. It comprises a hollow foam soccer ball and uses a microcontroller to vary the tones emitted by a miniature buzzer based on a motion sensor (see Fig. 1.1). Since it is programmable, it provides a richer and more diverse form of interaction by allowing the tones to be changed easily. For comparison, balls with buzzers produce a fixed tone regardless of the balls motion and thus can lead to confusion or frustration [3]. Balls with an embedded bell or those covered in a plastic bag [4], but can not be heard when stationary and effect the motion and game-play of the ball. Based on initial user-testing, it seems a reason for this is that they are less frustrating to sighted team-mates and thus allow for a richer form of interaction.

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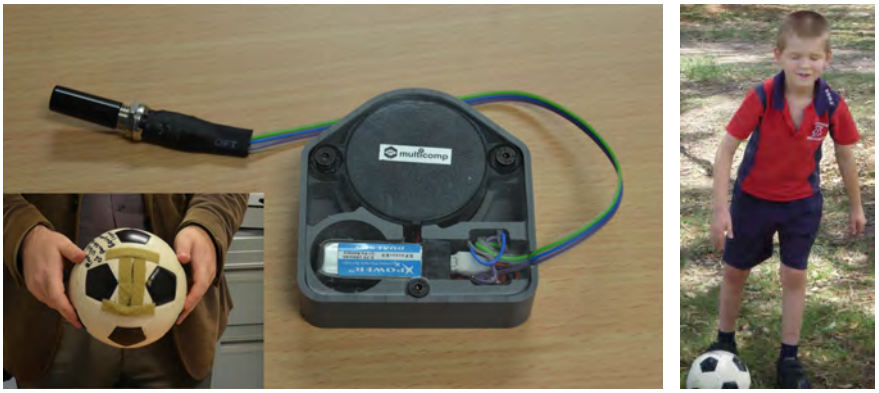

(a) I-Ball Adaptive Tonal Interface (b) I-Ball User

Fig. 1. (a) The I-ball features a smart embedded circuit, a rechargeable battery, and a gyro to provide an adaptive tonal assistance (in inset: ball with circuit installed). (b) A child with total vision impairment playing soccer using the I-ball

Based on this, the I-Ball produces a quiet background tone that is increased in pitch and volume depending on the roll rate of the ball as measured using the MEMS gyro. The design of the ball is based on the needed to present location information about the ball when stationary (hence the base tone) and to information about the motion of the ball (hence a second variation pitch varying tone tied to roll rate). The microcontroller mixes the tones in a smooth manner so as to minimize conflicting harmonics and minimize dissonance.

1.2 Modes of User Interaction

Sport is not only important for physical exercise, but also social development and peer interaction. As noted, the programmable interface affords many degrees of freedom to the designer from playing music files to varying operation by time of day.

For simplicity, the study uses simple tones and focuses on the relative interaction via user studies of various tonal couplings to roll rate against a baseline control of a fixed tone (i.e., the standard beeper ball). Operation is assessed via user feedback surveys and via camera footage that is subsequently analysed to determine game durations and the level of teammate interaction.

1.3 Field Testing

This has been prototyped within a foam ball and is undergoing field testing. Initial feedback on the ball suggests that the extra interaction flexibility afforded by the programmable interface allows for a richer interaction and longer periods of play by both the visually-impaired and fully-sighted.

Some highlights of the feedback received via user surveys (as categorized by function) include:

- Sound emission effectiveness and directional feedback:
  - The sound emission allows participants to hear where the ball is coming from almost all of the time
  - Intermittent beeping transitioning into beeps which are closer together when the rate of the ball increases does help
- Judgement of Ball Speed:
  - When the ball is moving back and forward within a small space 3-4 metres, the ability for the alternation in sound is hard to pick up and hence cannot be used that well within this range to judge speed/rotations.
  - Once participants are further apart (5m or more) the ability for participants to pick up changes in rate of motion are more readily made
- Ball location when it is possessed by another player:
  - The ability to judge the location of the ball of course becomes more difficult the further the participant is away from it
  - Open spaces compared with closed indoor spaces naturally decrease hearing levels due to a number of factors such as lack of sound reverberation and the inclusion of more back ground noise.

With regards to (sighted) teammates, it is found that after the players get familiar with the ball and over its novelty that they find it less distracting than a standard beeper ball. Playtimes are significantly increased.

Future work is considering this interaction as it relates to environmental conditions (e.g., temperature and wind) and on hardware usability improvements based on the current analysis.

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