Developing a Programmable “Interactive Ball” for Junior Blind Sports

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http://robotics.itee.uq.edu.au

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The Interactive-Ball
Our Goal: Accessible Robotics
Current Aids Are Not Smart
The Devil is in the Details

```c
DAC_SPIBUF = (unsigned short)(((unsigned short)(AudioBuffer1[FifoCt] + 32767) >> 4) & 0x0FFF) & 0x0FF;

if (buffFlag)
{
    LATGCLR = 0x200;
    DAC_SPIBUF = (unsigned short)(((unsigned short)(AudioBuffer1[FifoCt] + 32767) >> 4) & 0x0FFF);
    foo1 = ((AudioBuffer1[FifoCt] + 32767) >> 4) & 0x0FFF;
    DAC_SPIBUF = foo1;
    while(DAC_SPISTATbits.SPIBUSY);
    while(!DAC_SPISTATbits.SRMT);
    LATGSET = 0x200;
}
else if (!buffFlag)
{
    LATGCLR = 0x200;
    foo2 = ((unsigned short)(((unsigned short)(AudioBuffer2[FifoCt] + 32767) >> 4) & 0x0FFF));
    DAC_SPIBUF = (unsigned short)(((unsigned short)(AudioBuffer2[FifoCt] + 32767) >> 4) & 0x0FFF) & 0x0FF;
    DAC_SPIBUF = foo2;
    while(DAC_SPISTATbits.SPIBUSY);
    while(!DAC_SPISTATbits.SRMT);
    LATGSET = 0x200;
}
FifoCt++;
if (FifoCt == 255)
{
    buffFlag = !buffFlag;
    FifoCt = 0;
}
else if (FifoCt == 127)
{
    ReadEN = true;
}
IFS0bits.T1IF = 0;
```

UQ Robotics
Roll Motion
Team Ball Passing Game

![Graph showing roll rate (revs/sec) over time (sec)]

- X-axis: Time (sec)
- Y-axis: Roll rate (revs/sec)
Unexpected Challenges
Thank you
Future Research Directions

Belt unit with radio receivers, motion processor, and directional vibrotactile feedback

Earphone spatial audio feedback

I-Ball with inertial sensors, ultrasonic and wireless transmitter module

wireless signals
Psychoacoustics for the Visually Impaired

Maximize "perceived" loudness 
(by minimizing SPL/phon)

Sound pressure level in dB

Frequency in Hz

Hearing threshold

100 phon
## Future Research Directions

<table>
<thead>
<tr>
<th>Year</th>
<th>Development</th>
<th>Sensors</th>
<th>Motion feedback</th>
<th>Feedback mode</th>
<th>Social benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>I-Ball 1.0 concept</td>
<td>Inertial</td>
<td>Bearing, speed</td>
<td>Audible buzzer</td>
<td>Improved interaction</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quadraphonic audio output</td>
<td></td>
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<tr>
<td>2013</td>
<td>I-Ball 2.0</td>
<td>Inertial</td>
<td>Bearing, speed</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Wireless bone-conduction</td>
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<tr>
<td>2014</td>
<td>I-Ball 3.0</td>
<td>Inertial</td>
<td>Bearing, speed</td>
<td></td>
<td>Inconspicuous, greater peer acceptance</td>
</tr>
<tr>
<td></td>
<td>I-Ball with spatial sensor fusion</td>
<td>Inertial-ultrasonic</td>
<td>Range, bearing, velocity</td>
<td>Audio-tactile, bone conduction</td>
<td>Improved situational awareness</td>
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<tr>
<td></td>
<td>I-Ball with planning algorithm</td>
<td>Visual tracking</td>
<td>Range, bearing, velocity</td>
<td></td>
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<tr>
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<td>Audio-tactile, bone conduction</td>
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