The goal of this project was to develop juggling balls with an embedded system capable of determining the current juggling pattern and changing color accordingly. Each ball contains a small microcontroller, a three-axis accelerometer, and an RF transceiver.

A variety of pattern detection algorithms were implemented with varying results. PCBs were designed to increase reliability and to ensure the hardware could fit inside the plastic sphere.

Siteswap
Siteswap is used “to keep track of the order that balls are thrown and caught” (Knutson, 1993). Space-time diagrams (Figure B) are useful for visualization. A throw is labelled “N” if N-1 throws occur before that same ball is thrown again. It can be helpful to think of the number as representing the height of the throw (Figure A).

Pattern Recognition
- **Throw/Catch Event**
- Generate all possible event sequences for each pattern
- **Throw/Catch Event**
- Eliminate mismatched sequences
- Only sequences from one pattern remain?
  - Yes: **Pattern Detected!**
  - No: Increment all throw counters
- **Which ball was thrown?**
- Ball #1 = N-1
- Add to Sequence, Reset Ball #1 Counter
- Sequence Exists?
  - Yes: **Pattern Detected!**
  - No

Results
We achieved fast pattern detection for 3 siteswaps (3, 51, 531). The balls change color once a pattern is recognized and confirmed. Faulty events delay the pattern recognition, however, this occurs less often now that the balls are more securely fabricated.

Future Work
Increase portability by moving the pattern detection onto the microcontroller. This system could support up to six balls which would greatly increase the number of available patterns for detection. Of course, juggling six of these is no easy task.

Finally, the addition of RGB LEDs would enable more color options to match the increase in available patterns.

References

Prototyping
Figure 1. First prototype, inside plastic softball. Powered by 9V battery.
Figure 2. Three balls of first prototype.
Figure 3. Printed Circuit Board.
Figure 4. Final Prototype, LiPo powered.