

Building cheap sensors for the new pulsed RCJ soccer ball

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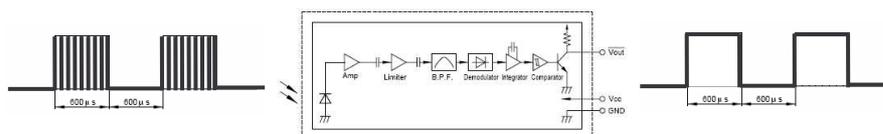
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RoboCup
1-5th of July, 2009
Graz, Austria

Motivation

- **Previous RCJ soccer balls emitted non-modulated IR light**
 - ❖ Highly sensitive to ambient light and other interference
 - ❖ Took RCJ soccer away from the spot-lights!
 - Hiding the soccer fields away from light
 - Thus, away from spectators!
- **Modulated IR light solves the problem**
 - ❖ Used for nearly 30 years in remote controls of consumer electronics!
 - Sending pulses at a given frequency allows receivers to discriminate from other sources



4th of July, 2009

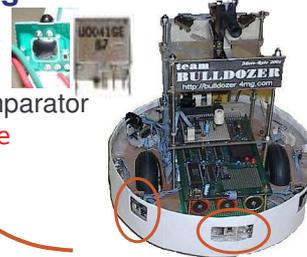
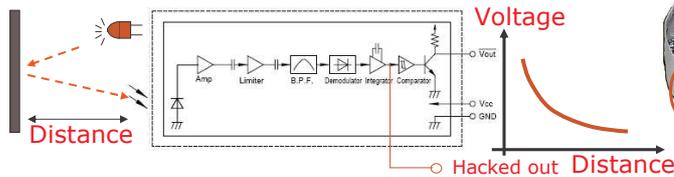
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Motivation

- In the 90s, it was typical to hack modulated IR-receivers to build obstacle sensors

- ❖ Measured intensity of reflected IR light
- ❖ Very cheap, gross measure of distance
- ❖ Analog output extracted before final comparator



- Nowadays the same hack is not possible → current receivers use molded plastic cases!

- ❖ We can use the receiver **digital** output, only, without information on distance...
- ❖ Or we try to find a work around...

The new ball requirements

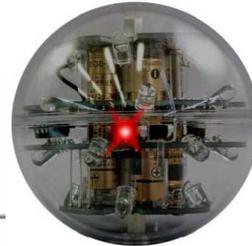
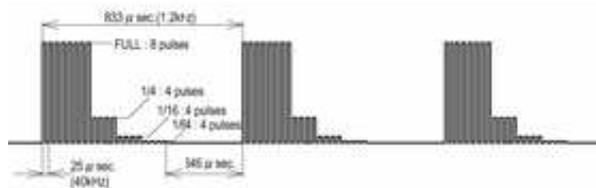
- In late 2008 a group of companies and RCJ representatives triggered a new ball spec

- ❖ Finally **use modulated IR-light** to achieve
 - Strong detection capabilities
 - High resilience to interfering light
 - Strong reduction in energy consumption
 - Higher physical durability
- ❖ Maintain **compatibility with cheap IR receivers**
 - Preferably providing some info on distance

The new ball (RCJ05)

- The solution devised by EK Japan

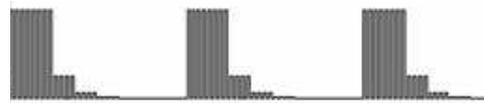
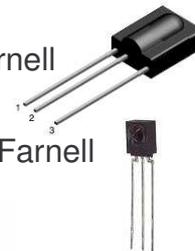
- ❖ Meets all requirements, including compatibility with cheap sensors providing gross info on distance 😊
- ❖ Stepped sequence of pulses



Cheap sensors

- Receivers that work as expected

- ❖ TSOP1138 (Vishay) – 1,52Eur from Farnell
- ❖ GP1UX511QS (Sharp) – 1,09Eur from Farnell



- ❖ Closer → larger output pulses



- ❖ Farther → shorter output pulses

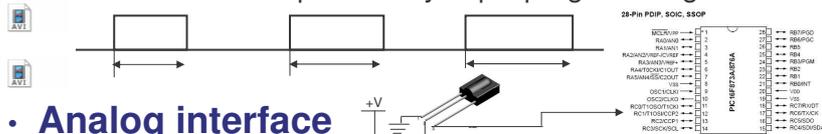


Note: The actual output of these devices is negated

Cheap sensors – basic detection

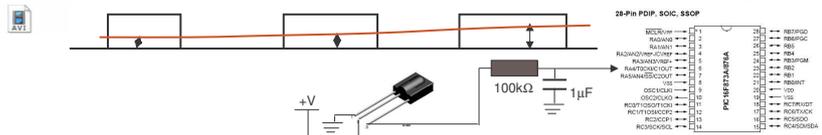
• Digital interface

- ❖ Measure the pulse width with a timer/counter input
- Needs more proficiency in μC programming



• Analog interface

- ❖ Convert the varying pulse width to an average continuous signal using a trivial low pass filter (RC)
- Enters the ADC and is processed as any analog signal



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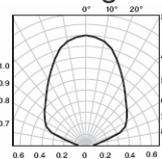
Cheap sensors – adding direction

• Collimate the sensors

- ❖ Use a tube or similar to reduce angle of detection

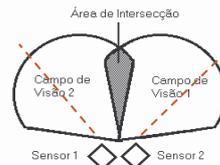
• Rotate single sensor

- ❖ Sensor fixed on robot and rotate robot
- ❖ Sensor mounted on rotating head



• Combine several sensors

- ❖ e.g., 2 sensors with an angle and subtract their outputs! (analog interface)



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Conclusion

- **The new ball meets all requirements** 😊
 - ❖ High insensitivity to interference
 - ❖ High detection capability
 - ❖ Strong gain in battery duration
- **Particularly, it allows building cheap but robust sensors** 😊 😊
 - ❖ Can be combined and interfaced to a μC in many ways
 - ❖ Provides gross information on distance

Enjoy! 😊 😊 😊