Robocup 2016

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What is RobocupJunior NZ?

- A robotics competition for children (primary/intermediate/high school)
- http://www.robocupjunior.org.nz/
- Regional events (Auckland, Canterbury, Otago, Southland, Waikato, Whanganui, Wellington)
- ... feeding into a national event (location varies)
 - This year it's Auckland
- Open-platform but Lego remains popular
- Off-the-shelf through totally DIY
- Drag-and-drop through text-based coding
- Stable competition & rules year-to-year
- School resourcing can get expensive

(Note: there is no "RobocupSenior NZ")

Competition and Competitors

- Encourage teamwork, problem-solving, planning, perseverance
- Many technical and creative challenges
- Teams usually up to 4 (prize limit)
- Teams and teamwork typically school-based
- Comp Sci and Info Sci also run after-school programmes
- Also teacher outreach programmes
- Stable, open event beneficial for teachers

Section 1

Robocup Otago

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Robocup Otago (Dunedin)

- Running for 11 years now
- You've missed this year's, sorry (Sat., June 25)
- Around 100–120 entries (peak 170)
- Started by TeacherDirect (LegoEducation franchisee, later MTA)
- Sometimes combines with Southland
- Committee includes industry, primary & tertiary education reps
- Robocup Nationals 2016: Auckland, Sep 10

My involvement

- Serve on the committee
- Look after the Theatre music
- $\bullet~A/V$ wrangling on the day
- After-school mechatronics programme

A/V spectator system

- 2-4 hired large-screen TVs for spectators
- Raspberry Pi SFF computer per event site, plus one for venue projector
 - Logitech C920 HD USB camera each
 - Local HDMI output
 - Streaming video (VLC)
 - Display local/remote video stream, slideshow
- Dedicated Ethernet network
 - Maybe later: PoE
- Control laptop (DHCP, SSH, etc.)
- All running Linux

Robocup Event Categories

- Robot Soccer
- Search & Rescue
- Robot Theatre

Soccer

- Two a-side (attack + goal)
- Colour-coded field
- Ball with infra-red beaconing



Search and Rescue

- Modular obstacle course
- Find, lift, and place the target
- Line-following, ramps, colour detection
- Multiple levels: Junior, Senior, Premier





Theatre

- Demo, dance, music, theatre, ...
- Interview
- 1–2 minute performance
- 6 mins total (incl. set-up time)
- Junior and Senior categories
- Children often act/dance/etc. too









Judging

- Varies across event categories
- Use of sensors, actuators, logic
- Communication between robots encouraged
- Remote human control prohibited (beyond starting)
- Style, creativity, etc.

	Robocup Otago Our Theatre Entry Endgame		
Future event categories			

- Racing
- Sumo
- Battles?
- . . .

Lighting challenges

- Many robots rely on optical sensors
- Problem: controlling the lighting conditions
- Solution: lighting canopy
- Provides shade and controlled lighting
- Also mounting for the TVs, cameras
- Even then, robust light sensing can be tricky



Section 2

Our Theatre Entry

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Robocup 2016

Mechatronics at Information Science

- After-school programme
- Started ca. 2012 by Holger Regenbrecht as Arduino Club
- Aimed at more senior students, more DIY, electronics, hacking
- I teamed up in 2013; we built a Dalek $(\frac{1}{4} \text{ scale})$
- Meet Mondays and Tuesdays from 4:00-6:00

Robot Orchestra concept

- Small group of robo-musicians
- Acoustic instruments, electronic control
- Use standard MIDI wiring and protocol
- Centralised co-ordination, daisy-chaining
- Use cheap, DIY hardware
- Custom circuit boards





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Robot Orchestra: Pedagogy

- Different types of actuator: motors (DC, brushless, servo, stepper), solenoids and solenoid valves
- Serial data communication (MIDI, 31.25 kbit/s)
- Opto-isolated current loop (reliability, noise-immunity)
- Bits, bytes, binary, hex (MIDI data, channel DIP sw.)
- PWM (pulse-width modulation) signals for lighting, servos
- Control systems theory (wind supply regulation)
- Functional abstraction
- Arduino programming (simple C++)
- Code re-use through libraries
- Real-time issues: serialism, blocking, latency

MIDIBot hardware

- Arduino shield (piggyback circuit board)
- 3 servo outputs (5 V supply, control signal (PWM), ground)
- 4 MOSFET-switched 12 V outputs (one with PWM for light fading, motor speed)
- Activity LEDs, protection diodes for each MOSFET output
- Power LEDs for 5 V and 12 V supply lines
- MIDI channel DIP switches (16 channels: 4 switches)
- Reset button, programmable status LED
- Potentiometer input
- Several spare GPIOs (stepper motor, etc.)

MIDIBot hardware (cont'd)

- KiCAD for schematic capture and PCB layout
- Through-hole construction for kid-friendly soldering
- Socketed ICs
- Polarised connectors
- Simple fuses (in case of short circuits)
- Self-test button (for bot-specific test routine)
- Molex power input (older 4-pin hard drive connector)
 - Convenient power input from old ATX PC PSU
 - High current, regulated
 - +5 V (servos, lighting)
 - +12 V (lighting, solenoids, motors, etc.)

MIDI In/Thru circuit (KiCAD schematic)





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DrumBot

- Cheap Kmart toy drum set
- Bass drum servo
- Side drum servo
- Cymbal servo
- Lamp
- PNG Timer library (async. motion)
- Tweakable timings



PercussionBot

- Modelled after DrumBot
- African drum servo
- Triangle servo
- Egg shaker servo
- Lamp



UkeBot

- Strum servo with plectrum arm
- Slide actuator (in progress)
- Lamp
- Calibration, note mapping TBA
- Backlash (mechanical hysteresis) a problem



SynthBot

- Monophonic square wave
- Uses AVR's PWM signal generation
- External speaker drive circuit



LightingBot

- Blue, white LED chains
- Lamp
- RGB lighting bar (5 V)
- Servo outputs for RGB fading
- External RGB drive circuit
- One MIDI note per light
- Velocity: RGB fading



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MusicBots video			

https://www.facebook.com/samuel.mann/videos/10206990444462956/





Things to do (before Nationals!)

- Finish refactoring common code into a library
- Test and tweak latency correction
- More permanent power connectors
- Woodwind instruments: slide whistle, pan pipes, recorder, ...
- Woodwind air reservoir and control system
- Laser-cut acrylic logo (illuminated by old scanner light-bar)



Section 3

Endgame





Robocup Junior NZ

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Thanks

- Sandy Garner for all her amazing work and enthusiasm
- Robocup Committee, event judges and helpers
- Elim Church Centre, esp. Jason Campbell for technical assistance
- Strawberry Sound
- LandSAR for the catering
- All the sponsors
- Paul and Ian at Makerspace (circuit design help, suggesting DirtyPCBs)
- Holger Regenbrecht, and the CMRLab for tolerating our mess and noise!
- Sam Mann for event photographs, video
- Phillipa at Hatch (laser-cutting)
- Arduino, KiCAD, DirtyPCBs, PNG framework (Timer library)

Links/Resources

- http://www.robocupjunior.org.nz/
- http://learningwithrobots.weebly.com/think-tank.html
- http://dspace.org.nz/
- http://www.moonbaseotago.com/
- https://www.arduino.cc/
- http://png-arduino-framework.readthedocs.io/
- https://www.midi.org/specifications
- http://www.rosegardenmusic.com/
- http://puredata.info/
- Pat Metheney's Orchestrion project
- Compressorhead robot band

Demo, Q & A, Discussion

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