RoboRugby 2010

Robotics Design Project

EEEN 10020

Lecture 6 – Robots, Sensors, Navigation

UCD School of Electrical, Electronic and Mechanical Engineering

Scoil na hInnealtóireacta Leictrí, Leictreonaí agus Meicniúla UCD

Project Plan

- Plan - what do you have to do?
  - design a good robot
  - build the robot
  - write programs for the robot
  - test as you go along
  - re-design if needed, etc., etc.
- When will you do it?
  - ~17 lab hours before competition
  - set targets for each week, and keep to them…
- Who will do it?
  - team members may choose to specialise
  - everyone must be familiar with everything

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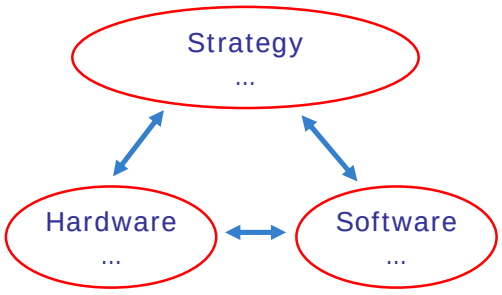
Design Process



Don't underestimate the software task!

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Robot Design

- What do you want your robot to do?
  - from strategy and rules
- What is the best way to make it do it?
  - big, strong, heavy, slow…
  - small, light, fast, but weak…
  - many other compromises
- Bracing
  - for strength - rugged
- Gearing
  - for speed or force?
- Friction
  - some good, some bad

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Robot Design - ball handling

- "Collector" robots
  - need scoop or arms?
  - need holding area
  - keep balls in when reversing
  - get balls out in scoring area
  - protect scored balls?
- "Kicking" robots
  - arm, paddles, wheels?
  - width and location?
  - drive with motor or servo?
  - avoid kick towards own goal
- Many other possibilities…
  - you design to suit your strategy!

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Navigation 1

- How to find your way around the table?
- Dead Reckoning
  - timed movements – unreliable
  - OK for first few seconds – not recommended later
- Walls – define boundaries
  - detect collisions – switches
  - detect proximity – distance sensors
  - both can be fooled by other robot!
  - walls allow simple improvement on dead reckoning
    - drive until hit, not for fixed time (but time limit)

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Navigation 2

- Lines - for guidance
  - 10 of 15 balls are on lines at start of match
  - follow line (or wall) when moving north-south
    - avoids collision with pedestal…
  - what will happen at junctions?
- Walls – for guidance
  - drive along wall - in contact ?
  - drive parallel to wall - distance sensor ?
  - orient robot using wall
    - e.g. align perpendicular to wall after collision

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Navigation 3

- Beacons – must use for start
  - guide towards target or home
  - orient robot in any position?
  - decide whether or not to operate kicker…
- Scoring areas - how to know you have arrived?
  - grey table surface – detect optically
    - idenitifies conversion zone only
  - bumps – detect mechanically or optically?
  - wall - collision or distance measure?

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Sensors

- Switches
  - 5 provided – 2 long lever, 3 short, hinged both ways
  - detect collisions, bumps

- Distance sensors
  - 2 provided – no more available
  - detect balls, walls, robot?

- Reflective optical sensors
  - 2 provided – can build more if needed
  - sense table colour, or any close object
- Other optical sensors?
  - detect position of Lego parts
  - detect ball in robot collection area

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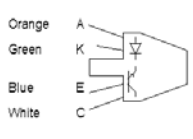
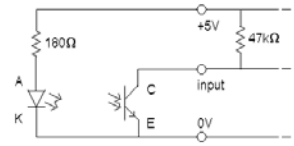
Optical Components - reflective sensors

- Infra-red LED and photo-transistor
  - angled for short-range sensing
    - two versions: with wires or pins
  - need resistor in series with LED
  - need resistor in series with transistor
    - 47 kΩ built in to Handyboard works well
  - more light on transistor ⇒ more current ⇒ lower voltage at Handyboard input





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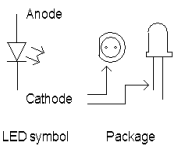
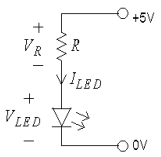
Optical Components - LEDs

- Infra-red or visible light
  - use with resistor to set current
  - more current => more light
  - typical current 10 mA, max 30 mA
  - connecting backwards will destroy!





$$V_R = 5V - V_{LED}$$

$$I_{LED} = \frac{V_R}{R}$$

- visible: typical V_{LED} = 2 V
- infra-red: typical V_{LED} = 1.3 V

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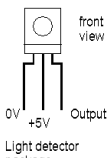
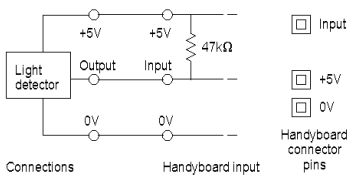
Optical Components - light detectors

- Convert light intensity to voltage
  - dark - few mV
  - bright - up to 3.5 V
  - connect to analogue input port on Handyboard





- 47 kΩ resistor built in to Handyboard
- not needed here, but not harmful

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Optical Sensors

- Visible light ?
  - easy to see
  - horizontal transmission allowed
  - detector can use room lighting
  - may need shield to avoid room lighting
- Infra-red light ?
  - cannot see
  - need infra-red light source
  - transmit light downwards only
  - little interference from room lighting
  - possible interference from beacons, distance sensors
- Choice depends on application

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Applications

- Line detection, line following, etc.
  - reflective sensor - short range, sharp change
  - LED + light detector - longer range, gradual change
- Ball detector (is ball present?)
  - rely on reflection or blocked transmission?
  - horizontal operation must use visible light unless contained within robot
- Detect part of robot?
  - e.g. has arm moved far enough?
- Other ?

This Week

- Read "The Art of Lego Design"
  - bracing, gears, etc.
  - if plan to use optical components, read web pages: optical parts, circuit building, soldering
- In the lab session
  - try out a few more ideas ?
  - continue building competition robot
  - start writing program for demonstration next week
- Tutorial on building circuits - optional
  - 5 minutes in lecture theatre
  - then move to lab to practice soldering
  - if plan to use optical components, need this

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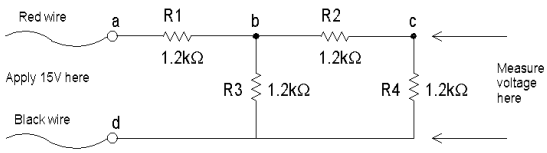
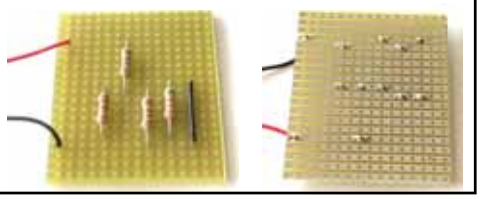
Building Simple Circuits

- Connect wires & components
  - solder makes permanent
- Insulate and protect
  - heat-shrink sleeving
- Use flexible wire – multi-strand
  - solid wire will break in use
  - different colurs – avoid errors
- Handyboard plugs
  - solder wires onto pins
  - cover and strengthen with sleeve

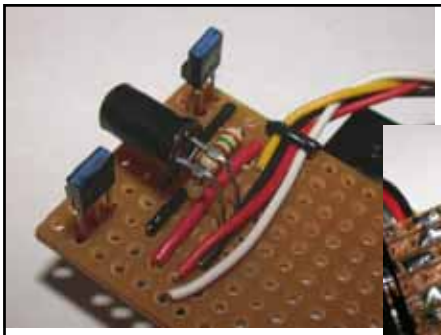
Bigger Circuits

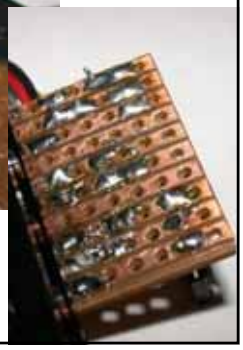
- Solder components onto *strip-board*
- each strip is one node





Examples





Soldering

- Makes permanent electrical joint
- Not hard, but takes practice

1. Clean parts and iron
   - solder will not flow over dirt/grease

2. Make mechanical joint
   - solder is weak

3. Heat the parts
   - small amount of solder on tip of iron - help flow of heat
   - apply iron to both parts
   - heat will damage electronic parts - need to be quick!

Soldering

4. Apply solder
   - solder melts, flows over joint
5. Remove solder and iron
   - allow joint to cool
   - no movement, don't blow on it!
   - good joint: smooth & shiny

6. Cut off surplus wire

- more detail on web pages…

Soldering - Safety

- **Hot soldering iron, hot-air gun**
  - risk of burns to skin, other damage
- **Hot molten solder**
  - risk of burns to skin
  - risk of serious damage to eyes
  - wear **eye protection** while soldering!
- **Toxic materials**
  - avoid breathing fumes
  - wash hands after soldering
  - no food or drink in lab
- **No soldering unless trained!**