Physics 124: Lecture 6

Projects

Adapted from T. Murphy's lectures

The Rubric, Once Again

- Sense some real-world quantity
  - input: analog or digital
  - sensor or user input (switches, keypad)
- Process the information
  - code in software
  - analog processing could play a role
- Do something externally
  - in reaction to the input and processing
  - LCD display at simple end; controlled motion on the other

Physics 124 Project Demonstrations

Mayer Hall Addition 3574 & 3544

Friday, March 20, 12:45 PM to 2:15 PM

Every year for Physics 124 (formerly Physics 120B and before that 121), the students come up with fun and innovative projects interfacing to the real-world. On Friday, 3/20, starting 12:45 PM, this year's batch will present their projects to the rest of the class, and we welcome interested visitors. Space may be a bit tight depending on turnout, but we can likely accommodate several dozen onlookers.

Projects

This year's project titles are (in proposed order of presentation):

- **Parallel Parker**: Josh Pomorski and Qiwang Zhang
- **Obstacle Avoider**: John Gombar and Thomas Massarany
- **Pinball Wizard**: Grant Haskins, Alan Sanchez, and Christopher Werry
- **Isothermal Shower**: Jared Myers
- **Compass Navigator**: Juan Camacho and Shane Robinson
- **Beer Pong Champ**: Jeff Lamattery and Sean Myers
- **Tailgater Tell-Off**: Bristol Keele Scott and Ann Pasquan
- **PIP: Printer-Inverted Pendulum**: Jason Bunk
- **A Sketchy Project**: Bac-Son Nguyen and Brittney Vierra
- **Hot Tub Drum Machine**: Matt McCaw and Andres Padilla
- **Gravity Compensator**: Clayton Anderson and Jinting Liu

At the end, students will vote on best projects (two categories) for engraved immortalization as Earl Dolnick Award recipients.

We want to emphasize the fun aspect of the demonstrations, and support the students in what they accomplished, even if some demonstrations fall short of ambitious dreams. So come with smiles on...

2014 projects

Projects

This year's project titles are (in proposed order of presentation):

- Ryan Layton: **Maze Crawler Robot**
- Sebastian Pfaff and Adrian Wong: **Bluetooth Beamer (BMW)**
- Jesse Cohen and Eric Iwinski: **Knockin' on Heaven's Door**
- Slater McArdle and Rhiannon Williams: **Groovebot**
- Kirill Kouprine and Christina Valen: **ARFF: Automated RF Finder**
- Thomas Morales and Molly Whitnack: **Smart Safe**
- Vicente Espinoza and Adrian Cusigch Botamino: **Block Mopper Hopper**
- Jonathan Trisnadi: **Turn Your Voice Up (or Down)**
- Becca Bladorn and Danny Chi: **Linearity is a Rarity: taping the future of transport?**

Example (Student) Voting Form

Two Categories

You are voting for two different awards. Both will be commemorated on a plaque for future generations to see. You can vote the same project for both prizes, if you see fit. Please resist the temptation to vote for your own project: if it's going to win, it probably doesn't need your help, and it distorts the process. Projects don't *have* to perform flawlessly to get your vote (unless you personally regard this as essential).

Most Awesomest

Pick the project that you think is most wicked, rad, bomb, or least ghetto. You just think it's a really cool idea and enjoyed watching it perform (or try to). This prize: it's about the project.

Most Impressive

Pick the project that garners the greatest respect for how much work, cleverness, technical prowess, or otherwise impressive traits were displayed by its creator(s). This is sort-of a hats-off vote: it's about the people.

The Ballot

Place an X in the first column for the most awesomest, and another X in the right column for most impressive. It is okay to nominate the same project for both, if this is an accurate reflection of your thoughts. Again, resist the urge to vote for your own.

bomb	respect	Group and Project Title
____	____	Manav Singh & Mike Chu: **Darryl the Maglev Train**
____	____	Devon Murphy and Zak Kmak: **Sketch an Etch**

Getting Ready

- Find a partner
  - not committed to stay in initial group
- Bat around project ideas
  - useful to have several in mind, if you can
  - could be based around a sensor, a technology, an action
  - we'll look at a variety of examples from the past
- Create a written, detailed proposal so that
  - we can evaluate the feasibility and level-appropriateness of the project
  - we can suggest expansions or reductions, easier alternatives, or come up with fallback de-scope options
  - you think through what the project needs in advance

Proposal Contents

- Motivation and overall concept
  - the big picture: why and what
- Functional definition
  - more detailed description of what the thing should do, and how it will react to all foreseeable operating states/stimuli
  - when you code the behavior, it is this section that defines what you are trying to do
- Sensors
  - what input devices are you going to use
  - how do they behave and how are they to be used

Proposal, Continued

- Mechanical Considerations
  - this is where things can get janky
  - it's easy to wave this off as not a big issue, but can be the hardest part in getting the project to work well
  - how is the device supported?
  - how are elements attached?
  - what custom pieces will have to be made?
  - out of what material?
  - do we have the necessary materials on hand?
- Electrical Considerations
  - what elements are needed, and how are they hooked up?
  - analog electronics needs/functions
  - circuit diagram
  - wiring (mechanical aspect: what wires, connectors, etc.)

Proposal, continued

- Interface
  - what (presumably) Arduino unit?
  - what pins/inputs/outputs are needed?
  - what communications?
- Software
  - how will the programming go?
  - what are the tricky parts?
  - what libraries might you use?
  - what new capabilities do you need to explore?
- Testing
  - how easy is it to test performance in the lab?
- Safety
  - flame, sharp objects, high velocity, high voltage, chemicals, etc.
  - how will you manage safety if these things are involved?

Proposal, continued

- Parts and Reusability
  - what parts do you need?
  - what parts are on hand?
  - what new parts are needed?
  - which parts will be consumed vs. reusable by future projects?
  - are there long lead-time items on the list?
- Expansion Options
  - what enhancements might you consider if things are going very well?
- De-scope Options
  - what ambitions might you shed if things are tough
  - fallback positions defining minimum capability

Proposal, continued

- What you will turn in
  - a brief section of the proposal explaining the contents of the report you expect to hand in at the end
  - a well-written proposal can serve as 70% of the final report

- Why all the work?
  - proposals are a key part of science
    - a spear with which to chase down Mammoths (NSF, NASA, DoE)
  - proposals focus the mind to clearly think through a project
  - the proposal becomes a template or guide to your work
    - helps organize/prioritize actions
  - gives a chance to sync up to class expectations

A Template Proposal

- For the fourth-week lab, we will switch gears a bit and make a mini-project following a proposal-form write-up
  - light-tracker with optical collision sensor/interrupt
  - you get a good example of what a proposal contains
  - you learn more about what a project takes to accomplish, on a smaller scale
  - you are turned loose to apply the skills acquired in first few weeks of the course
  - extra time to turn this in; proposal comes first

Due Dates

- Proposals are due by the end of 5th week; midnight Nov. 3, please don't leave it to the last minute
  - Gives us weekend to read and offer feedback next week
- You will have about two weeks to work on both the project proposal and the mini-project
- Don't worry about a complete report for the mini-project
  - usual functionality check by TA/prof
  - turn in code
  - paragraph about contributions
- Mini-project due Feb. 14/15
- Midterm Wed. Nov. 8 noon, here.

Equipment Needs

- We have an amazing array of useful junk/parts
  - start here; much of it is in workshop, but look in cabinets and on shelves in main lab rooms
- Stuff we don't have, you either purchase yourself, or UCSD buys
  - do you intend to keep it afterwards?
  - will it be usable/useful in future student projects?
  - is it reasonably-priced?

Work Shop

- You might have access to a workshop with power tools
  - dangerous: rule is someone else must be in room when you are operating the band-saw, drill-press, sander, hand drill or anything else that could be dangerous
- Keep it clean!
  - restock drill index after you are done
  - put away tools when you are finished
  - sweep up chips/dust/scraps

List of previously used devices/techniques

- Compiled by Fred Driscoll; • represent instances in past several years; ◆ represents Arduino-based
- Digital Out
  - many LEDs •••◆◆
  - Relay/Valve/Solenoid •••
  - AC power control (relay) ••••
  - Stepper motor ••◆◆◆◆◆◆
- Digital In
  - pushbutton/keypad •••••◆◆◆
  - light break (photogate) •••◆
  - magnetic sensor (present or not) •
  - encoder ◆
  - IR proximity ••◆◆◆◆◆◆◆
  - Passive IR (thermal) •

Components, continued

- Analog In
  - potentiometer •◆
  - joystick ••
  - phototransistor •••◆◆◆◆
  - thermistor or RTD •◆
  - flex strip •••
  - accelerometer •◆◆◆◆◆
  - gyro or compass ◆◆
  - weight •
  - RF input power ◆
  - audio bands ••••
  - coherent detection •
  - audio input (yes in past, no records) ◆◆◆
  - audio output (yes in past, no records) ◆
  - piezo vibration sensor ◆◆
  - Hall sensor (magnetic) ◆
  - 40 kHz ultrasonic (raw) ••◆

Components, continued

- Analog Out (PWM)
  - LED brightness control ●●●●◆
  - DC motor speed (drive; optoisolated) ●●●●●●●●◆◆◆◆◆◆◆◆◆◆
  - motor position (servo) ●●●●●●●●●●●●◆◆◆◆◆◆◆◆◆◆◆◆◆◆
  - buzz ◆
  - audio output ◆◆
  - phone line (dial out) ●◆
  - signal conditioning (yes in past, no records) ◆◆◆◆
  - electromagnets/coils (yes in past, no records) ◆◆
  - High current/power (yes in past, no records) ◆◆
  - ESC/brushless DC (no prior records) ◆

Components/techniques, continued

- Serial I/O
  - MIDI •••◆
- I^2C protocol
  - Temperature •••••
  - blood pressure •
  - PC input ••
  - Camera •◆◆
  - Sound synthesizer •
  - USB
  - RF communications (yes in past, no records) ◆◆
- Parallel I/O
  - Liquid Crystal Display (LCD) •••◆◆◆◆◆
  - DAC •

Components/techniques, continued

- Timing
  - RPM ••
  - echo-distance ••◆◆◆◆◆◆
  - valve time •••
  - data logging •
- Time Slicing
  - 7-segment display •
  - keypad ••
  - touch-sensitive caps ••
  - remotes ••
- High Current or Voltage
  - kill switches ◆◆
  - power transistors ◆◆
  - opto-isolators ◆◆

Some Time Touring Old Projects

- http://physics124.barreiro.ucsd.edu/projects/
  - has Winter 2017 projects
- http://www.physics.ucsd.edu/~tmurphy/phys124/projects/projects.html
  - Starts with Arduino, Winter 2013
- http://nnp.ucsd.edu/Phy120B/tour_121/
  - before 2013: lots of images, and brief descriptions
- Should also be past project reports to thumb through (in lab 3544, shelves near front of room)
  - more complete descriptions and how they were done