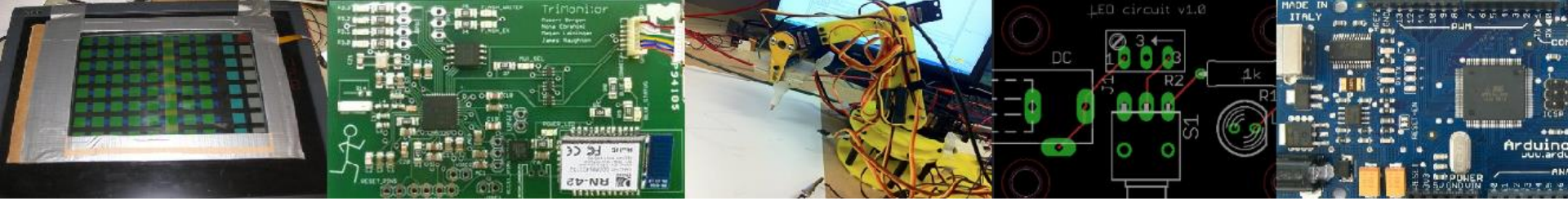


EECS 473
Advanced Embedded Systems

Expo

MICHIGAN

Status

- If you’re having major problems, please see me after class.

Expo day (1/2)

- Start at 10am in the lab
  - Gives time for folks to set up and deal with things that go wrong
- At least 2 people from each group there from 12:00-4:00
  - If you can't do that (other courses, etc.) let us know ASAP.
- Teardown and put away things 4-5:30pm
  - Clean up stations etc.

Expo Day (2/2)

- The staff will be seeing a demo from each group.
  - About 10 minutes per group.
  - We will be working on a “next group” scheduling model
    - Trying anything else farther out always results in something breaking and the schedule being a mess.
    - Sri will be the point person on scheduling during the day.
- Think about what you want to say and what you want to show.
  - Time is a bit tight.

Posters for the Design Expo

- A few quick things:
  - If you have them sent to all of the staff **(as a pdf)** by Monday 11/27 at 8pm and we'll print (and pay for) them, otherwise you're on your own with your own money.
    - Include "473 poster" in the subject of your email.
    - Name the poster X_name_poster.pdf where X is your group number, name is some one-word descriptive name of your group, and poster is the word poster.
      - So 18_frisbee_poster.pdf for example.
  - The printer we'll be using is 36" wide. Poster boards are likely 32"x40"

Purpose of the poster

- To give people something to read while you are talking to someone else.
  - Good pictures
  - Solid and clear details
- To help draw people in.
  - If you project doesn't move, you need something!
  - Pictures!
- To give you something to point to as you talk
  - For parts of your talk you can point to the project
    - But basic ideas, including function and purpose need something more.
  - Pictures
    - And generally **not** of your project (it will be there too).
      - Sometimes you want pictures of it doing something though

Target audience

- It’s very unclear who will be there.
- Probably mostly students and faculty.
  - The trick is to keep a narrative flowing with details available.
    - Generally “walls of text” can be okay for the detailed stuff.

Image issues

- ***Be really sure you have high-resolution images.***
  - Things generally look better on the screen than they do printed.
    - As an overkill rule-of-thumb, make it 2x as large on the screen as it will be printed. If that looks good, you should be golden.
    - People often mess up things like the UM logo, etc.
- At least a handful of images should be clear from 7 feet away.
  - Put it on the screen in normal size and stand 7 feet away.
  - Some, more detailed, images can be smaller. Use that carefully.

Text issues

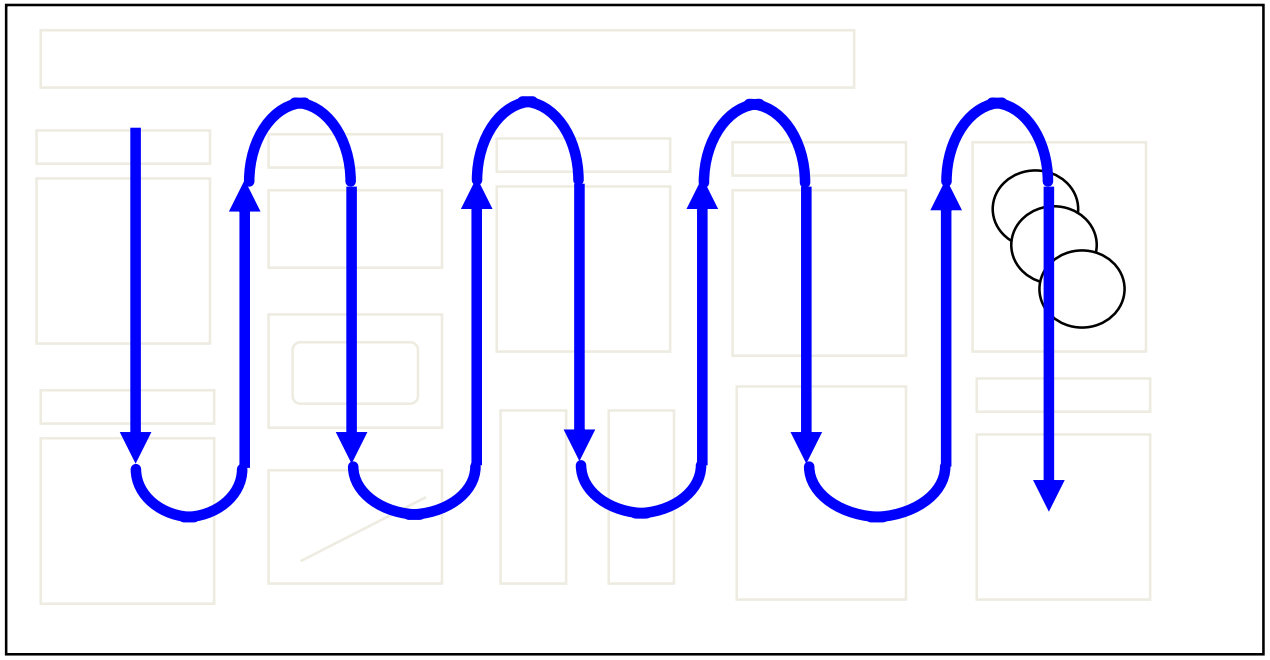
- Title and major topics should be easily readable at 7 feet.
  - Detailed text can be smaller.
    - Though 12 point font is the very smallest you should even consider for anything. Ever.
      - Really.

- Avoid more than about 10 words per line. Especially if text is dense in that section.
  - Makes it hard to find the next line down when reading.

Narrative clarity

- It should be clear what images and text go together.
  - If there is an ordering things should be read in, that should be clear.

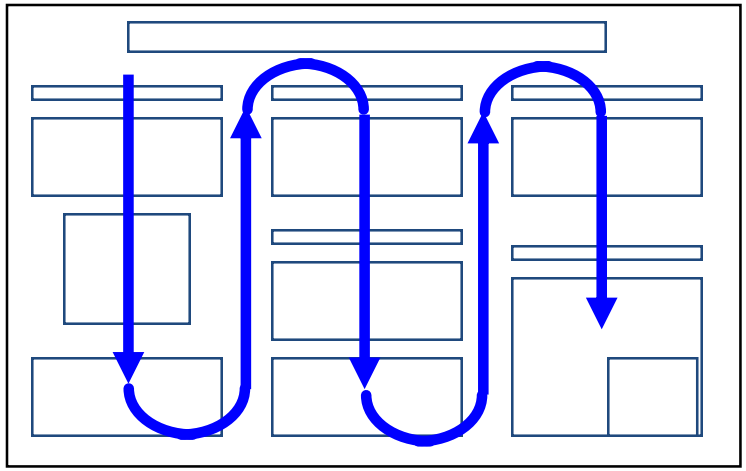
Viewing Sequences



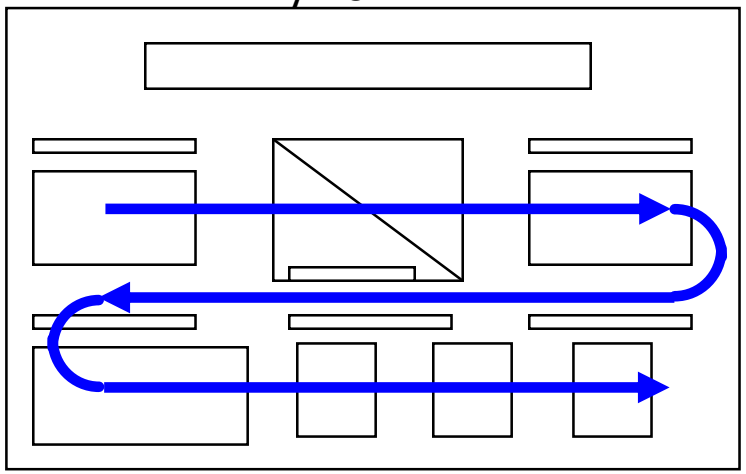
Thanks to Jack Fishstrom for this and the next slide!

Viewing Sequences

By Column



By Row



You really want the flow of the poster to be easy to figure out and follow. Use of columns or rows of white space to cause the reader to follow the poster as shown here and on the previous slide.

Required things

- Clear title
- List of students
- Course identified
- Department and/or College Logo
- Acknowledgement of any company, group, or people you got support or gifts from.
  - Infineon for everyone!
  - Guy on the Internet, design team, etc.
  - Include logos where reasonable.
  - If significant parts of your project are based on open source projects, they should be mentioned.

Things you might want

- References/further reading
- Costs?

Examples for discussion

- See comments section in power point for thoughts on each poster.

Biomedical Application of Induction Heating

A Novel Therapy for Benign Prostatic Hyperplasia (BPH) Treatment

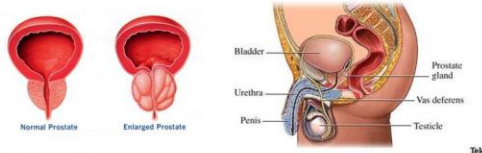
Aaron Willey; Kyle Cram

Project mentors: Tobey Clark; Dr. Mark Plante; Stefan von Büren; Kyle Clark

The University of Vermont
College of Engineering and Mathematical Sciences

What is Benign Prostatic Hyperplasia (BPH)?

- Age related growth of prostate tissue which commonly causes urethral obstruction.
- The prostate is a small, walnut-shaped organ measuring roughly 3-6cm in diameter, surrounding the urethra immediately below the bladder



Motivation

- The prostate is the most commonly affected organ for either benign or malignant cell growth in men[1]
- BPH is so common that it has been said, **"All men will have an enlarged prostate if they live long enough"**[2]
- From a histological perspective **95%** of men in their eighth decade are found to have evidence of BPH[3]
- BPH can significantly decrease **quality of life, causing:**
  - discomfort, inconvenience, and sleep disruption
  - urinary tract infections
  - bladder and kidney damage
  - bladder stones

Current Treatment Options

Transurethral Resection of the Prostate (TURP)

Surgical cutting of tissue to open urethra
- requires an operating room and anesthesia
- 2-4 days of hospitalization, inconvenient and costly

Transurethral Needle Ablation (TUNA)

Thermal ablation causing destruction of tissue
- sensitive heating system may cause charring
- nearly **50%** require TURP within 3 yrs[4]

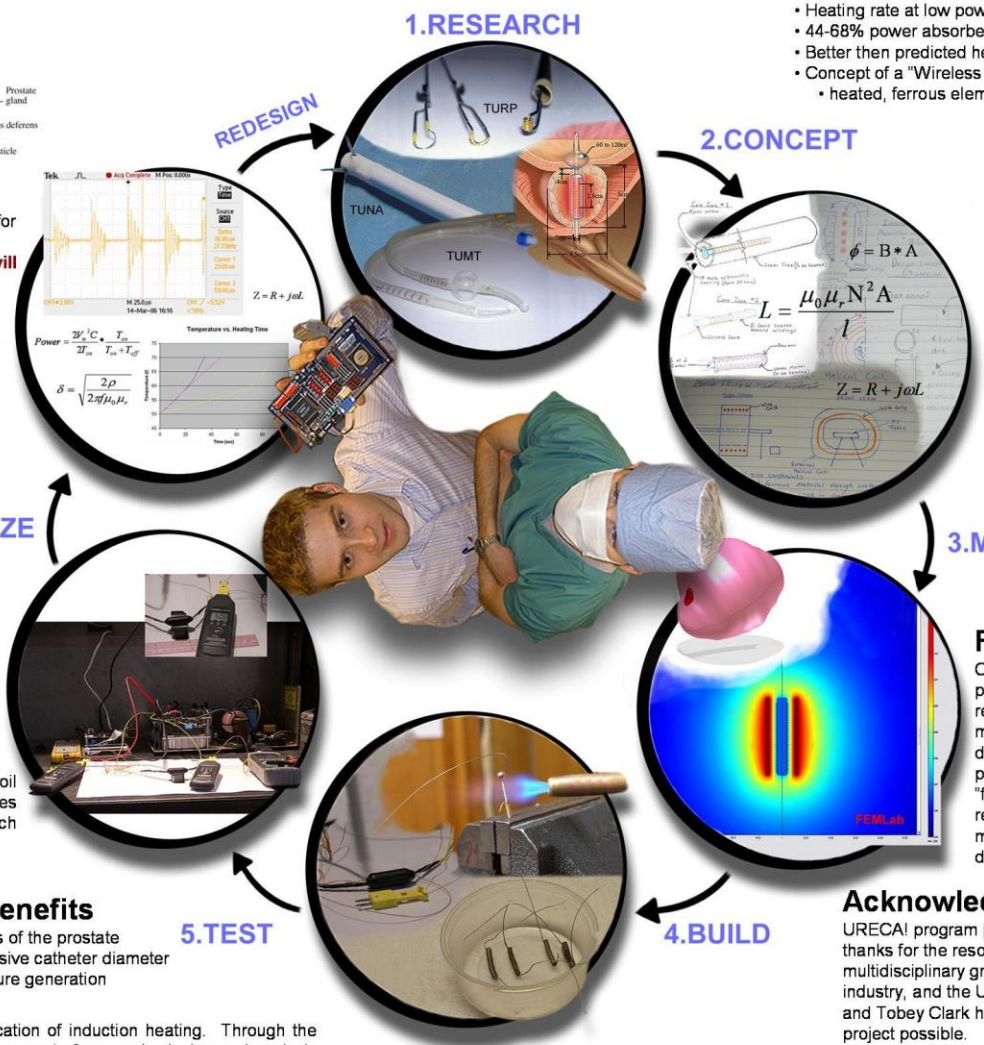
Transurethral Microwave Thermotherapy (TUMT)

Microwave energy heats tissue to thermal destruction
- failure to anatomically heat prostate
- depth of heat therapy questionable

What Is Induction Heating?

Induction heating works by delivering an AC signal to a coil creating a local alternating magnetic field. This field induces eddy currents to flow in adjacent conductive materials which by the joule effect releases thermal energy.

Project Development

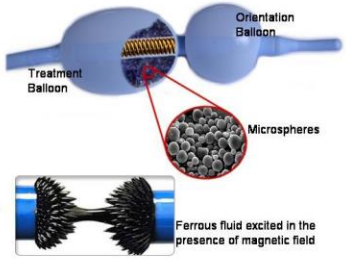


Intermediate Analysis of Heating Method

- Promising results show the induction coil, designed to scale, has the ability to heat an external ferrous element to desired temperature of 50 °C
- Heating rate at low power (14 Watts) shown to be impressive .57 °C/s
- 44-68% power absorbed by heater as determined by on/off cycles of power supply
- Better then predicted heating by FEMlab modeling (.17°C/s)
- Concept of a "Wireless Heater" is feasible
  - heated, ferrous element may be placed 4mm away from induction coil

Current Concept

- Anatomical dual balloon catheter system
- Induction heating of balloon filled with injected materials:
  - ferrous Fluid
  - superparamagnetic microspheres
- Treatment balloon allows for:
  - smaller catheter size
  - perfect fit to urethra wall
  - passive targeting of tumorous tissue



Future Directions

Current research into induction heating proves to be promising. Target temperatures of 50 °C are easily reached with this heating method at low powers. This method may make depth of heat penetration a simple time dependent function, which would reduce complexity of the problem. Next step involves attempting to heat ferrous "fluid", and maximize the heating coil's effectiveness. If results remain promising prototype testing on biological model will come next. Plenty of work still needs to be done.

Potential Application Benefits

- Targeted heating to treat specific regions of the prostate
- 37 % Reduction in size of minimally invasive catheter diameter
- Low power, low cost, and high temperature generation
- Wide range of heating coil designs

Little research has been done into the biomedical application of induction heating. Through the process of developing this novel treatment an extensive amount of research, design and analysis has been undertaken. The process of project development can be seen to the right. Pictures in each step show images ranging from early conceptual designs to actual constructed and tested heating coils.

References

[1] Emil A. Tanagho and Jack W. McAninch, *Smith's General Urology*, 16th Edition (CITY: McGraw-Hill Medical)
[2] National Institute of Health; http://kidney.niddk.nih.gov/kudiseases/pubs/prostateenlargement/
[3] Tanagho and McAninch
[4] Paul D. Miller, Ian Eardley, and Steven A. Kaplan, *Benign Prostatic Hyperplasia: Laser and Heat Therapies*, (London: Martin Dunitz Ltd., 2001)

Acknowledgments

URECA! program provided the funding to make this project possible. Many thanks for the resources and professional knowledge provided by our multidisciplinary group laying at the intersection of medicine, engineering, industry, and the University. Dr. Mark Plante, Stefan von Büren, Kyle Clark, and Tobey Clark have provided significant insight and direction to make this project possible.

iTec Innovative Technology Solutions
iTherm Technologies
IMF Instrumentation and Model Facility

Empirical Research Methods Poster

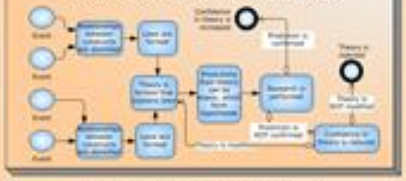
Check for the latest version at: http://vosseinhofmethods.typepad.com

Define research question

Research question examples:

- What are the key success factors of object-oriented frameworks?
- Does the proposed software improvement increase the efficiency of its users?
- How does software development methodology and team size influence developers productivity?

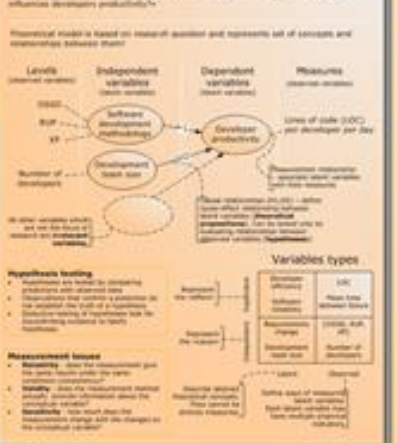
How facts become theories



Create theoretical model

Research question: «How does software development methodology and team size influences developers productivity?»

Theoretical model is based on research question and represents set of concepts and relationships between them:



Consider threats to the research

Threats to the research are related to operationalization and measurement issues:

- **Operationalization issues** - The validity of the operationalization
- **Measurement issues** - Reliability, validity, sensitivity (see below):

Reliability threats – refers to the question whether the research can be repeated with the same results.

- **Stability reliability** – Does the measurement vary over time?
- **Representative reliability** – Does the measurement give the same answer when applied to no groups?
- **Equivalence reliability** – When there are many measures of the same construct, do they all give the same answer?

Validity threats

- **Face validity** – Research community says[that]
- **Content validity** – Are all aspect of the conceptual variable included in the measurement?
- **Criterion validity** – Validity is measured against some other standard or measure for the conceptual variable.
- **Predictive validity** – The measure is known to predict future behavior that is related to the conceptual variable.
- **Construct validity** – It measure is found to give certain predictions in multiple correlated research processes. This confirm both theoretical and the construct validity of the measure.
- **Conclusion validity** – Is concerned with the relationship between the treatment and the outcome of the experiment. Method of sample size, choice of statistical tests).
- **Experimental validity** – (see reliability)

Sources of invalidity

- **Internal** – Is concerned with the validity within the given environment and the existence of causes. In relation to validity of research design, controls and measures.
- **External** – Is the question of how general the findings are. Can you carry over the research results into actual environment?

Sensitivity

- How much does the measurement change with the change of the conceptual variable?

Positivist research model

Qualitative vs. Quantitaive analysis

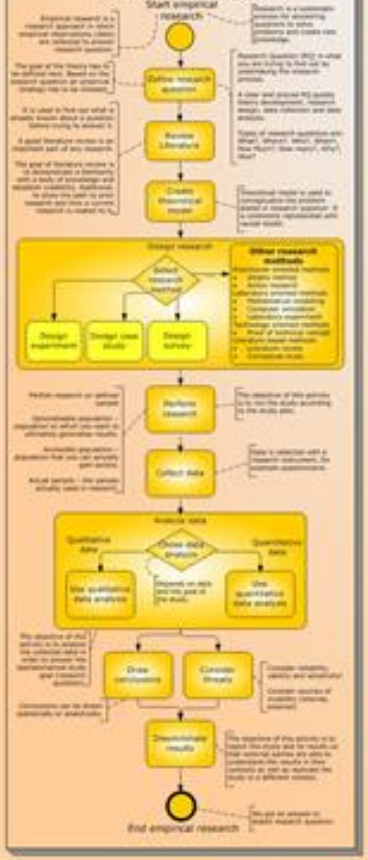
Qualitative (=subjective=)

- Tends to be the poor relative.
- Is the collection of textual and perceptive views making the judgement.
- The data collection is more basic in nature.
- Differences of opinion over interpretation.
- Not easily measurable.
- Is the scientific and social facts. Data can be subsumed to shorter term cases.
- Can help to understand assessments of performance between teams over time and between project elements.
- Subjective opinions have to be given less status than quantitative ones.

Quantitative (=hard numbers=)

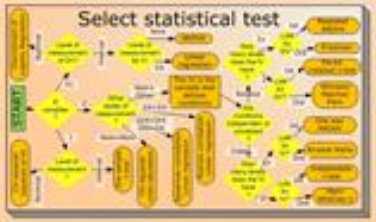
- Easier to implement and collect data. Tool based.
- Easier to make comparisons over time and between teams.
- Can be a quick to view organizational level performance data in quick to natural science.
- Easier to process through a computer.
- Easier for other researchers to examine and comprehend.
- Trends and patterns easier to identify.
- Can detect the evaluation process so we measure what it says to measure.
- Can lead to unbiased judgements and the data mean samples picture in general.

The research process



Select research method

Select statistical test



Analyze quantitative data

Statistics is a mathematical science pertaining to the collection, analysis, interpretation or explanation, and presentation of data.

Statistical methods can be used to summarize or describe a collection of data; this is called **descriptive statistics**. In addition, patterns in the data may be modeled in a way that accounts for randomness and uncertainty in the observations, and then used to draw inferences about the process or population being studied; this is called **inferential statistics**. Both descriptive and inferential statistics comprise **applied statistics**.

Descriptive statistics

Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data.

Measures of central tendency
It is measures of central tendency is a single number that is used to represent the average score in the distribution.

- **Mode** – the most common score in a frequency distribution
- **Median** – the middle/most score in a distribution
- **Mean** – the common average

Measures of variability
A single number which describes how much the data vary in the distribution.

- **Range** – The difference between the highest and lower score in a distribution.
- **Variance** – The average of the squared differences from the mean.
- **Standard deviation** – The square root of the variance, a measure of variability in the same units as the scores being described.

Correlation and regression
Correlation quantifies between two variables.

- **Correlation** – The strength of the relationship between two variables.
- **Regression** – Predicting the value of one variable from another, based on the correlation.

Inferential statistics

Inferential statistics or statistical induction comprises the use of statistics to make inferences concerning some unknown aspect of a population.

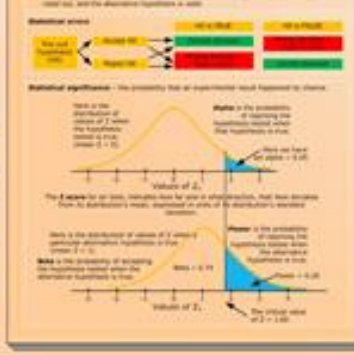
Sampling distribution – the distribution of means of samples from a population.

Sampling distribution have three important properties:

- It has the same mean as the population distribution.
- It has less variability (smaller spread) than the population distribution.
- As the sample size becomes larger, the shape of the distribution approaches a normal distribution, regardless of the shape of the population from which the samples are drawn.

Hypothesis testing – is the use of statistics to determine the probability that a given hypothesis is true. The usual process of hypothesis testing consists of four steps:

1. Formulate the **null hypothesis H0** (the hypothesis that is of no scientific interest) and the **alternative hypothesis Ha** (statistical term for the research hypothesis).
2. Identify a test statistic that can be used to assess the truth of the null hypothesis.
3. Compute the P-value, which is the probability that a test statistic at least as significant as the one observed would be obtained assuming that the null hypothesis were true. The smaller the P-value, the stronger the evidence against the null hypothesis.
4. Compare the P-value to an acceptable significance value alpha (sometimes called an alpha value). If p≤alpha, that the observed effect is statistically significant, the null hypothesis is ruled out, and the alternative hypothesis is valid.



Design Experiment

Design case study

Design Survey

A survey is a study in activity (a group of) people from a population about their opinion on specific issue with the intention to define relationships outcomes on this issue.

Literature used

- Bernd Freimut, Teade Punter, Stefan Biffl, & Marcus Ciolkowski 2002, *State-of-the-Art in Empirical Studies*, Virtuelles Software Engineering Kompetenz-zentrum
- Johnston, R. & Shanks, G. Research Methods in Information Systems. 2003
- Neuman, W. L. 2005, *Social research methods : qualitative and quantitative approaches*, 5th ed. edn.
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- www.wikipedia.org

About the Research Methods Poster

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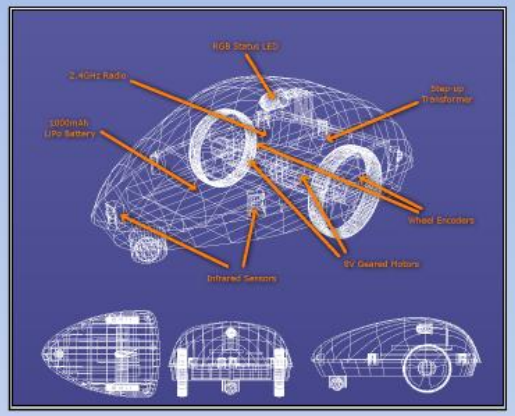
Poster version: 0.5 (DRAFT)
http://vosseinhofmethods.typepad.com

Swarm of Tiny Autonomous Robots

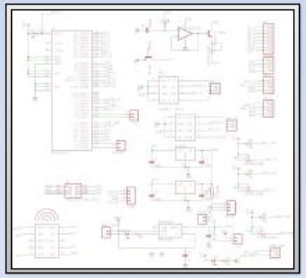
Alex Karantza – Matthew Keller – Robert LiVolsi

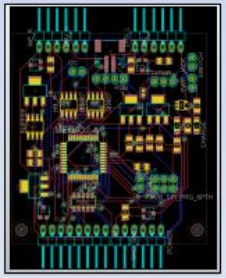
Rochester Institute of Technology
Dept. of Computer Engineering
Senior Design Project Spring 2011

Hardware



Each robot is capable of range-finding and neighbor identification via modulated infrared in all directions, radio communication over a 2.4 GHz network, and motion on a flat field using independent bilateral motors. An 8-bit microcontroller is used for real time processing of sensor data and rule based decision making. Custom power management provides 8 V, 5 V, and 3.3 V rails to the rest of the system.





Special Thanks

Dr. Roy Czernikowski, Dr. Roy Melton, Rick Tolleson,
Kyle Blemel, the CIAS Industrial Design Lab, and the CET Etch Lab

Project Description

Swarm intelligence is an emerging field impacting all of robotics, and is distinguished by features including flexibility, robustness, decentralization, and self-organization. The Swarm of Tiny Autonomous Robots (STAR) platform is a complete system built from the ground up for developing, testing, and demonstrating swarm algorithms. The platform is comprised of both the hardware specification for palm sized autonomous robots and a complete software suite for algorithm development, simulation, verification and analysis, real-time monitoring, and hardware debugging.

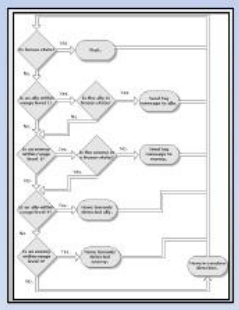
The Team

Alex Karantza Matt Keller Rob LiVolsi

User Interface

The software suite allows for detailed observation of the robot's current status by receiving information over the 2.4 GHz radio. The software allows for algorithm development using the simple rule design which can be set wirelessly. The suite also acts as a simulation platform in order to test and observe the desired reactions of the system given the current set of rules.

Rule Logic



The rule system is a form of decision tree that processes input from the microcontroller in order to choose which action to take. The rules use a conditional to branch to an action or the next conditional. The platform implements a simple game of freeze tag to demonstrate the use of all the subsystems in tandem.

Cost Breakdown

Component	Distributor	Part	Quantity Used	Unit Cost	Total Cost
Microcontroller	Mouser	ATMega32-16PU (DIP)	1	$4.69	$4.69
Radio Transceiver	Digikk	Linx TYP-2.4G	1	$19.00	$19.00
IR Demodulator	Mouser	Vishay IR Sensor	8	$0.87	$6.32
IR LED	Mouser	Everlight IR 336-A	3	$0.09	$0.18
LiPo Battery	Pololu	Pololu #1572	1	$8.95	$8.95
LiPo Charger	Mouser	MAX-1555	1	$1.42	$1.42
Voltage Regulator	Mouser	LD39115DV	2	$1.76	$3.52
Metal Gear Motor	Pololu	Pololu #1116	2	$10.00	$40.00
Step-up Converter	Pololu	Pololu #791	1	$13.95	$13.95
PCB	BatchPCB	Eagle (maximum)	1	$10.84	$10.84
Wheels (pair)	Pololu	Pololu #1088	1	$8.88	$8.88
Hull Plastic	KPlastics	Acrylic Sheets (in)	1/3	$5.95	$2.00
Total					$126.54
Total Project Cost					$688.70

Wireless Medical Monitor Network

By Eric Ball, Andrew Lee, Hangcheng Lou,
Jonathan Mejeur, Michael Neri, & Garrett Sinclair

Fall 2010 – EECS 452: Digital Signal Processing Laboratory

MichiganEngineering
EECS Department
College of Engineering at the University of Michigan

Background and Overview

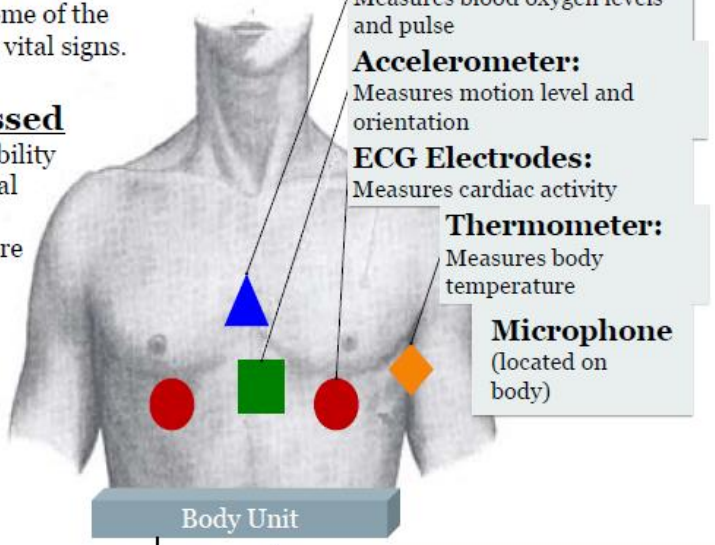
Medical instrumentation has many inconveniences associated with it. Our system addresses some of the major weaknesses by wirelessly monitoring vital signs.

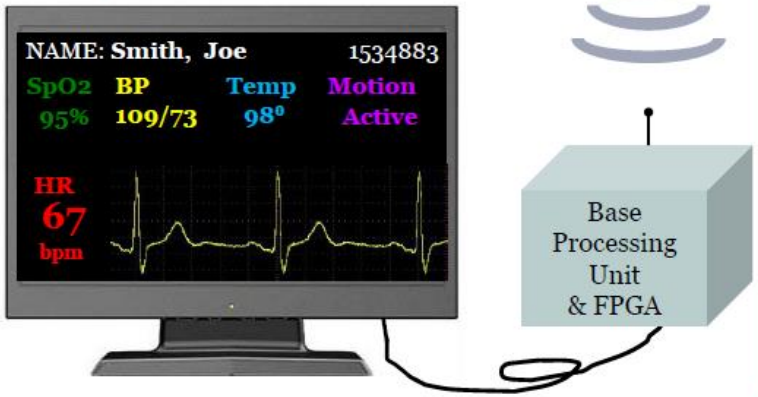
Applications & Issues Addressed

•Military – Battlefield soldier vitals and mobility
•Hospitals – Patient vitals and bulky hospital equipment
•Children and Senior Citizens – In-home care and increased patient mobility

Device Description

This device measures cardiac activity (ECG), oxygen saturation, blood pressure, body temperature, and motion level readings and wirelessly transmits these signals to a base station for remote monitoring.





Signal Analysis

ECG
Uses Discrete Wavelet Transform (DWT) to detect cases of Ventricular Tachycardia and Ventricular Flutter. Also used to detect pulse.

Accelerometer
3-Axis moving average power calculation and orientation threshold.

Blood Pressure
Uses the delay between ECG QRS wave and SpO2 waveform for calculating the velocity of blood through arteries in order to find the blood pressure.

Voice Recognition
Uses time-warping and Mel filtering to compare voice input and stored voice commands.

Process Flow

1. **Signals from sensor array**
2. **Conditioning circuitry**
3. **Body processing**
4. **Wireless transmission**

RF2500
Uses multiplexed Analog to Digital signals to sample biometric data, and transmits them using SimpliciTI wireless protocol

5. **Base processing unit**

C5505
Acquires the digital signal processes the signal with algorithms we designed, and sends to FPGA.

6. **Display via VGA**

The data from the C5505 microprocessor is transferred to the Spartan-3 FPGA to display the vital information by utilizing the VGA port on the FPGA.

Special thanks to Professor Mark Brehob, GSI Chao Yuan, and Professor Emeritus Kurt Metzger for the support and guidance throughout this project!

Image Processing Based Commercial Detection

Christopher Barch, Sir Francis Conway IV, Philippe Hauswald, Jay Patel, David Smolinski
Electrical Engineering Department, University of Michigan, Ann Arbor 48109

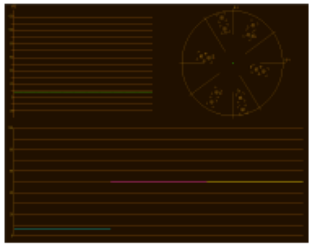
Introduction

While most people enjoy watching television programs, few enjoy having to watch or listen to the commercials that interrupt their favorite shows. Our project aims to use the audio and video signals of television programming to detect when channels switch to commercials. Our detector will identify commercials by detecting audio and visual cues that appear when a channel switches from its programming to a commercial break. The device proceeds to mute the television when the commercial comes on, sparing viewers from the annoying commercials.

Motivation

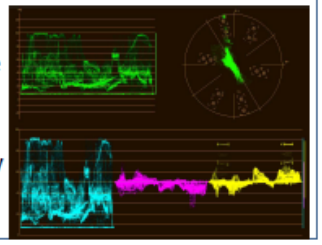
Some preliminary information that we used to gauge our success:

- Black screens easy to detect since Y Cb Cr values = "zero"
- Normal frames have color signatures that are easy to detect
- While trying to detect logos, the consistency of the pixel values allow us to easily tell if a logo is present or not



Above: Y Cb Cr values at "zero"

Below: Y Cb Cr values of Frame to the right



Implementation: Image

High Level Overview

1. Video Source to FPGA

- Video, NTSC compliant, is output from the video source as a composite signal (RCA) and is plugged into the FPGA's "Video In" port. The audio is plugged into the "Line In" port.
- The FPGA's built in video decoder chip processes the pixels one by one as they come in, focusing on pixels inside the boxes, shown underneath.
- The audio is processed by the Wolfson WM8731 24-bit sigma-delta Best-Quality Audio CODEC

Above: Red boxes outline o f detection areas

2. FPGA to Monitor

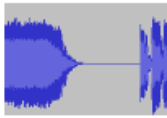
- Depending on the whether or not our algorithm detected a commercial, the FPGA either relays the video and sound information from the decoders to the speakers and monitor, or in the event of a commercial detection, the FPGA blacks out the video and mutes the sound

Implementation: Audio

Using the audio feed from the television our device was able to detect audio drops between shows and commercials breaks. The algorithm signaled to the imaging algorithms that a commercial break was about to begin or end.

Above: left audio chan

Below: right audio char



Future Work

Some future additions that could be made to increase the functionality of the detector:

- Detection for multiple video types
  - Sports
  - Movies
- Integration of SD card
  - Store music to play during commerci
  - Store images for a slideshow during commercial

Contact Information

If you have any questions or would like informa about this project, please free to email us at eecs452group@umich.edu.

Acknowledgement

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Finally: Practice before printing

- Consider answering the following questions:
  - What does it do?
  - How does it work?
  - What was the most difficult part?
  - What would you do differently?
- Are there any figures you *really* need to be able to point to in order to answer that question?

HW2 and the final

- HW2
  - HW2 will be posted on Wednesday
  - Due Tuesday 12/5
- Written report
  - Due Sunday 12/3
    - It is a non-trivial part of your grade…
- Final
  - We have a review session in class on Tuesday 12/5.
    - Expecting to have one on some other time too (discuss)
  - Exam is on Monday 12/11 4-6pm.
  - The old finals are a good place to study from for the final.
    - HW2 is also a good start.
  - And of course studying the midterms also useful.
    - Some material from earlier in the semester is going to be there.