
EE16A Lecture 15: Introduction to Locationing

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Questions/Discussion

Questions/Discussion

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Design Process

- **Step 1: Concretely state your goal for the system**
- **Step 2: Describe (e.g. with a block diagram) a strategy for achieving your goal**
 - Often involves reviewing what you can measure vs. what you wanted to measure, and how they relate to each other
- **Step 3: Implement the components within your strategy**
 - Think about what pieces you might already know how to build, or how to extend building blocks you know about
- **Step 4: Verify your design meets the original requirements**
 - Checking interfaces between blocks often the most critical
- **Iterate through these more than once...**

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Design Process: C Touchscreen Sensor

- **Step 1: Concretely state your goal for the system**
 - “I want my circuit to indicate if a finger is touching the screen (at a certain position) or not”
- **Step 2: Describe a strategy for achieving your goal**
 - Can’t measure the state of the finger directly
 - But do know that it can affect a capacitor in my circuit
 - So, let’s measure this capacitance as a proxy for the finger touch
 - As long as we know what the capacitance should be with a finger touch
 - Checking whether the capacitance is more or less than this should tell us whether or not the finger touched

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Design Process: C Touchscreen Sensor

- **Step 3: Implement the components within your strategy**

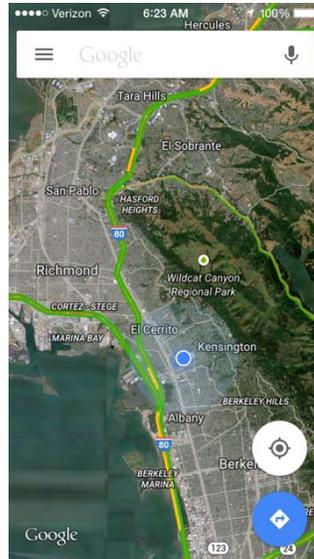
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Functions You Know How to Build with Circuits

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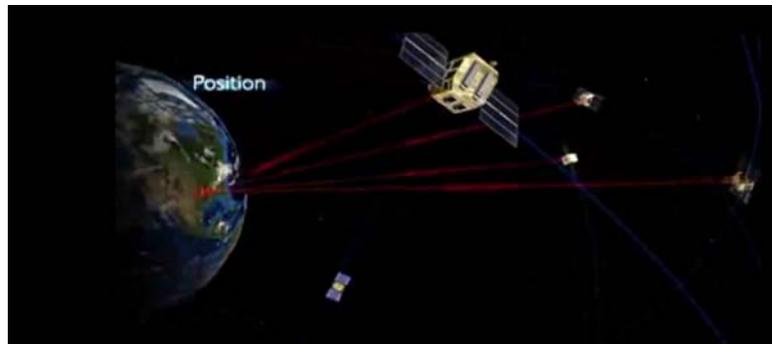
Locationing

- **Picture from Elad's phone this morning**
- **How does my phone know where it is all?**
- **And what causes the circle of uncertainty?**



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Global Positioning System (GPS)



- **Developed by US Dept. of Defense, started 1973**
- **Fully operational in 1995**
 - Continued improvements since then
 - Several other similar systems exist or in development (GLONASS, Galileo, etc.)

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Key Idea Behind GPS

- **Measure distance between you and some other objects in known positions**
- **How many known objects/positions do we need?**

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Effect of Distance Errors

- **Will learn in this module how to use more known positions than the bare minimum to reduce sensitivity to errors!**

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How Is Distance Actually Measured?

- **Need a way to communicate between the known objects (beacons) and the thing you are locating (GPS receiver)**
- **GPS uses electromagnetic waves**
 - In our lab we will use acoustic waves (sound waves)
- **So what is a “wave”?**

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Waves

- **Disturbance that travels through a “medium’ from one location to another**
 - E.g., grabbing the end of a slinky and letting it go
 - This disturbance has some energy associated with it
- **Our “medium” is generally air**
 - For sound, disturbance is in the pressure of local regions of the air
 - (EM waves can actually travel through free space)
- **Many of the waves we will be dealing with are periodic**
 - I.e., the disturbance behaves in a repetitive manner in time, space, or both

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Important Properties of Waves

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Important Properties of Periodic Waves

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Aside: Amplitude vs. Distance

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Locating System So Far

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Key Idea: Cross-Correlation

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Key Idea: Cross-Correlation

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Why This Works: Geometric Interpretation

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Why This Works: Geometric Interpretation

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