6.S062 Lecture 1 2/3/2016

Who are we + website

Intro -- what is this class about?

- Building software systems that include sensors and mobile devices

What is the prototypical architecture of a sensor system?

3 tier - sensor – gateway – server (slide)

What are some examples of such systems?

Home or industrial monitoring -- convenience, energy utilization, theft prevention, etc

Traffic or pothole detection using cars

Preventative maintenance -- connected sensors on equipment, comparative analytics to detect degraded operation & early signs of failure

Research examples -- what have Hari & Sam done (slide)

TinyDB
Pothole Patrol
Glimpse
Cricket

CMT (slide)

How is the class structured?

- Readings and discussion in class - 10%
    - Participation and attendance in class is an important part of your grade
    - Short reading summaries due before class?

- Labs: Anteater overview - 30%
    - Technologies: positioning, BLE, ranging, intertial sensors
  - iOS / MacOS -- survey -- who has a mac / who has an iphone
  - Team based

- Quiz (1) - 25%

- Final project -- 35%

Open ended team-based, using sensors & phones (we can supply some equipment, you imagine what you will do, though we can make some suggestions)

Why is this intellectually interesting? What are the big ideas?

- Sensors: complex systems for measuring position, orientation, time, etc
    - We'll study how these technologies work, and their limitations
    - Building systems that use this data require integrating statistical and signal processing techniques into the systems themselves
    - Technologies have different tradeoffs in terms of accuracy and cost to acquire & process data
    - Example: VTrack / CTrack
    - Learn how to use smartphone APIs for sampling them

- Networks: variety of technologies, multi-hop, disconnectivity ("store and forward", "muling"), low power, etc
    - We'll study resource limits can capabilities of different technologies
    - Multihop & disconnectivity have big effects on system design]
    (ZebraNet slide)
    (TinyDB example)

- Data: noisy & sparse signals,
    - Example: Pothole patrol

- New constraints: power, bandwidth/connectivity

Topic 1: Power Constraints

One of the cross-cutting principles underlying many mobile sensor systems is the fact that they must contend with severely limited resources, especially power and bandwidth.

Also a tension between system architects (you) and people analyzing data or running business

Data analysts always want more data
Sensor system architects limited by constraints

E.g.,
    Battery powered devices need to last X years
    Radios can transmit at Y bytes per second
    Device can store Z hours of audio

Example -- power:

Power consumption often limits what you can collect
Some technologies (e.g., 3G radios, GPS) use lots of energy

Physics Recap

SI Unit of Energy = Joule (J)
SI Unit of Power = Watt (W) = Joules / second
Wattage of a device is Amperage (A) x Voltage (V)
Wattage determines power consumption of devices (milliwatts, or mW)
Battery capacity is its stored energy; measured in milliamp-hours (mAh)

Example: iPhone 6 has 1800 mAh battery; LTE radio uses about 1700 mW when transmitting @ 1 Mbit/sec

iPhone is 3.8V, so 1800 mAh = 6840 mWh @ 3.8V; 6840/1700 = 4 hours

iPhone (doing nothing else) can transmit for about 4 hours on LTE

(Show power costs slide)

Some Caveats

Startup and shutdown times
    E.g., LTE radio 10 second shutdown

CPU power vs processing efficiency
    Faster processor less processing time

Radio power vs bandwidth
    Higher bandwidth --> more power
    Higher bandwidth --> less time --> less power

Uplink vs downlink

How does this affect you as a system designer?

More data --> more sensing, more processing, more transmission
    --> Collect what you need!

On device processing can reduce data transmission, but processing is also expensive

WiFi/BluetoothLE use MUCH less energy than 3G/LTE

Other resources, such as network, are also limited -- we will discuss in much more detail later in the course

Example: DriveWell Tag -- "triggered sensing"
Recap : topics