ECGR-6189/8189: Wireless Sensor Networks
Spring 2018
<u>Final Project #1</u>
Moving Target Tracking

The main objective of this project is to track the location of a moving target with respect to some anchors placed in a geographic area using the RSSI measurement. In this project few anchors will be placed in an area, e.g. three anchors placed at the corners of the target area. These anchors send periodic beacon messages. The moving target receives these beacons, estimates its distance based from the anchors based on the received RSSI values and transmits them to the base-station when each set of four beacons are received. The base station then applies multilateration using the distance estimates. This localization estimates are displayed using some visual tool.

Jobs to be done:

1. **1st week:** Fix the place where the experiment should be done and measure the channel characteristics of that place. Also, determine the method to estimate distances based on RSSI
2. **2nd week:** Start Writing the program of localization using RSSI from three beacons (will go to 3rd week as well).
3. **3rd week:** Finish and test the program of localization.
4. **4th week:** Make the demo ready, write report and submit.

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Spring 2018
<u>Final Project #2</u>
Number Recognition

The objective is to recognize characters using hand movements. The accelerometer stores the accelerator value and sends this to the base-station attached to a computer. Then the base-station recognizes the character that the person wants to write based on hand movements and displays that on the screen.

The system mainly detects eight sets of hand movement, denoted as →, ←, ↑, ↓, ↘, ↙, ↗ and ↖. Let us call these patterns as our set of strokes. The stroke → means the hand is moved from left to right, i.e. in the positive x-axis. Thus when the hand starts moving the x-axis acceleration starts increasing and when the hand stops, the acceleration decreases and comes back to zero. The y-axis acceleration remains same as shown in Figure 1(a). The ADC readings of all the other movement patterns are shown in Figure 1.

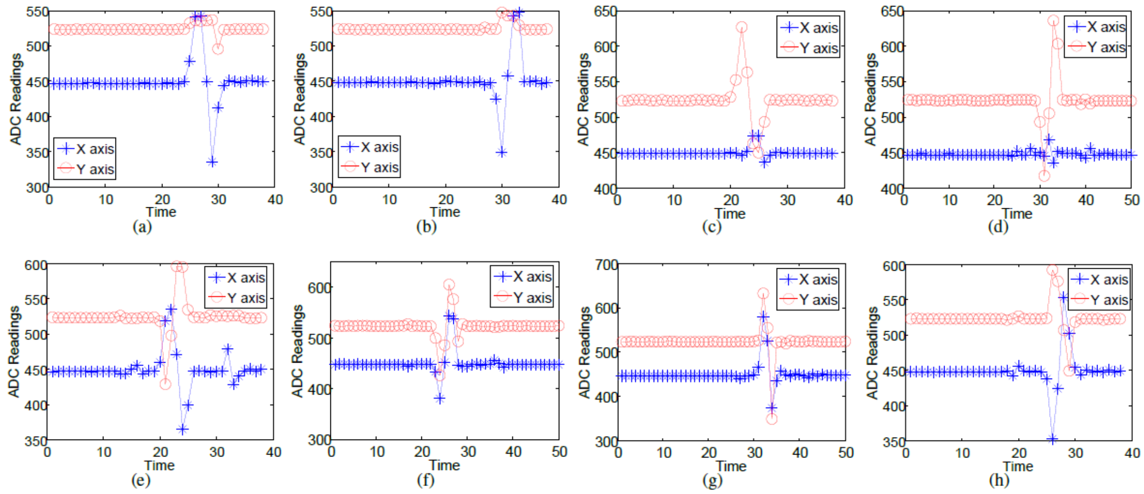

Fig.1 Movement patterns →, ←, ↑, ↓, ↘, ↙, ↗ and ↖

All the alphabets (A-Z) as well as all numbers (0-9) have to be written by some specific hand movements. An illustration is shown in Figure 2 and Figure 3.

As an example if we want to write Z, then we need to move our hands in the positive x direction (→), then pause a little bit, then move like ↙, pause a bit and move again in positive x direction (→). These pauses are necessary so that the system can detect the end of one stroke and the start of the next one.

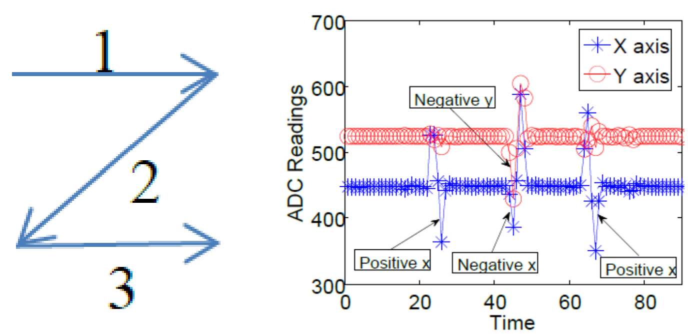

Fig.2 Movement patterns for writing Z

The ADC readings corresponding to writing Z is shown in Figure 2. Similarly all the characters can be recognized by detecting the set of strokes. When an user finishes writing a character, it needs to give some indications so that the basestation can understand the end of one character. While writing on a paper, we use a gap between two characters. In our scheme, we use the photo sensor (the photo sensor is part of the MTS310 sensorboard) to take that indication from the user. When an user finishes one character, he put this hand on the photo sensor. It blocks the light on the photo sensor, thus its value goes down. The basestation detects this and understands the end of one character and prints it on the screen.

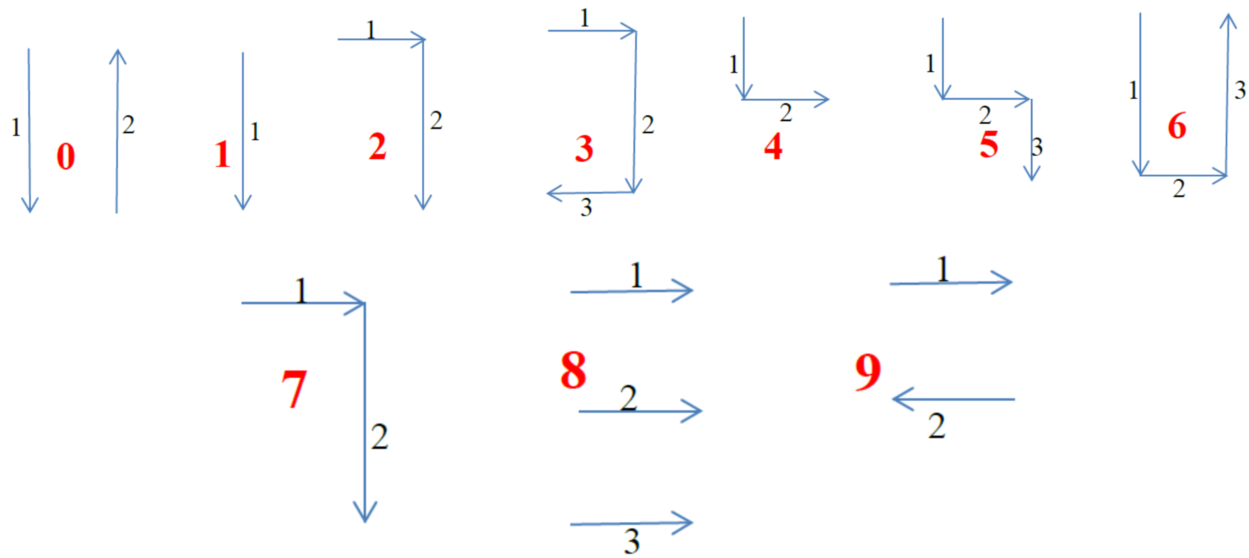

Fig.3 All numbers and their writing patterns

Jobs to be done:

1. **1st week:** Study the accelerometer readings with all the strokes.
2. **2nd week:** Write the program for detecting the strokes and print (will go to 3rd week as well).
3. **3rd week:** Develop a scheme for character recognition and test the program.
4. **4th week:** Make the demo ready, write report and submit.

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<u>Final Project #3</u>
Activity Sensor and Accident Detection

The main objective of this project is to track normal activities versus abnormal events such as accidental falls or other harmful events. In this scheme a mote with sensor board will be attached to a specific location of a person's body. When the person moves, the readings of the accelerometers (X and Y) change. The accelerometer values reflect the posture and movements of the person. Thus the goal is to record the sample values and make a determination of the posture and activity, such as lying down, sitting/standing, walking, running. Your tasks will be to

A. Identify the following states and their parameters:
   1.) State=Lying down
   2.) State=Sitting
   3.) State=Walking
   4.) State=Running

B. Develop a mechanism to detect sudden or anomalous events such as falling or other possible accidental events!

Jobs to be done:

1. **1st week:** Study the accelerometer reading for different movements.
2. **2nd week:** Develop a method to identify states (will go to 3rd week as well). Also, do your research on calorie calculation for different states
3. **3rd week:** Finish and test the program for the measurement tool.
4. **4th week:** Make the demo ready, write report and submit.

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Spring 2014
Final Project #4
Vehicle Distance Detection and Alarm

The main objective of this project is to implement a sensor for detecting the distance between two vehicles for avoiding accidental collisions. An IR distance sensor will be provided that needs to be interfaced with a mote to convert an analog voltage output to distance. Depending on speed, alarms should be generated when the sensor detects a close proximity with a vehicle or object in front.

Goal: automatically sound an alarm when the vehicle speed is high and an object is detected at distance X (high). At lower speeds the distance threshold X for alarms should be lower.

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Jobs to be done:

1. **1st week:** Implement the detection of object distance using the IR sensor
2. **2nd week:** Calibrate object distances from IR sensor readings.
3. **3rd week:** Finish and test the application, check the level of accuracy.
4. **4th week:** Make the demo ready, write report and submit.

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Final Project #5
Automatic Traffic Signals Using Vehicle Detection

The main objective of this project is to implement an automatic traffic signaling scheme with two sensor motes. Two motes A and B are used as two traffic lights at a road intersection. The third and fourth lights are not used.

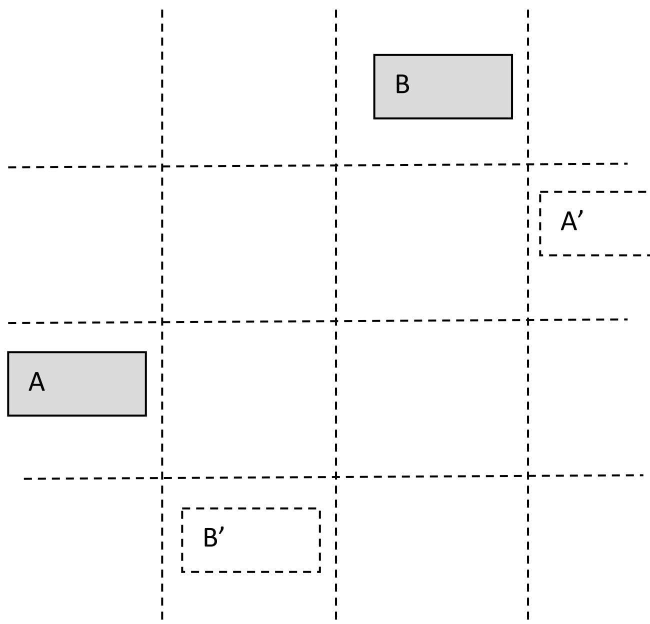
Step 1: By default, the AA' and BB' sequence repeats in following fashion.

AA': G → 20s→ Y → 3 s → R

BB': R → 20s → R → 3 s → R → 3 s → G → 20 → Y → 3 → R

Once one set of lights turn R, it should signal the other set to turn G after 3s

Step 2: When AA' is green and there is no car within 10s in the AA' lane, and a car is detected at the BB' line, then after 3 seconds, AA' turns Y for 3 seconds and then turn R. Reverse happens in the BB' side.



Jobs to be done:

1. **1st week:** Finish the first stage.
2. **2nd and 3rd week:** Finish the second stage.
3. **4th week:** Finish and test, submit the report.

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Final Project #6
Channel Estimation and Modeling

The project is divided into two parts. In the first part, the main objective is to come up with a tool to obtain the path loss factor (exponent) and the Lognormal fading factor (standard deviation) using two motes, where one is a transmitter that is placed in different distances from a receiver. The second is to estimate the characteristics of the packet delivery ratio versus transmit power with the two nodes at a fixed distance apart.

Part 1: Assume that a receiving node sends the RSSI form the transmitted signal from a node sending periodic messages. Develop a program by which the transmitting node can be repeatedly moved further away, at each position sending 10 packets for the receiver to estimate the average RSSI. After a few sets of readings, the base station should be able to derive the path loss factor from these measurements. After repeating the experiment in several different directions, the lognormal fading factor will be obtained.

Part 2: In the second part the transmitting node periodically sends packets with different power levels. The receiving node monitors the channel characteristic by estimating the packet delivery ratio vs transmit power (will be link sigmoid curve).

Jobs to be done:

1. **1st week:** Implement the system and program the sink for calculating the channel parameters.
2. **2nd week:** Finish the first part, study for making the prediction model for the second part.
3. **3rd week:** Start the second part.
4. **4th week:** Make the demo ready, write report and submit.

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Final Project #7
Optical Communication using MDA

The main objective of this project is use a laser beam (optical communications) for communication between motes. The idea is that a mote (attached to the MDA) gives interrupt through the MDA with different duration (to represent 0 and 1). This interrupt will switch on a laser. The mote placed on the other side reads the photo-sensor reading and decode whether this is 0 and 1.

Jobs to be done:

1. **1st week:** Study the MDA and how to send interrupt using the MDA.
2. **2nd week:** Generate interrupt voltage of different duration (to represent 0 and 1). Attach the output to a laser and check whether this is working or not.
3. **3rd week:** Read the photo reading on the receiver side.
4. **4th week :** Report your observations. If there are errors in bit, we need to do the reliability analysis (average bit error rate). Make the demo ready, write report and submit.

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Final Project #8
Soil Moisture Detection and Sprinkler Control

The main objective of this project is to develop a soil moisture detection node that uses a simple soil moisture probe using an MDA board. The moisture probe works on the principle of variable impedance that must be measured using the MDA and mote. When the moisture level drops below a level, a pump must be activated.

Jobs to be done:

1. **1st week:** Study the characteristics of the soil moisture probe to be supplied.
2. **2nd week:** Develop the code for soil moisture detection and calibration using the MDA.
3. **3rd week:** Develop the code for automatic activation of the motor to run the pump, to be supplied.
4. **4th week:** Test your scheme. Make the demo ready, write report and submit.

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Spring 2018
Final Project #9
Parking Lot Occupancy Detection

The main objective of this project is to develop a sensor network that will detect the number of available parking spaces available in a parking lot by detecting the number of cars entering and exiting the room by using a pair of motes equipped with photo sensors placed at the entrance and exit locations. These will be used by a base station to continuously update the occupancy and free spaces. The base station can update a table that can be accessed over the Internet in real time by a user, e.g. a Dropbox file.

Jobs to be done:

1. **1st week:** Study the characteristics of the photosensor in the MS310 for detecting people.
2. **2nd week:** Develop the code for reliable detection and counting of people. This count must be sent to the base-station whenever an entry or exit event occurs
3. **3rd week:** Develop the code for automatic updating of the occupancy file.
4. **4th week:** Test your scheme. Make the demo ready, write report and submit.

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Final Project #10
Restaurant Paging System

The main objective of this project is to develop an automatic paging system for use in restaurants for announcing table availability. The base station will be connected to a computer that will take inputs from guests (# of people in the table). This will be saved in a table and a mote will be automatically programmed (change LED to RED) for the customer to pick up. When a table of the size is available the server enters the information and the corresponding mote light up GREEN. Priorities and table updates are to be set automatically by the BS code.

Jobs to be done:

1. **1st week:** Develop the coding scheme.
2. **2nd week:** Develop the communication code.
3. **3rd week:** Develop the code for automatic programming of information and communication with motes.
4. **4th week:** Test your scheme. Make the demo ready, write report and submit.

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Spring 2018
Final Project #11
Accelerometer for counting steps

The main objective of this project is to enable a sensor mote equipped with the MTS-310 sensor board to detect steps, when placed on the body. The main requirements of this project are:

1. Distinguish between walking steps and running steps
2. Maintain counters in the mote for:
   - Number of steps walked
   - Number of steps run
3. Transmit these counters periodically to the base station so that when the person in close to the base station, it receives the counts and displays on screen.

Jobs to be done:

1. **1st week:** Study the accelerometer readings for different movements while the sensor mote is on the body: walking versus running characteristics.
2. **2nd week:** Develop a method to identify states (will go to 3rd week as well). Do your research on how these are done in apps in smartwatches, etc.
3. **3rd week:** Finish and test the program for the measurement tool.
4. **4th week:** Make the demo ready, write report and submit.

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<u>Final Project #12</u>
Spectrum Classifier

The main objective of this project is to implement automatic spectrum classification scheme of sounds obtained from the microphone. The project requires the following tasks:

1. Implement a DIT FFT algorithm of the highest order possible for implementation in the mote. You may get the pseudo code or the complete code online. Test it.
2. Develop an application that will take a certain number of samples (e.g. 256) of the microphone signal at 1KHz sampling rate (use the millisecond timer) and save it in an array. After sampling, pass the array to the FFT and obtain the following:
    - $C_1 =$ The power of the signal in the frequency band: 0 – 250 Hz.
    - $C_2 =$ The power of the signal in the frequency band: 250 – 500 Hz.
3. Display the result as following:
    - If $C_1 > C_2$: turn the green LED on
    - If $C_1 < C_2$: turn the red LED on
    -

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Jobs to be done:

5. **1st week:** Determine the sampling rate possible with millisecond timer and microphone. Also search for FFT routines.
6. **2nd week:** Implement the FFT in the mote
7. **3rd week:** Finish and test the application, check the level of accuracy.
8. **4th week:** Make the demo ready, write report and submit.