

Introduction

Background Information

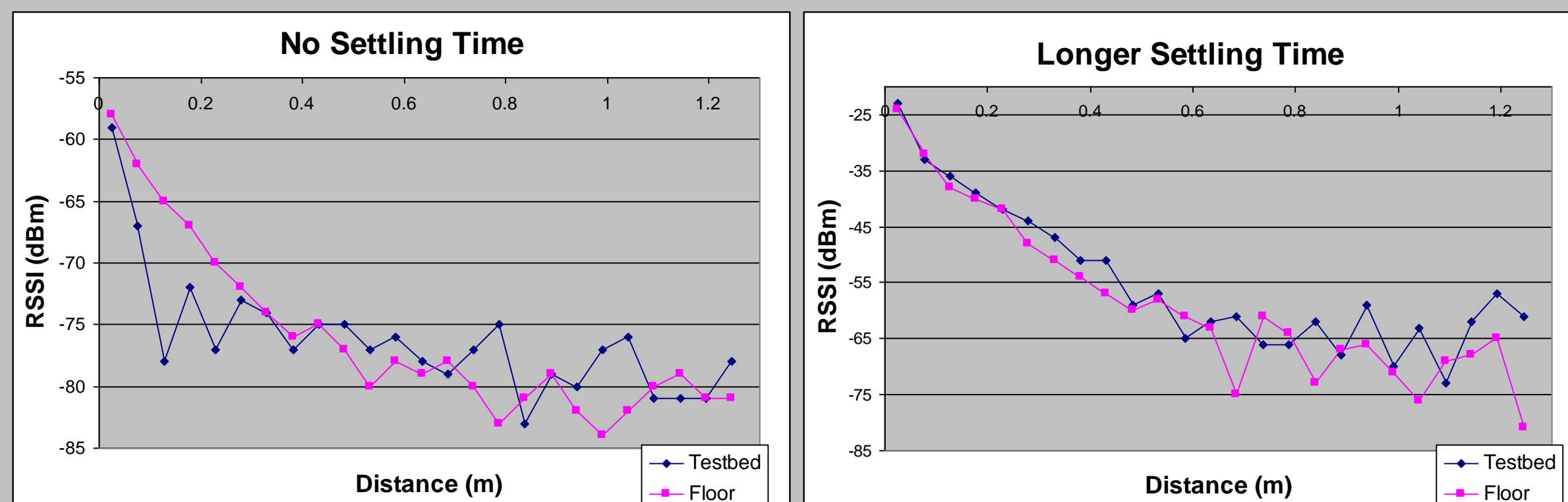
- Received Signal Strength Indicator (RSSI) distance measurement algorithm 1ft off the ground (E. Kenyon)
- Centralized movement simulation algorithms in Matlab (A. Turner)

Project Goals

- Learn to program on the EZ430RF2500 TI microprocessor development board
- Test the reliability of using **RSSI** for distance measurement at close distances
- Improve the RSSI distance sensing algorithm
- Develop and implement **Time Difference of Arrival** (TDOA) distance sensing
- Develop a **communication protocol** for the robots

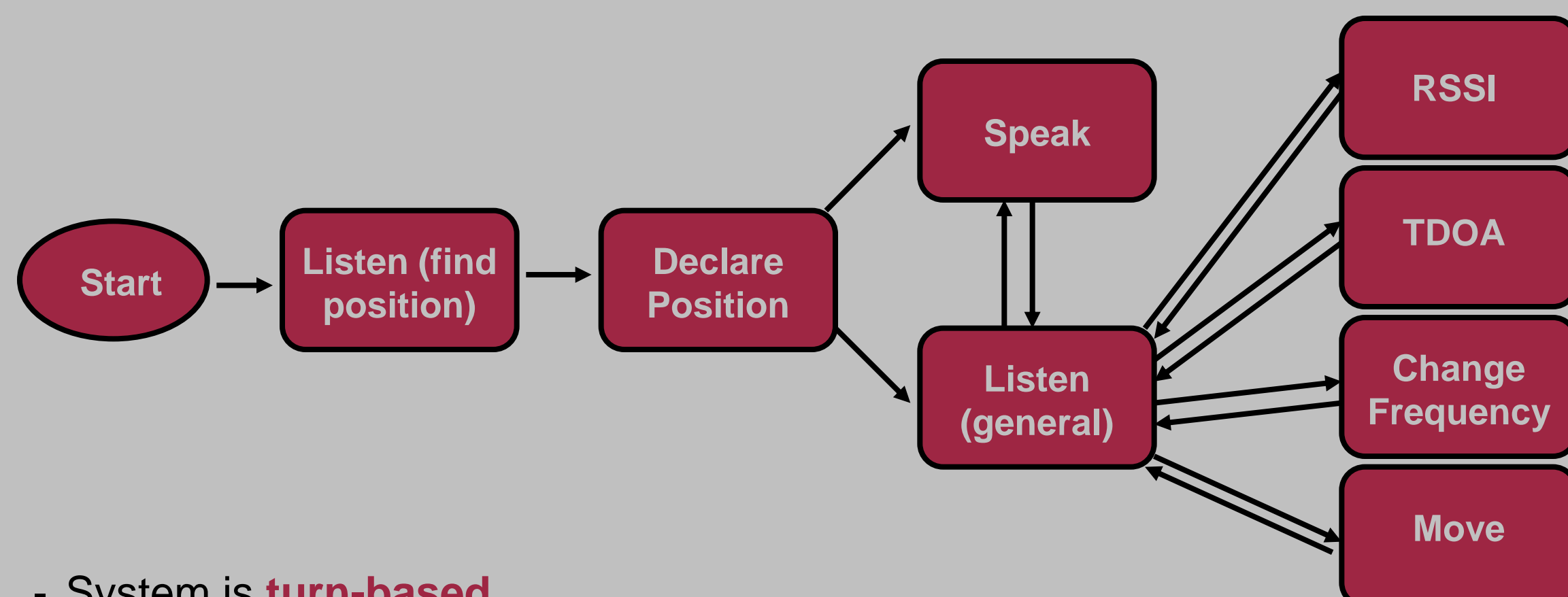
Received Signal Strength Indicator

The power present in a radio frequency signal is used to approximate the distance of the source



- RSSI detects distance accurately at less than 0.5 m
- Longer settling time and averaging are necessary on some surfaces
- Algorithm takes up to 4.7 seconds per reading

Communication Protocol



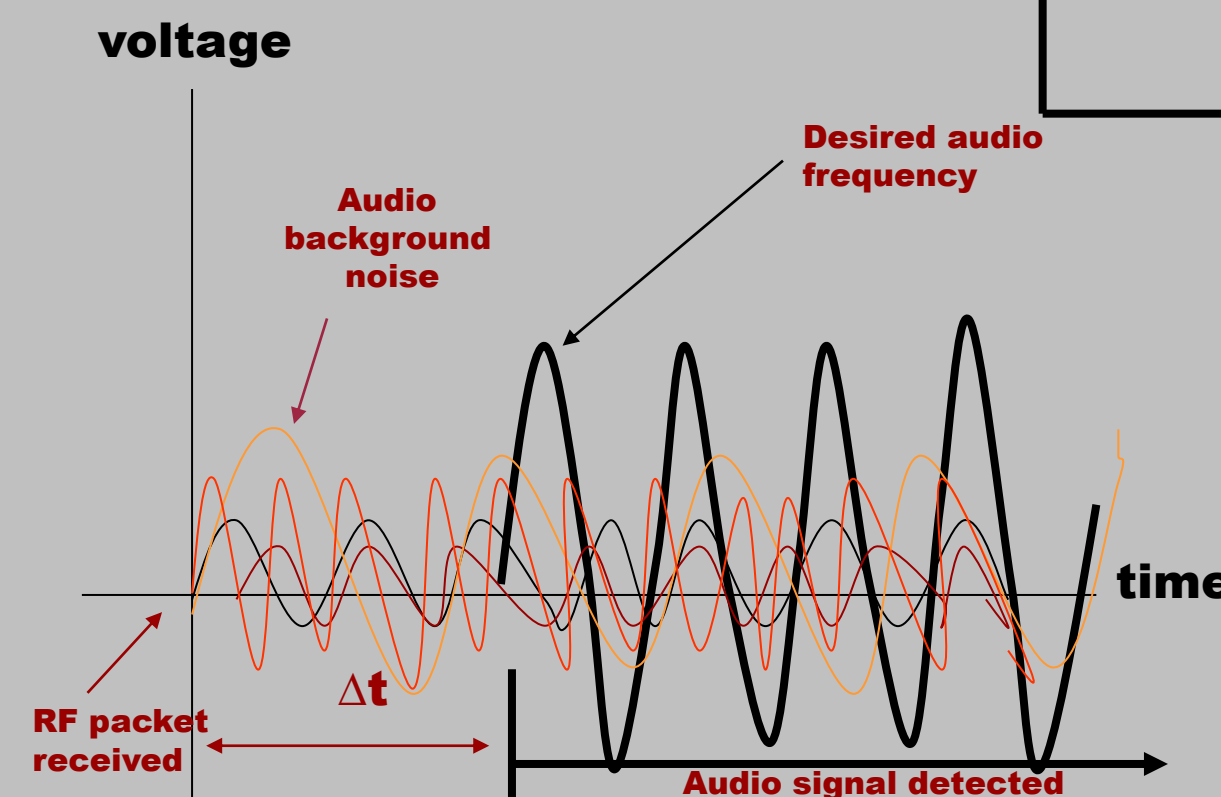
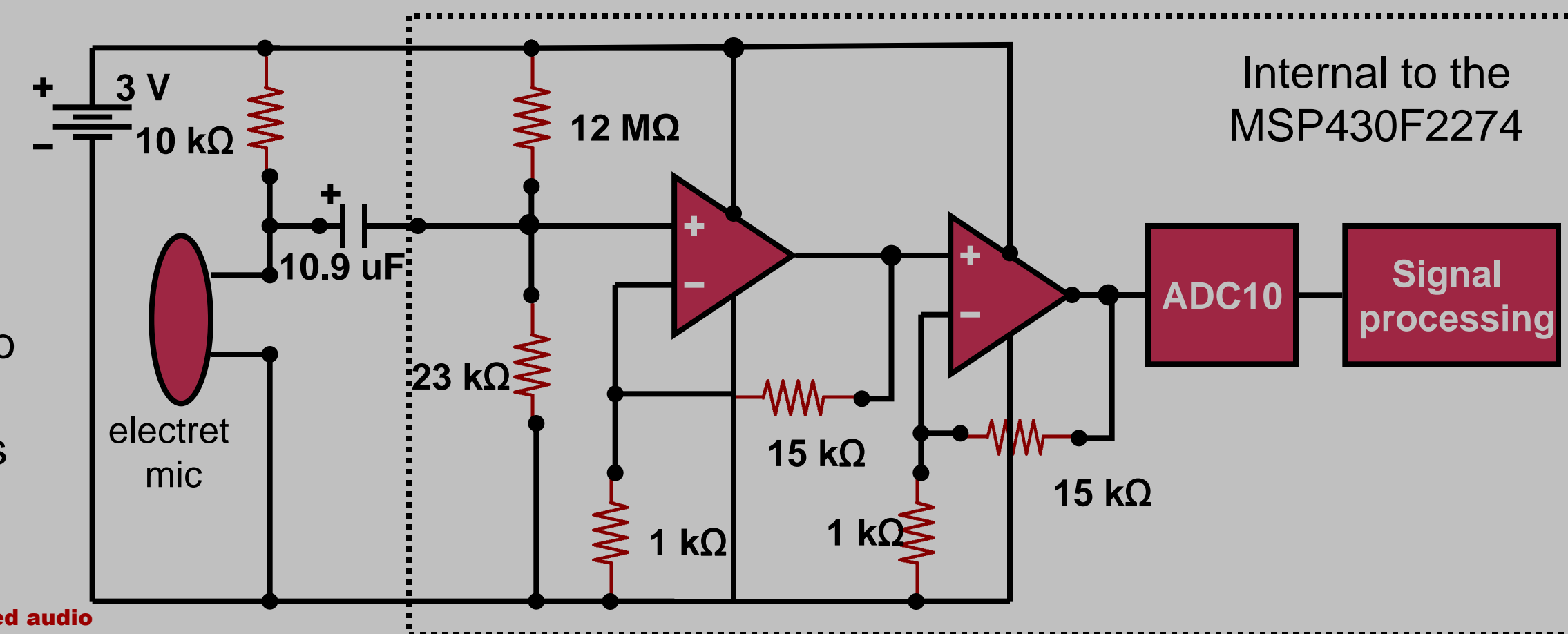
- System is **turn-based**
- Protocol allows swarm to **adapt** to the insertion and/or removal of other robots
- Each robot is of equal status (leaderless system)
- Protocol is written in a **modular fashion** to simplify further modifications

Time Difference of Arrival

The difference in time between receiving a RF packet and an audio pulse is used to estimate the distance between the receiver and the source

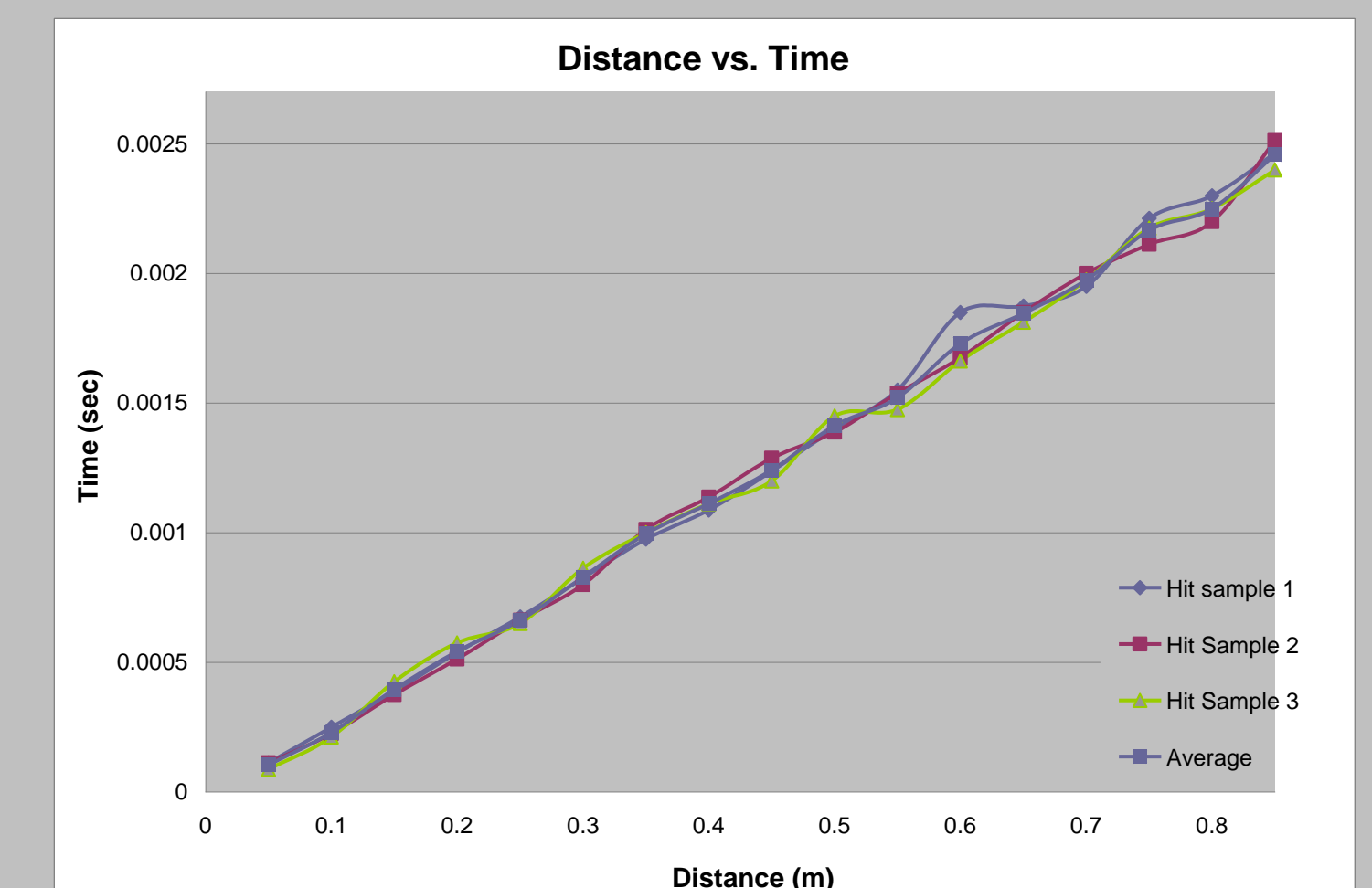
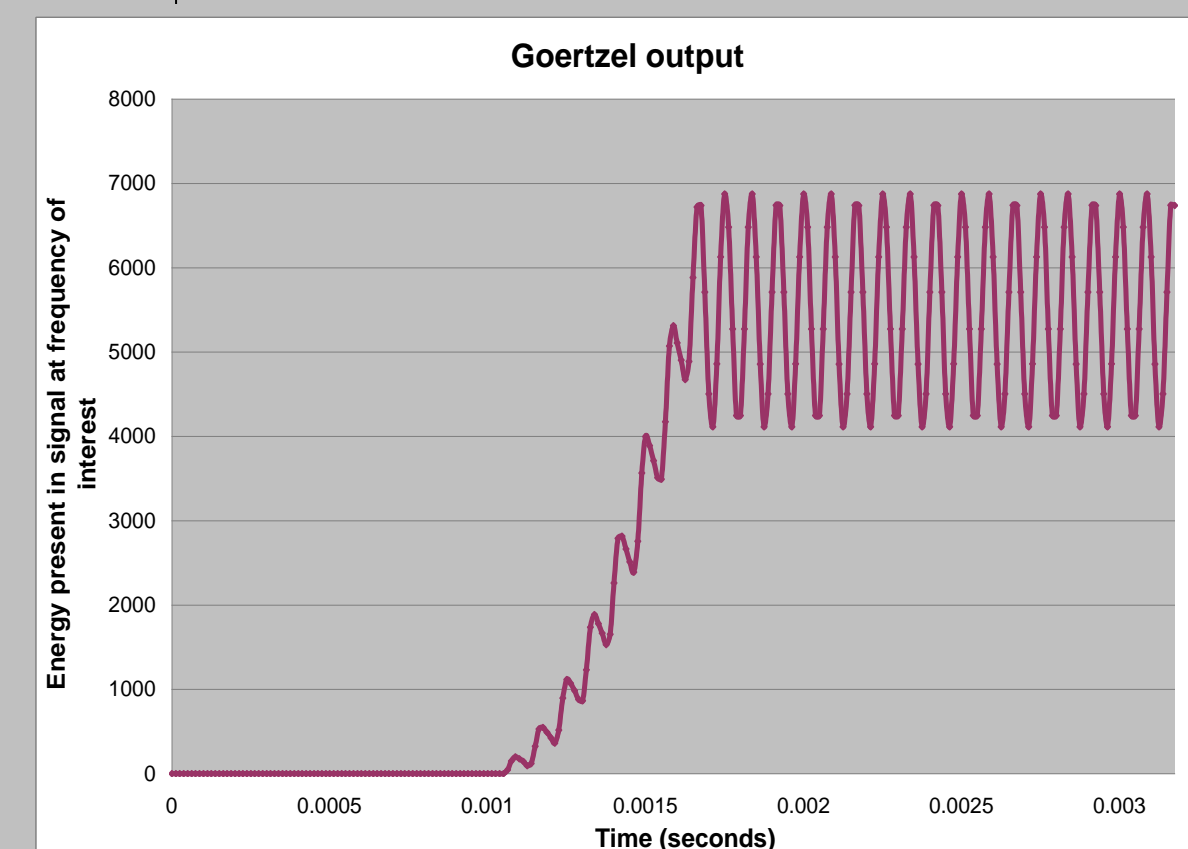
Hardware

- Implemented TDOA circuits using the MSP430
- Only the electret microphone biasing is external
- All amplification and analog to digital conversion is done using embedded components



Signal Processing

- On receipt of the RF "lightning" signal, a burst of 255 samples is taken from the microphone.
- The **Goertzel algorithm** is used to detect the presence of the frequency of interest.



- There is a linear relationship between the elapsed time before detection and the distance of the microphone from the sound source

Conclusion and Future Work

- With some optimization, RSSI can be used accurately at close range (< 0.5 m), and TDOA can be used at farther distances (0.10 m – 0.85 m).
- The proposed communication protocol should ease the overall integration of the movement algorithms and distance sensing techniques.
- In the future, we would like to improve the speed and efficiency of all algorithms, learn to better utilize on-chip resources (ex. flash memory, low power modes, etc.), and implement all algorithms on the finished robots.