

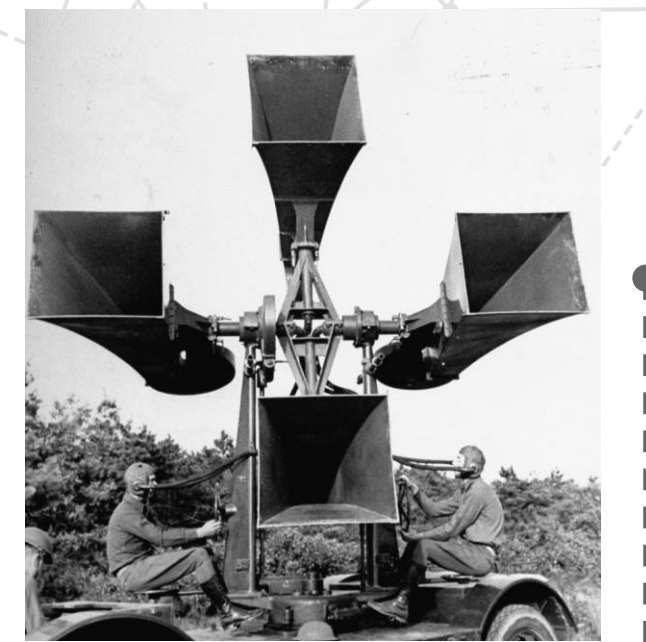
PASSIVE ACOUSTIC RADAR



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Project Objective

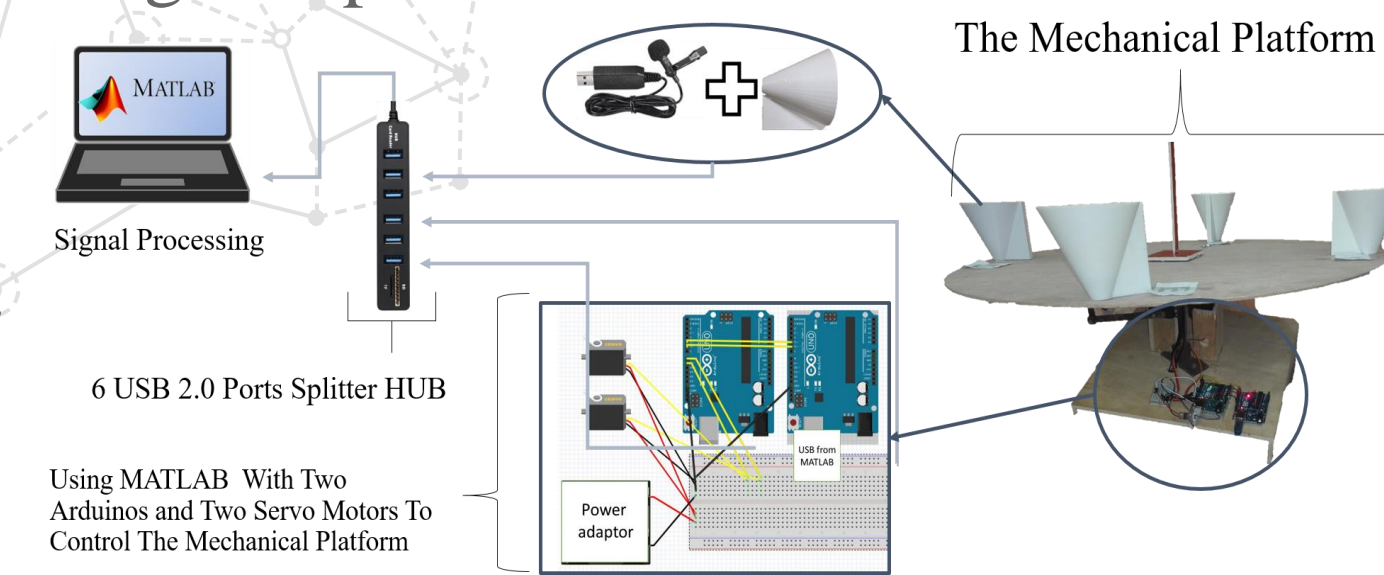
To build, prototype and test a passive acoustic radar. The radar is designed to track a 3D acoustic source movement of single tone frequency in a range (6.5 to 8.5) kHz.



System overview

The system has the following components:

- Acoustic receptors.
- Data aggregator
- Direction discriminator.
- Mechanical platform.
- Servo Motors
- Motion Controller.



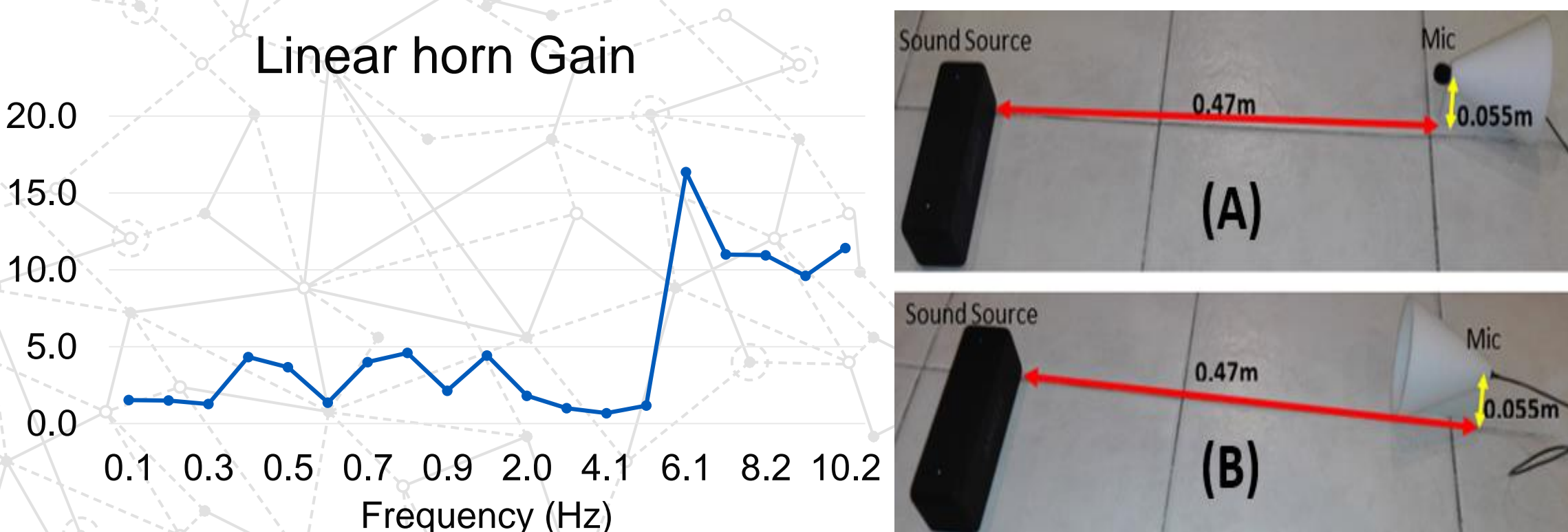
Acoustic receptors

An acoustic receptor consists of the following:

- USB microphone to act as an acoustic (sound) sensor.
- Acoustic Mechanical Amplifier.

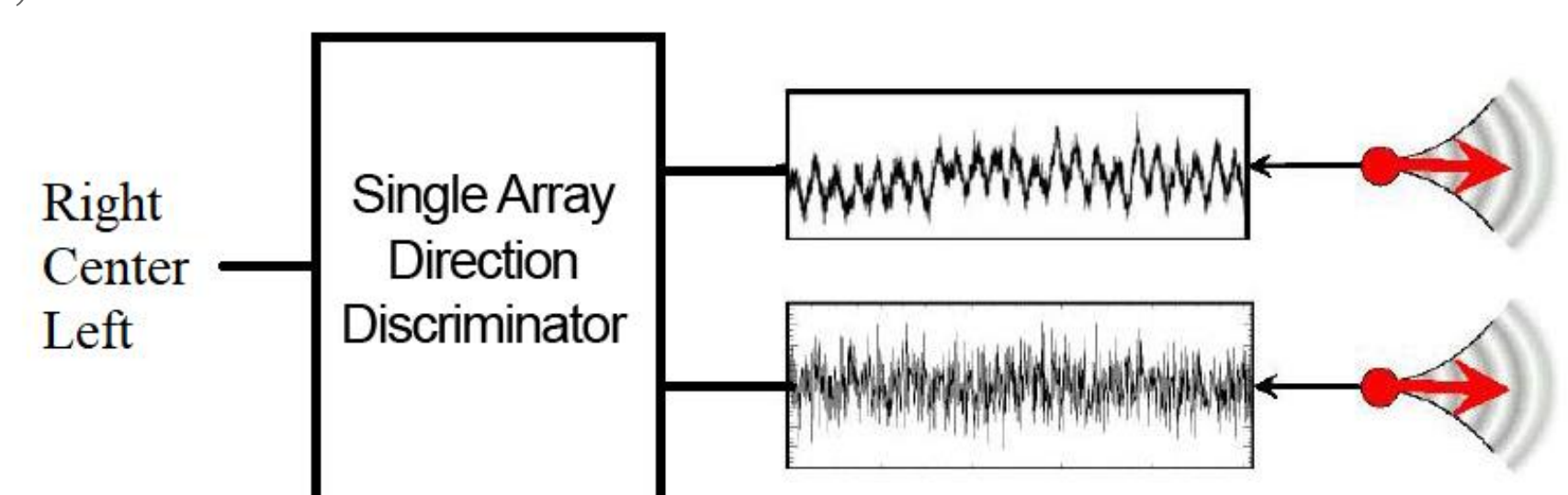


The Horn- Microphone unit is design and tested to have a large amplification relative to the microphone alone in a range of (6.5 to 8.5) kHz.



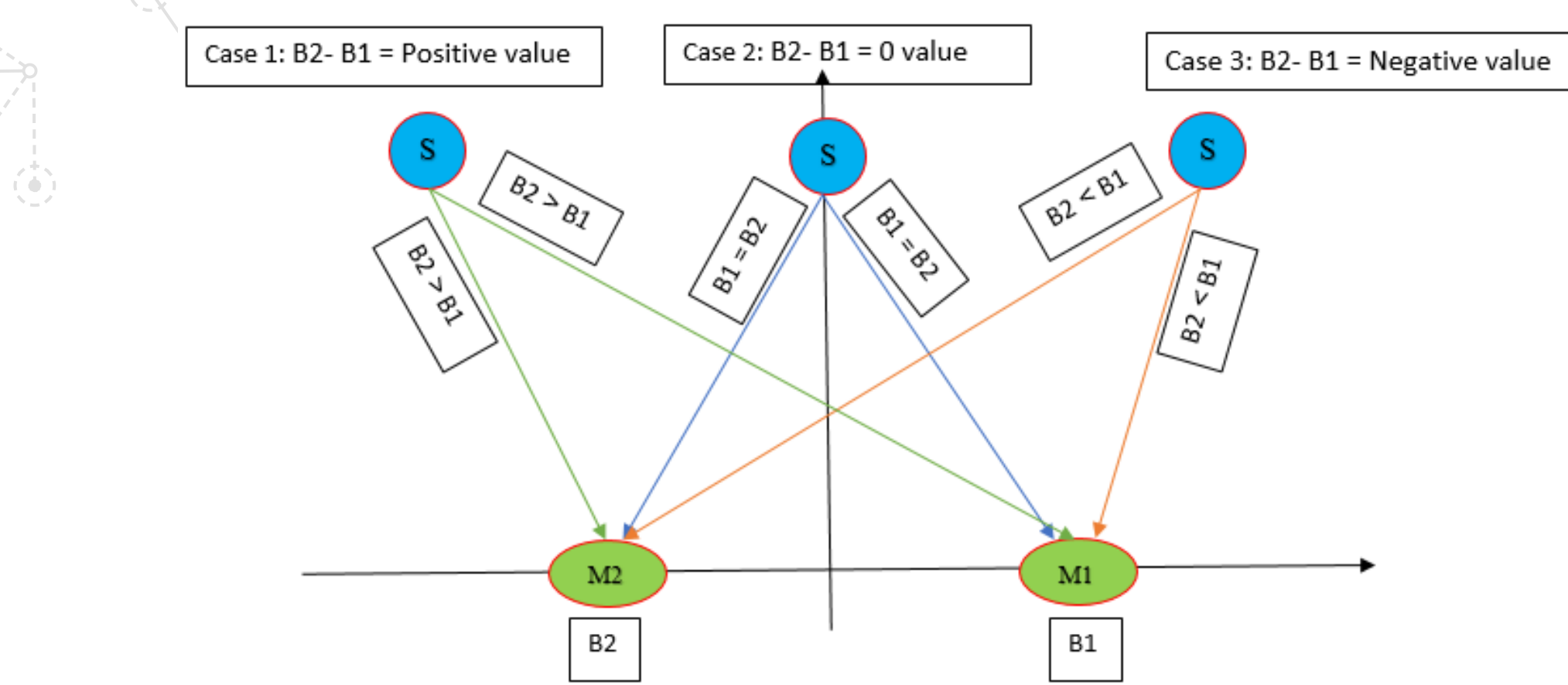
Direction Discrimination

Direction is based on a linear array that has two acoustic elements. The objective to know if acoustic source is to the right, left or center



An Algorithm based on the received sound intensity of each acoustic element is developed to localize the source with respect to the array center line.

$$\Delta B = 10 \log_{10} \frac{A_2^2}{A_1^2}$$

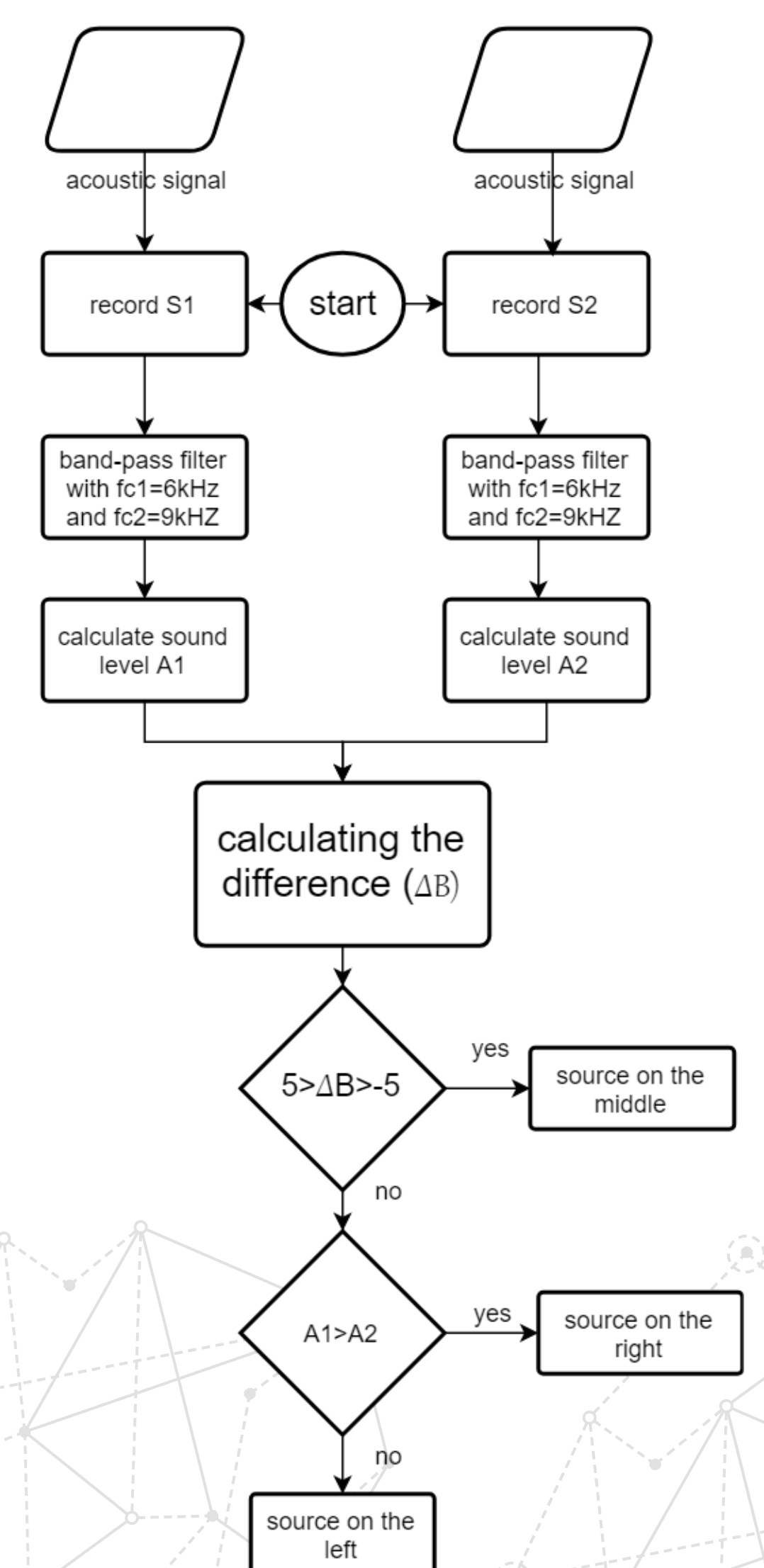


Mechanical platform

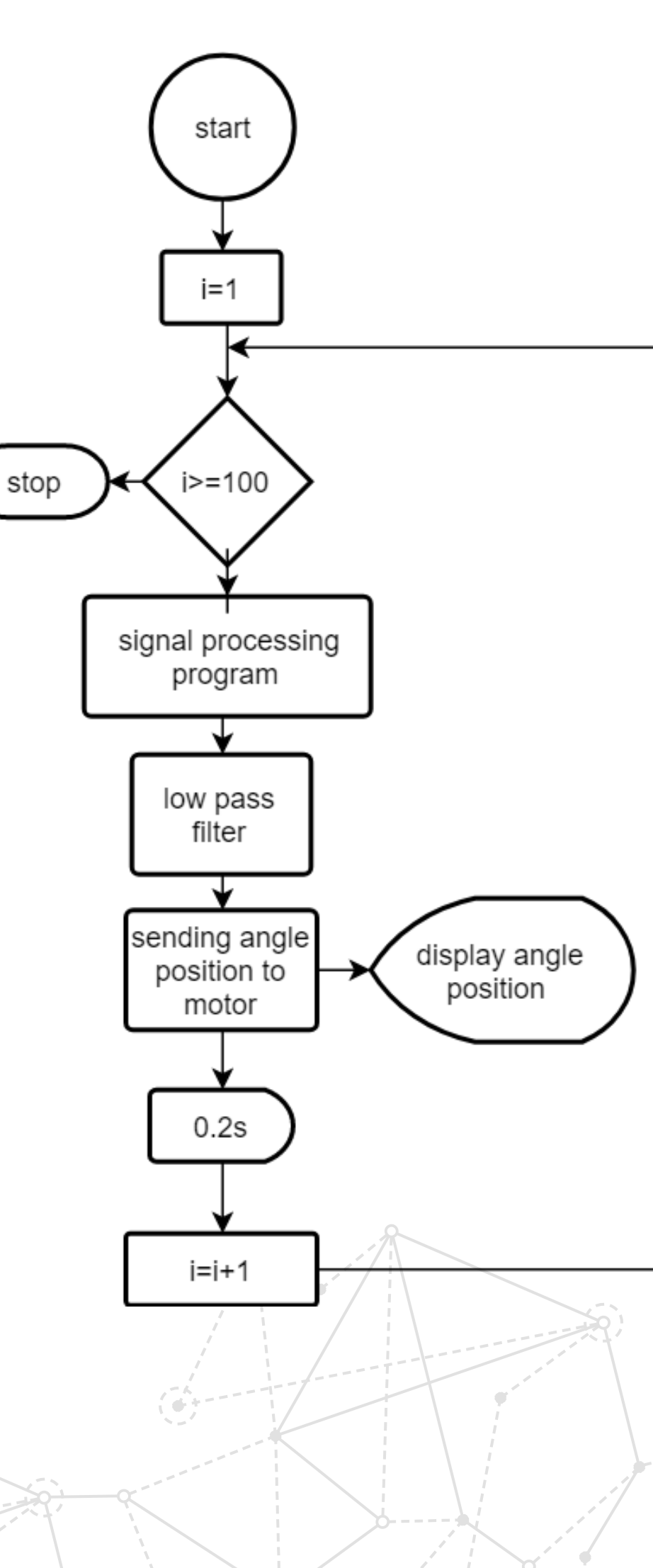
The mechanical platform is suspended by a universal joint. Two servo motors are used to actuate the motion along two orthogonal axes of the platform. The motors are controlled by two Arduinos microcontrollers which are connected to signal processor on MATLAB.



Direction discriminator flow chart

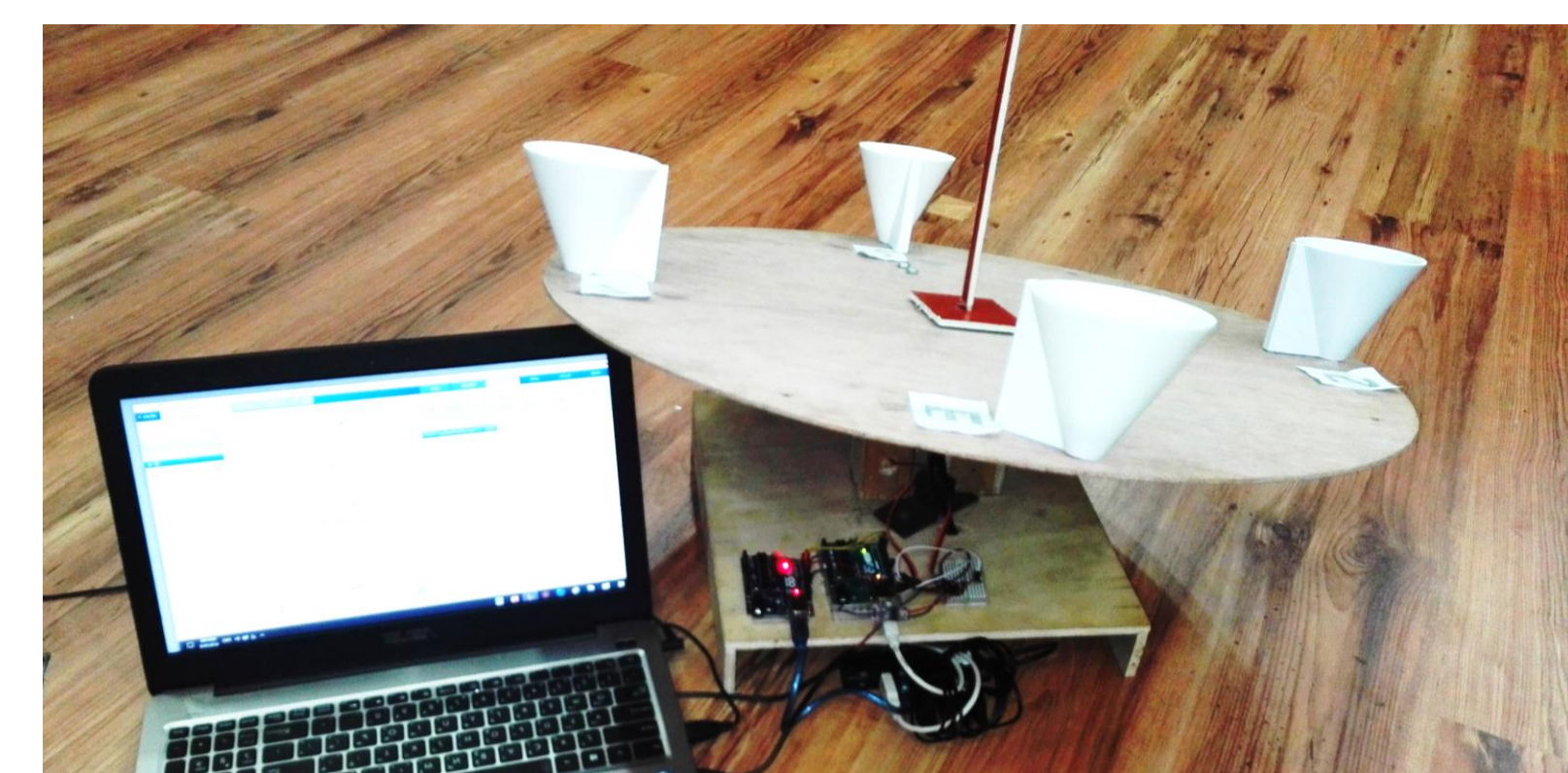
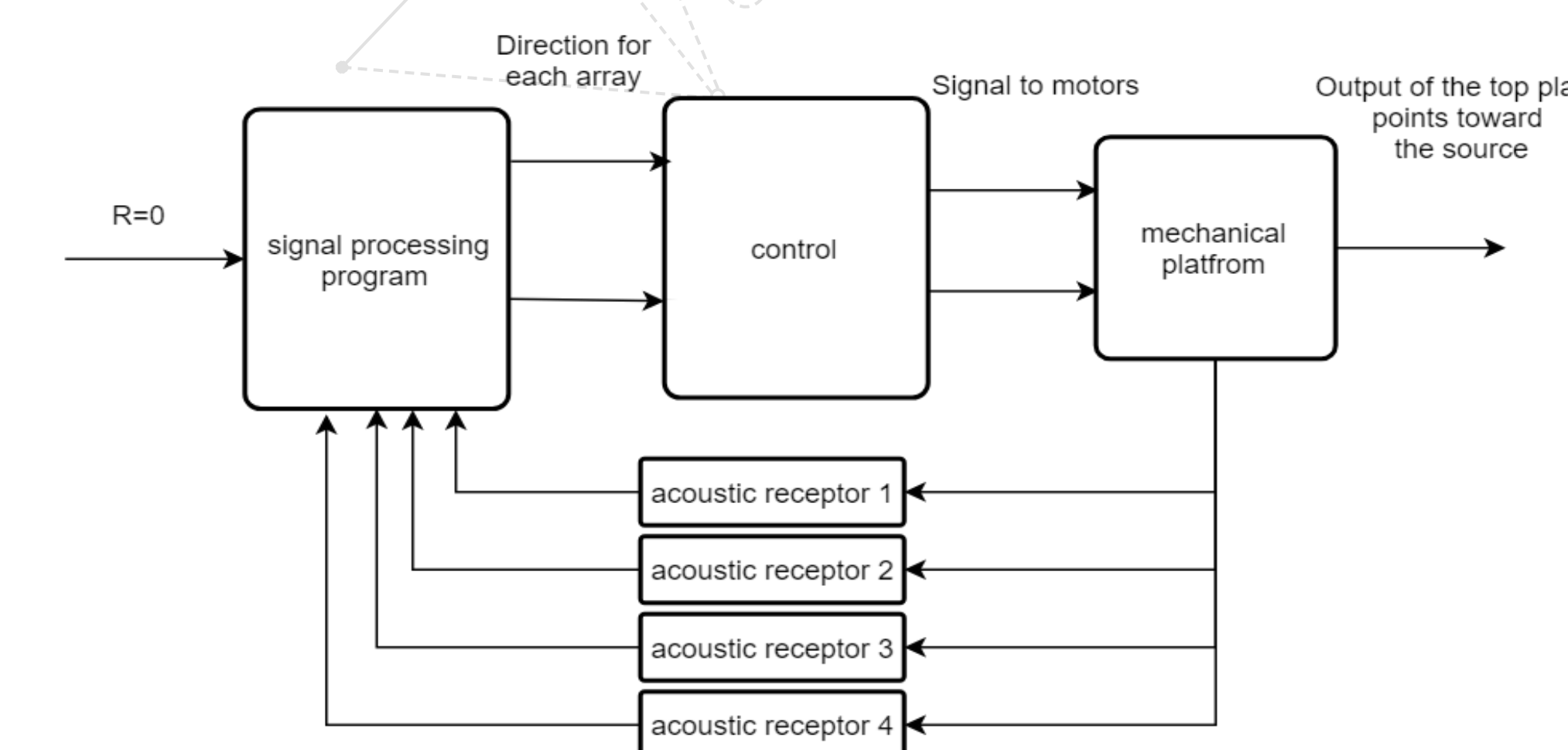


Motor Control flow chart



Integrated System

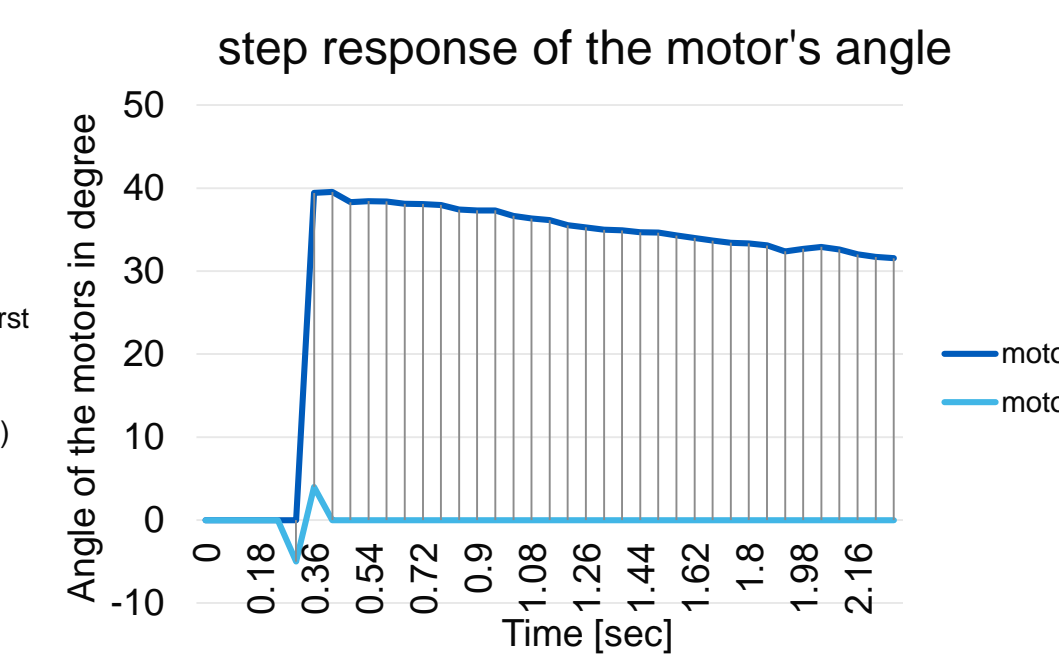
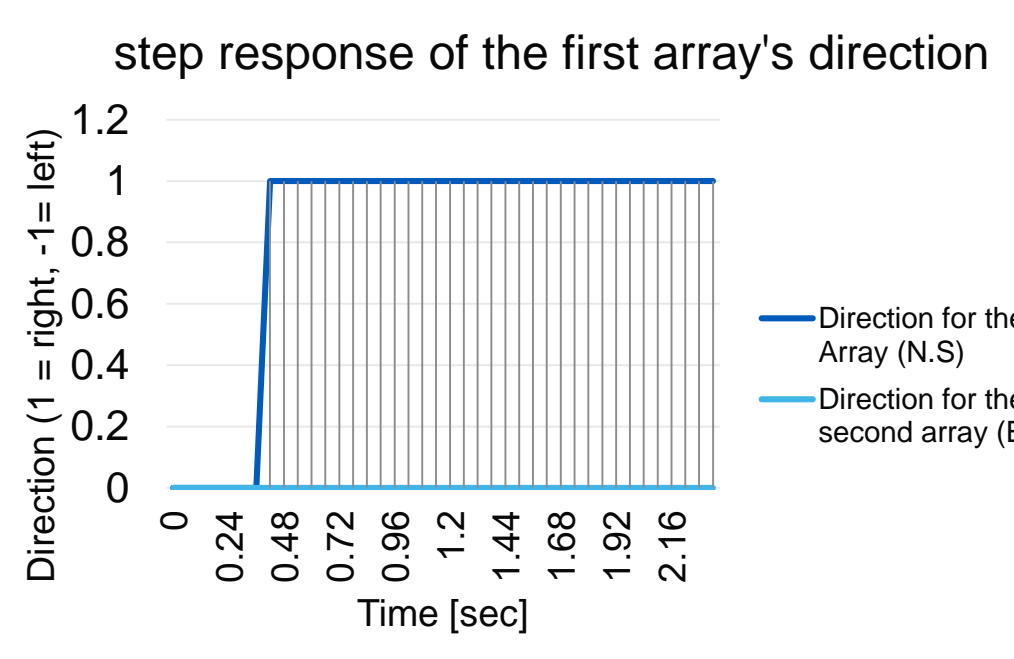
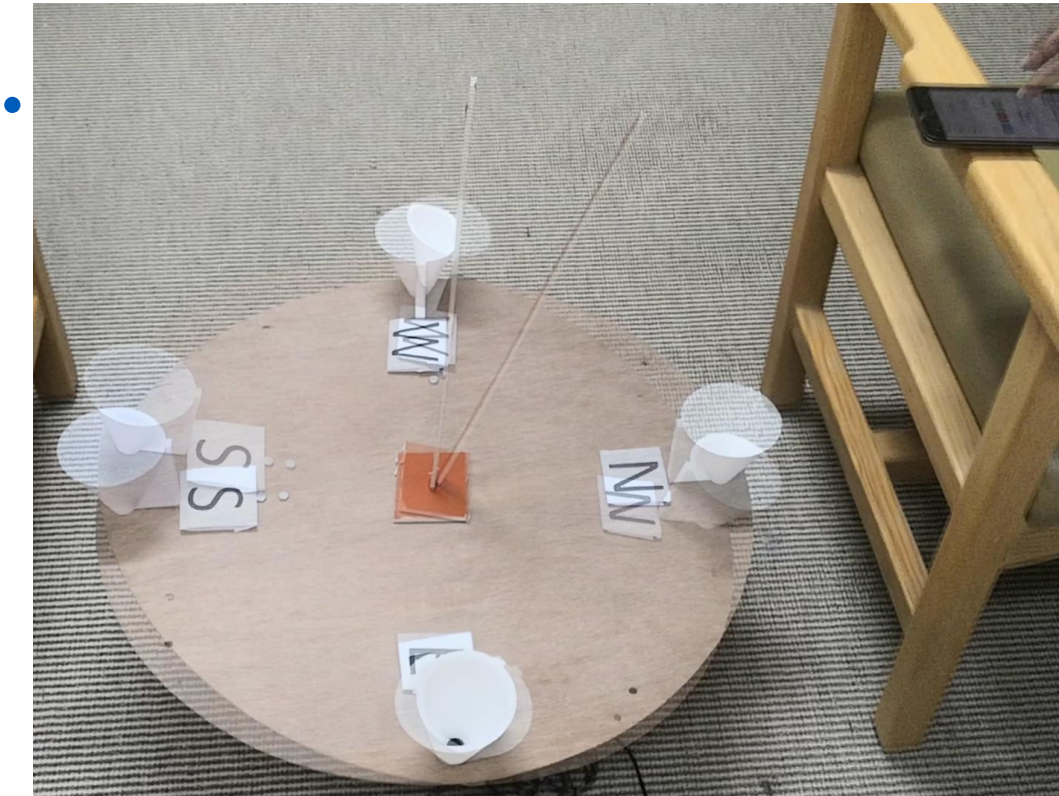
The components are integrated in the feedback configuration to construct the overall passive radar system



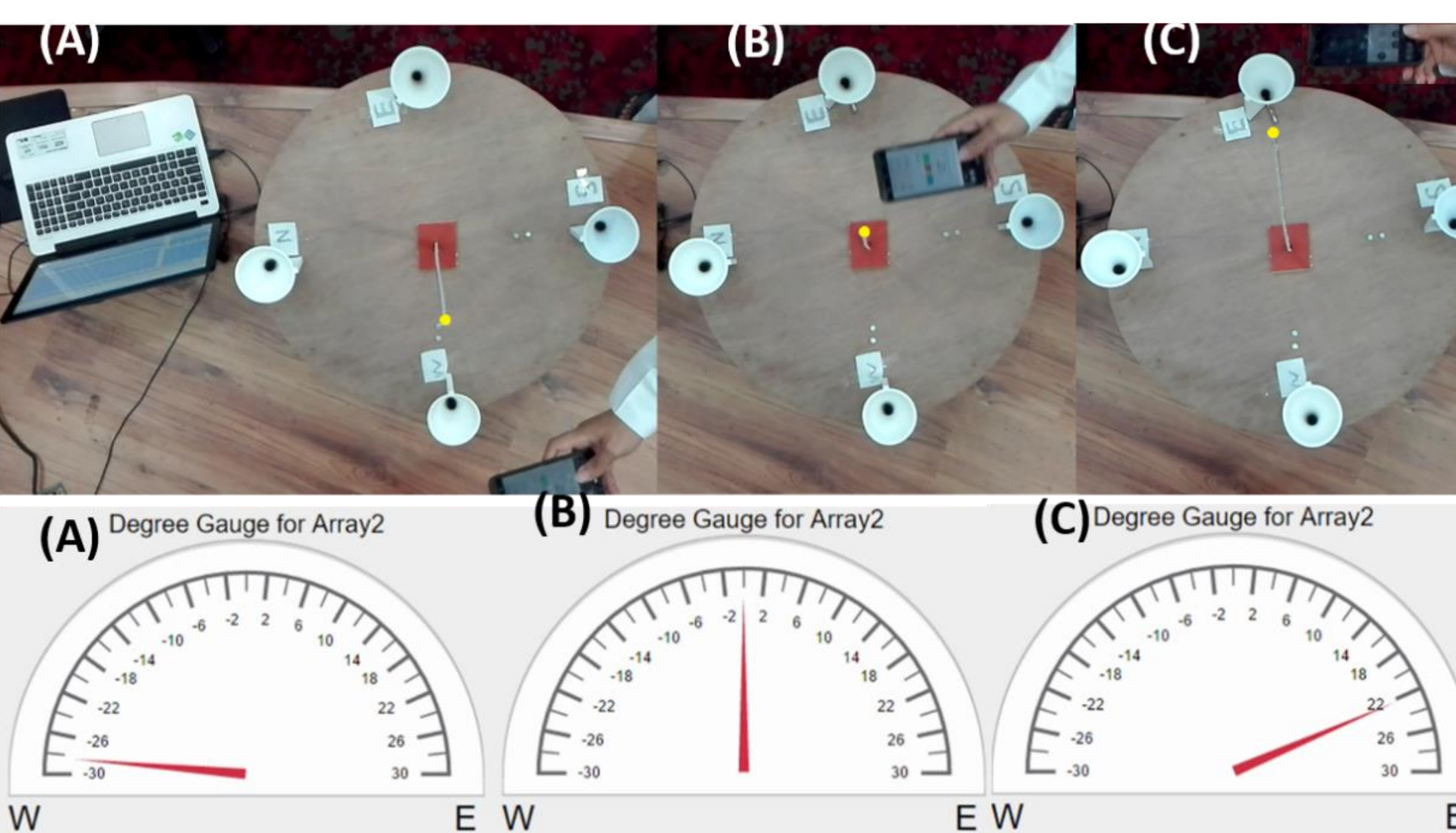
Testing and Results

Platform step response.

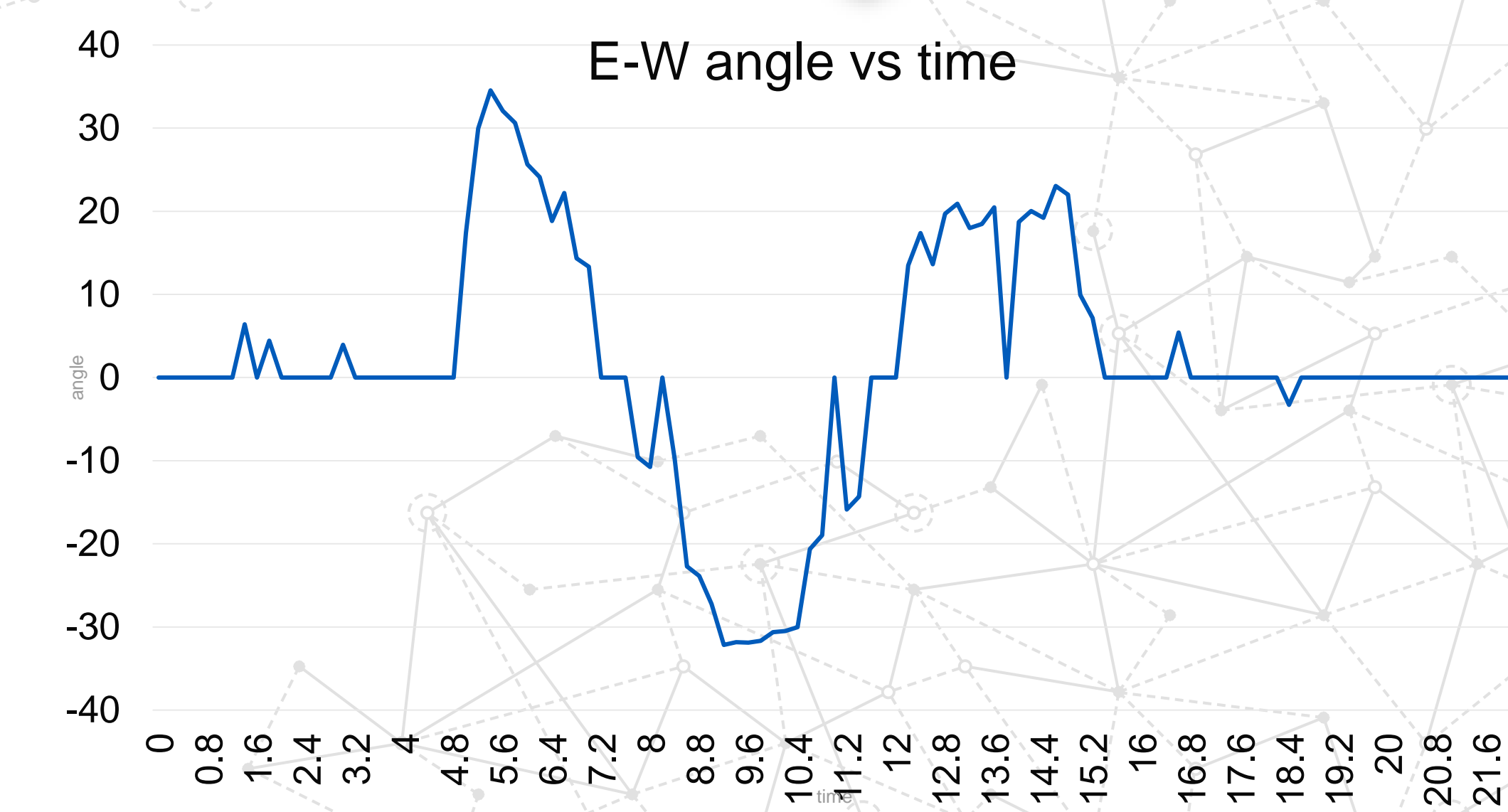
The platform step response test for stationary source was performed near the North receptor.



Single array movement test (West-East).



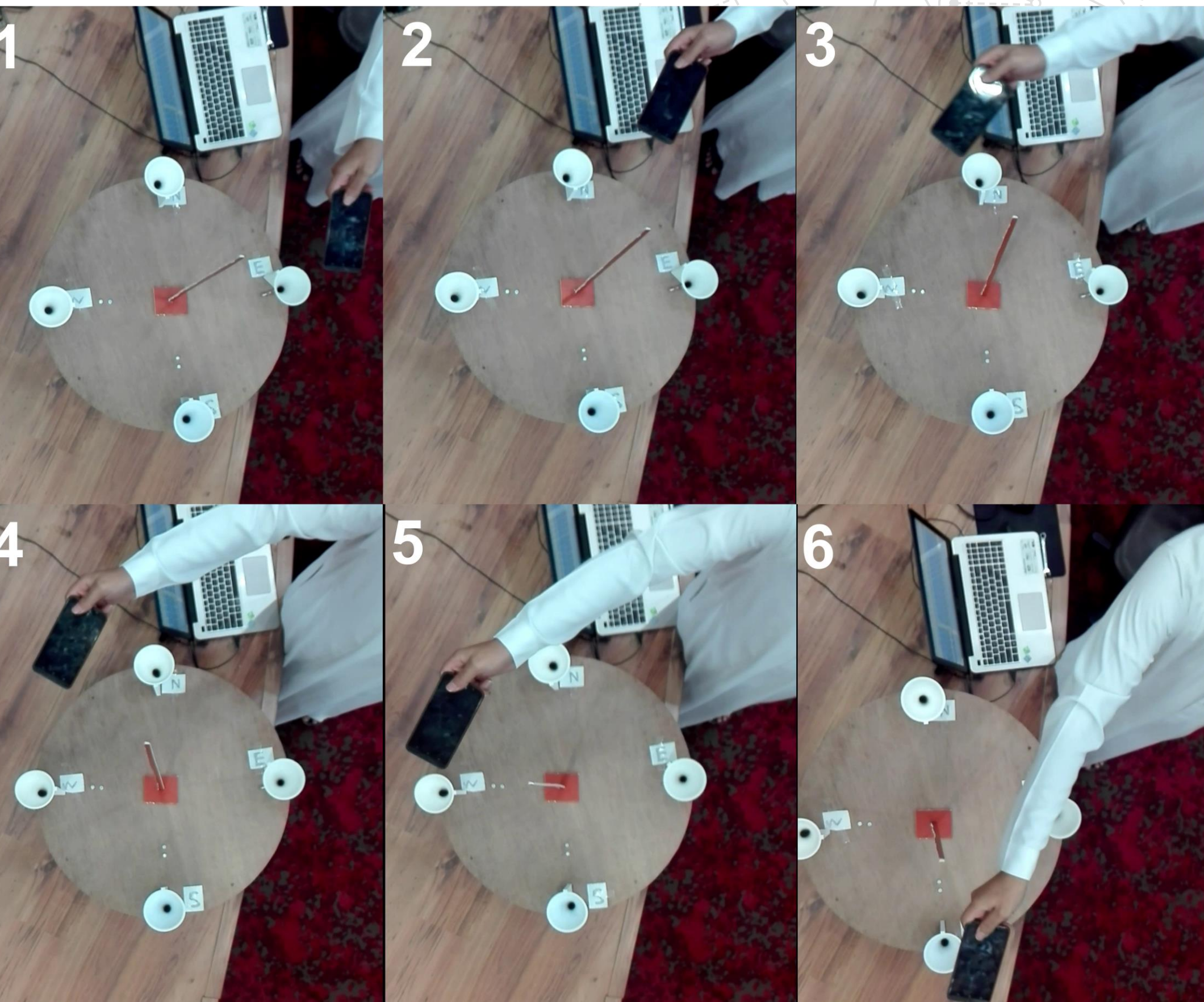
Three different locations of the source with its corresponding read angle from MATLAB in a form of gauges.



Angle position response for one array test versus time

Full system tracking test

This test demonstrate the ability of our system to track a random motion of an acoustic source in 3 dimensional space



Conclusion

- The design, implementation and testing of basic passive acoustic radar was successfully accomplished.
- The platform step response test proves the efficiency of our project in terms of time delay for the response to the acoustic source.
- The full system tracking test proves the full desired functionality of our project.