InnovateFPGA
2019
Grand Final

AS026

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iOwlT: Sound Geolocalization System

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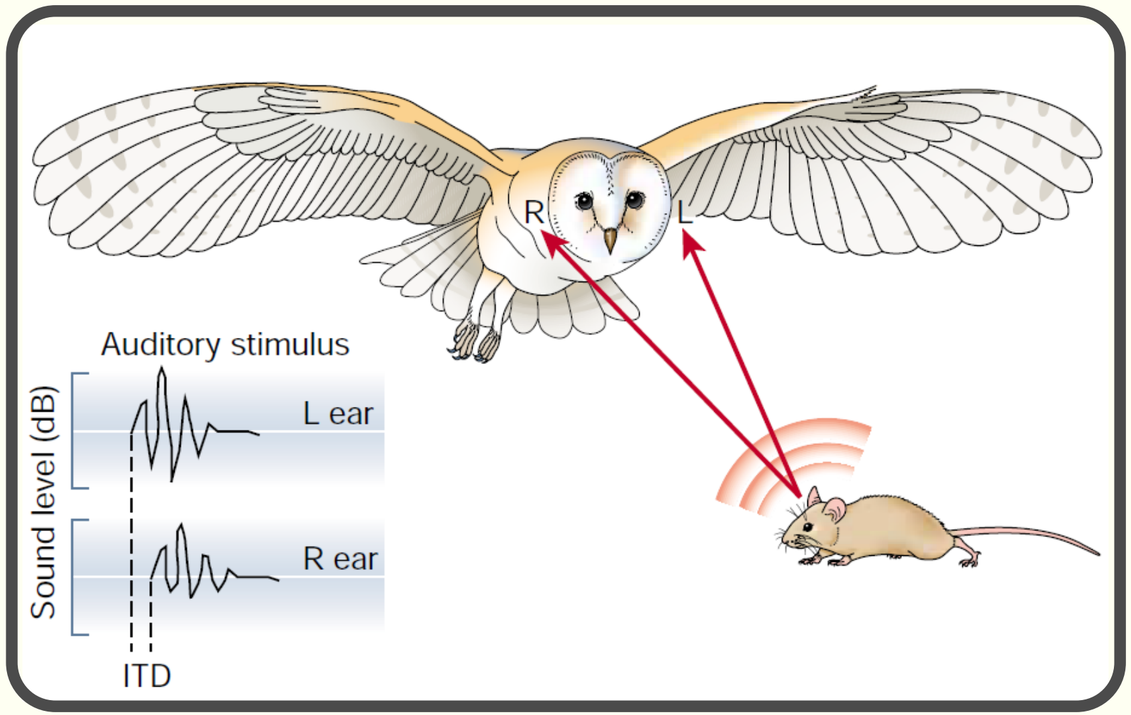
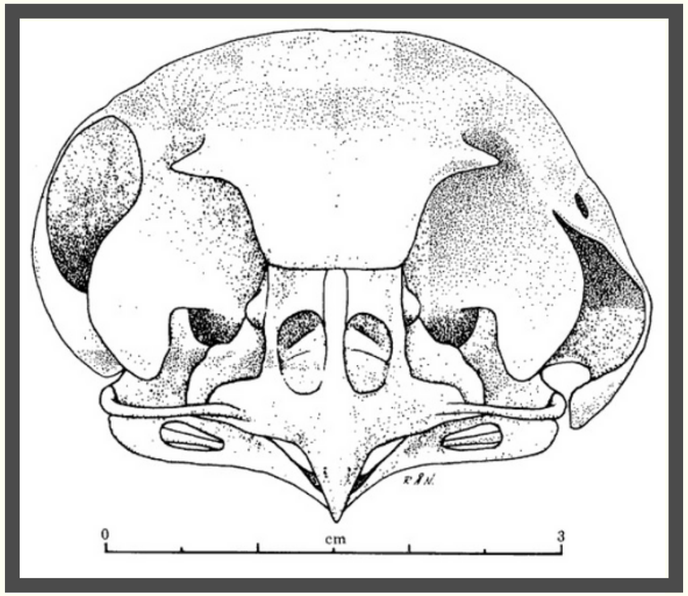
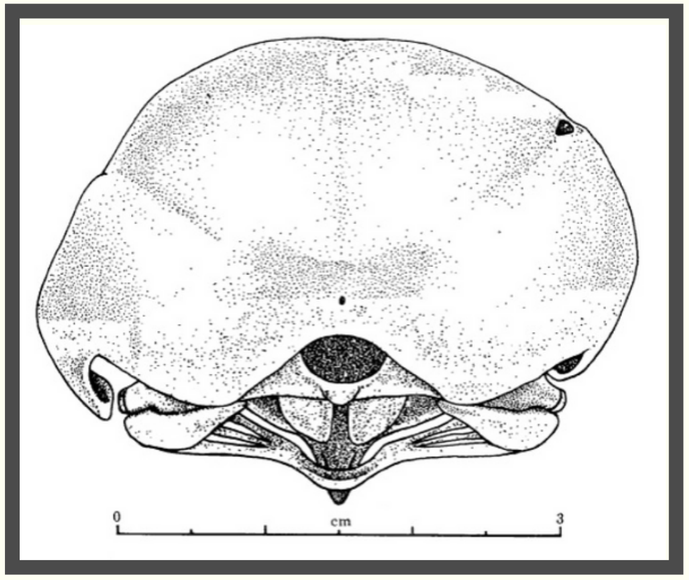
ELECTRONICS

MOTIVATION

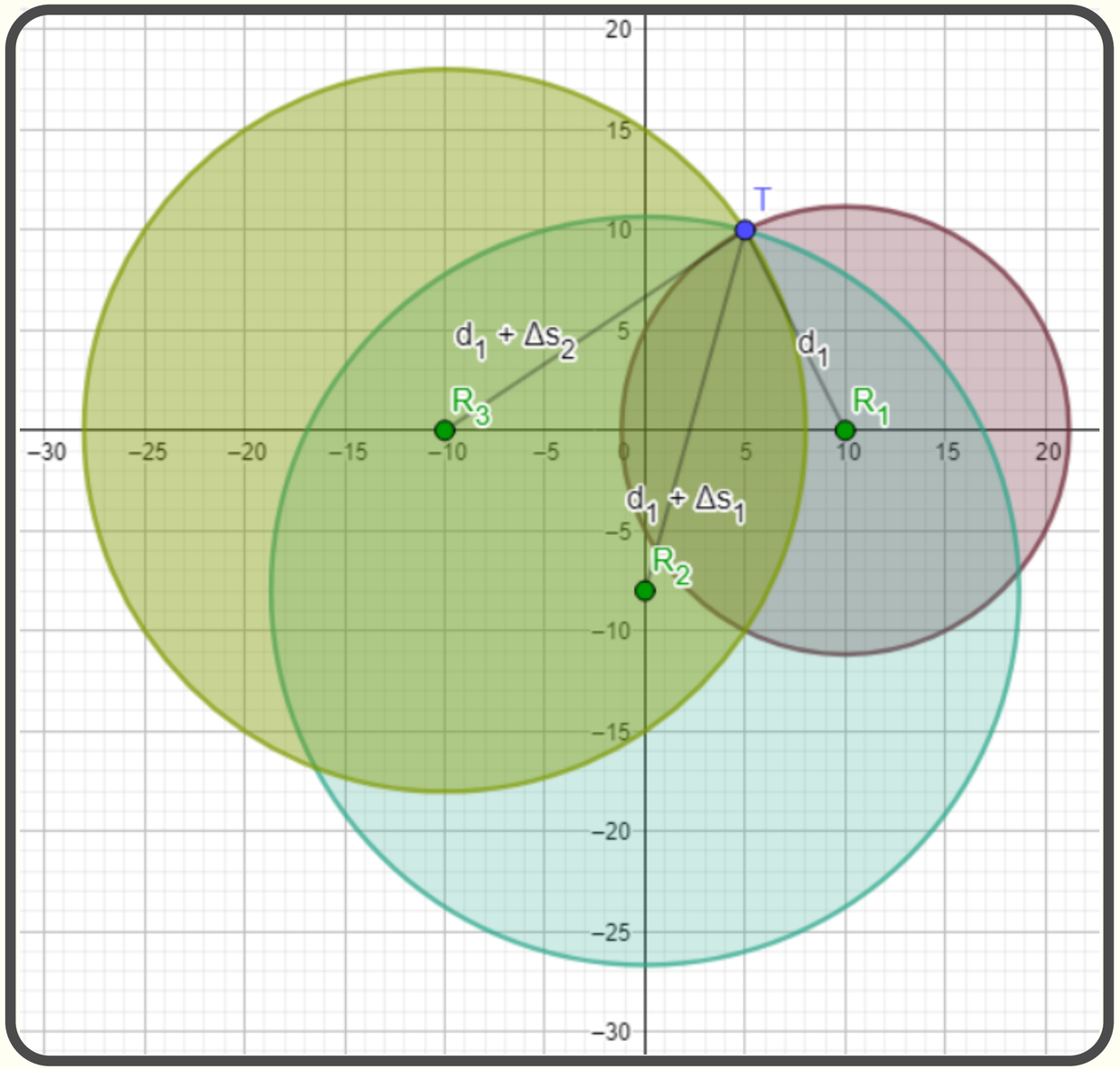






iOwlT

MOTIVATION



$$C_1 : (x - x_1)^2 + (y - y_1)^2 = d_1^2$$

$$C_2 : (x - x_2)^2 + (y - y_2)^2 = (d_1 + \Delta s_1)^2$$

$$C_3 : (x - x_3)^2 + (y - y_3)^2 = (d_1 + \Delta s_2)^2$$

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MOTIVATION

"Brazil leads the ranking of firearm deaths in the world"

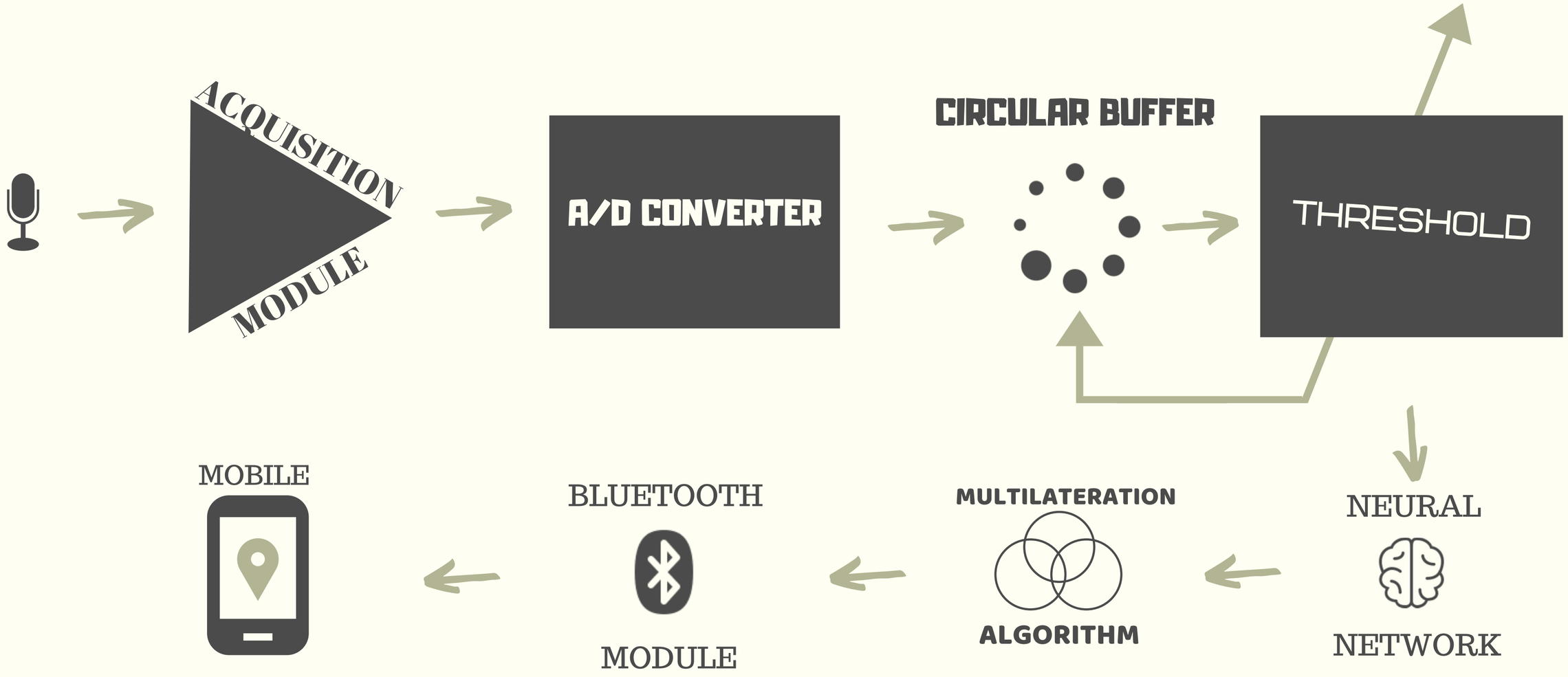
- Correio Braziliense -

"Nearly 40,000 people died from guns in US last year, highest in 50 years"

- The New York Times -

iOwIT

SYSTEM OVERVIEW



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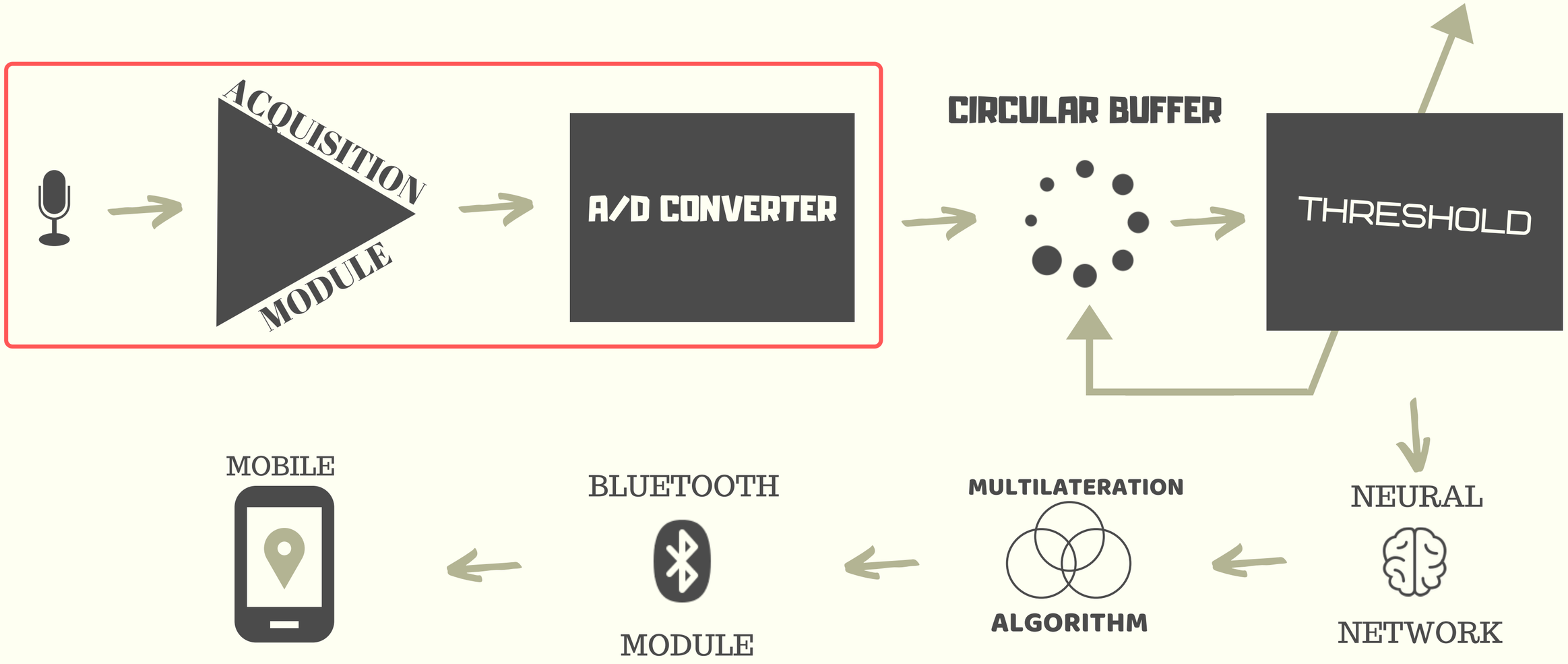
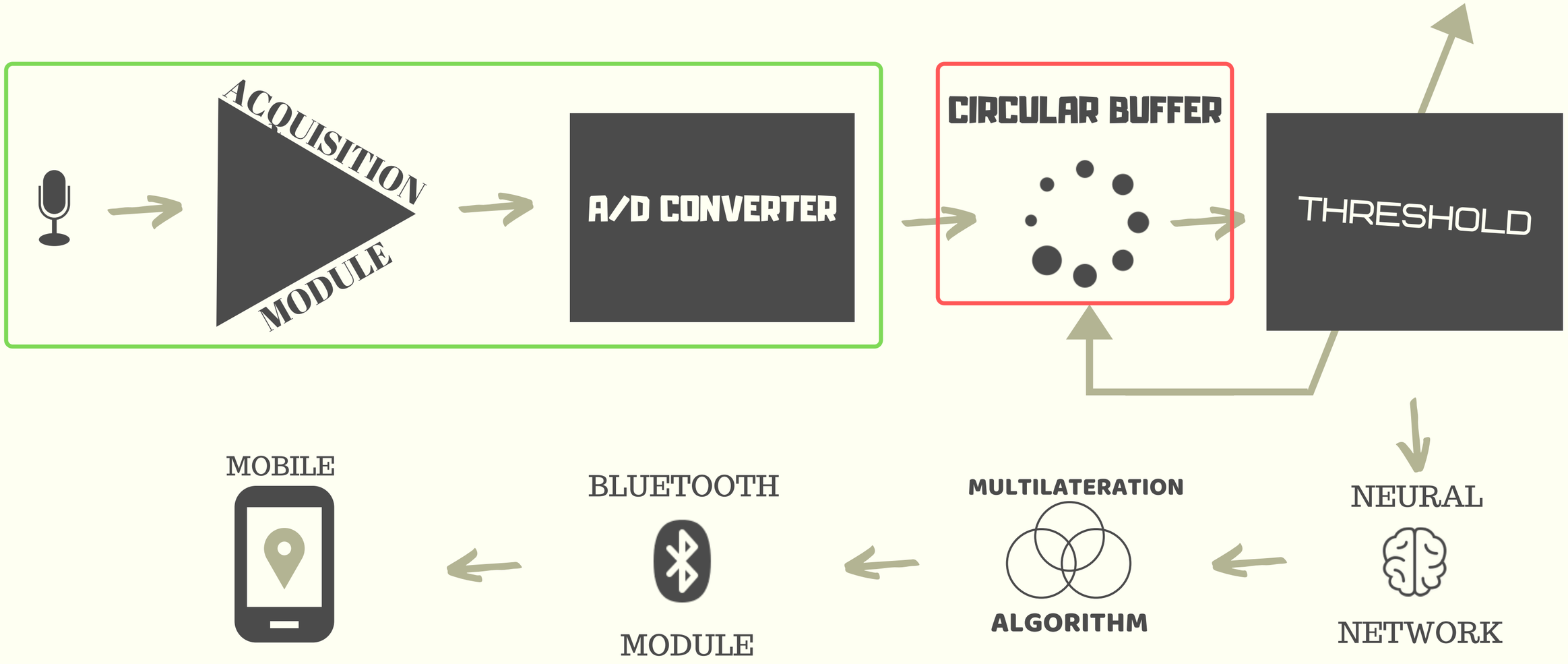


ACQUISITION MODULE

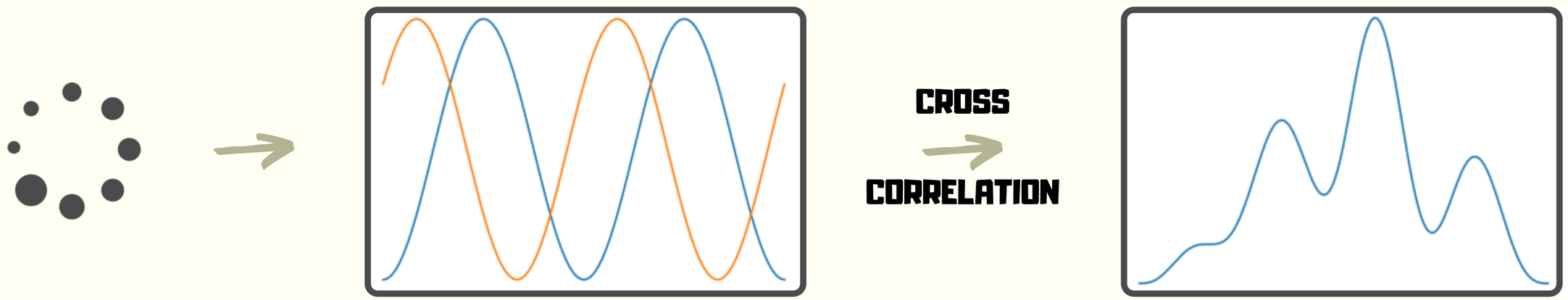
Pentagon geometry (Umbrella Module)

SYSTEM OVERVIEW



CIRCULAR BUFFER

- Data structure to store sound vectors



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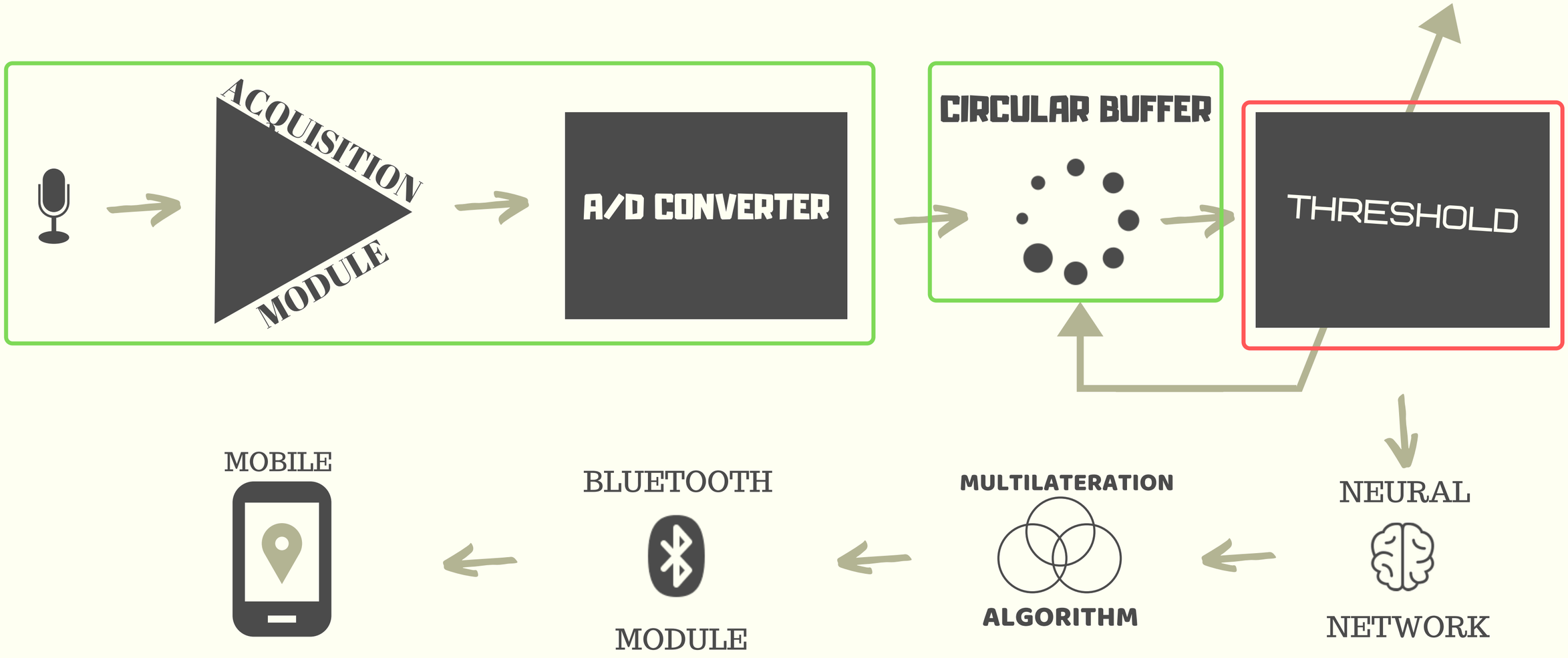
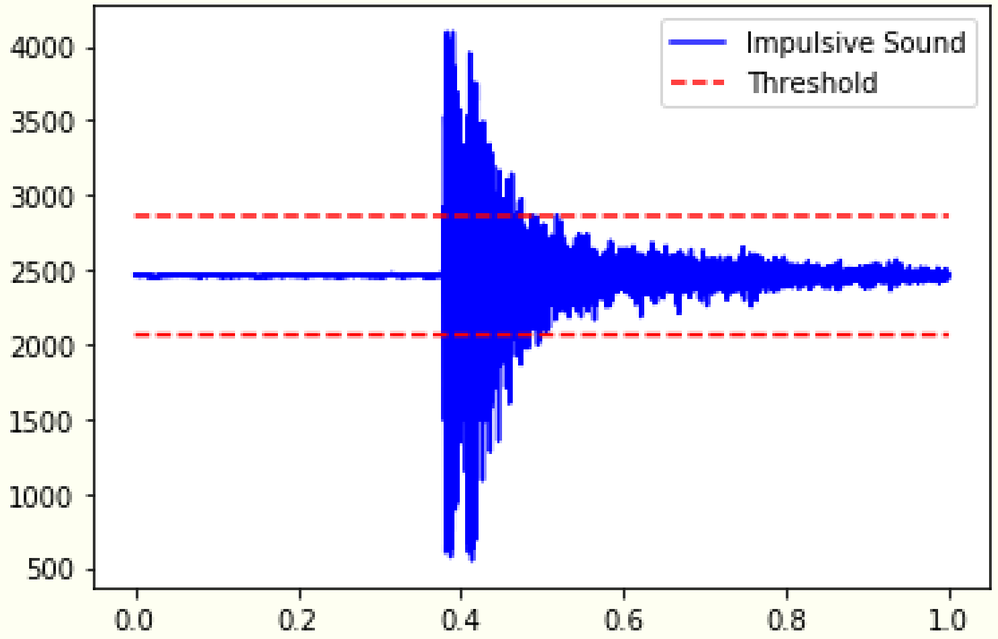
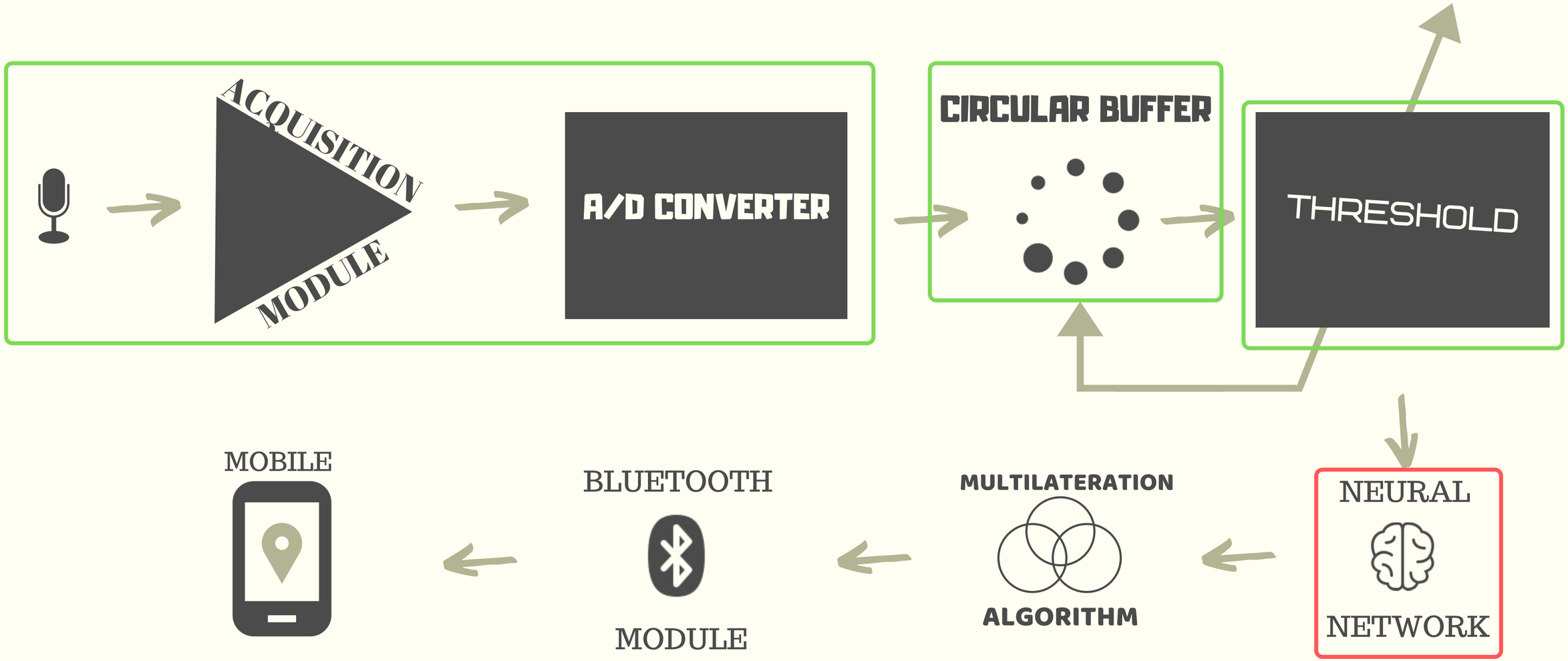


THRESHOLD

- Algorithm for adaptive impulsive detection

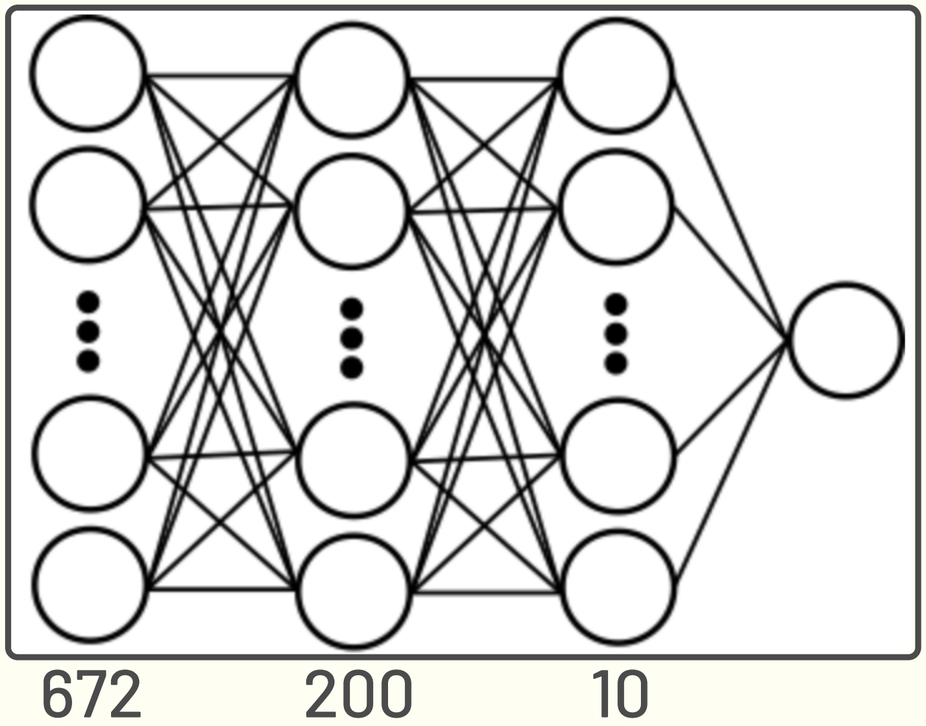


SYSTEM OVERVIEW



NEURAL NETWORK

- MLP Fully Connected
- MFCC Feature Extraction (672 input vector)
- 2 Hidden Layers (200 - 10)
- Holdout cross-validation
- Cooperation with local police authority for training



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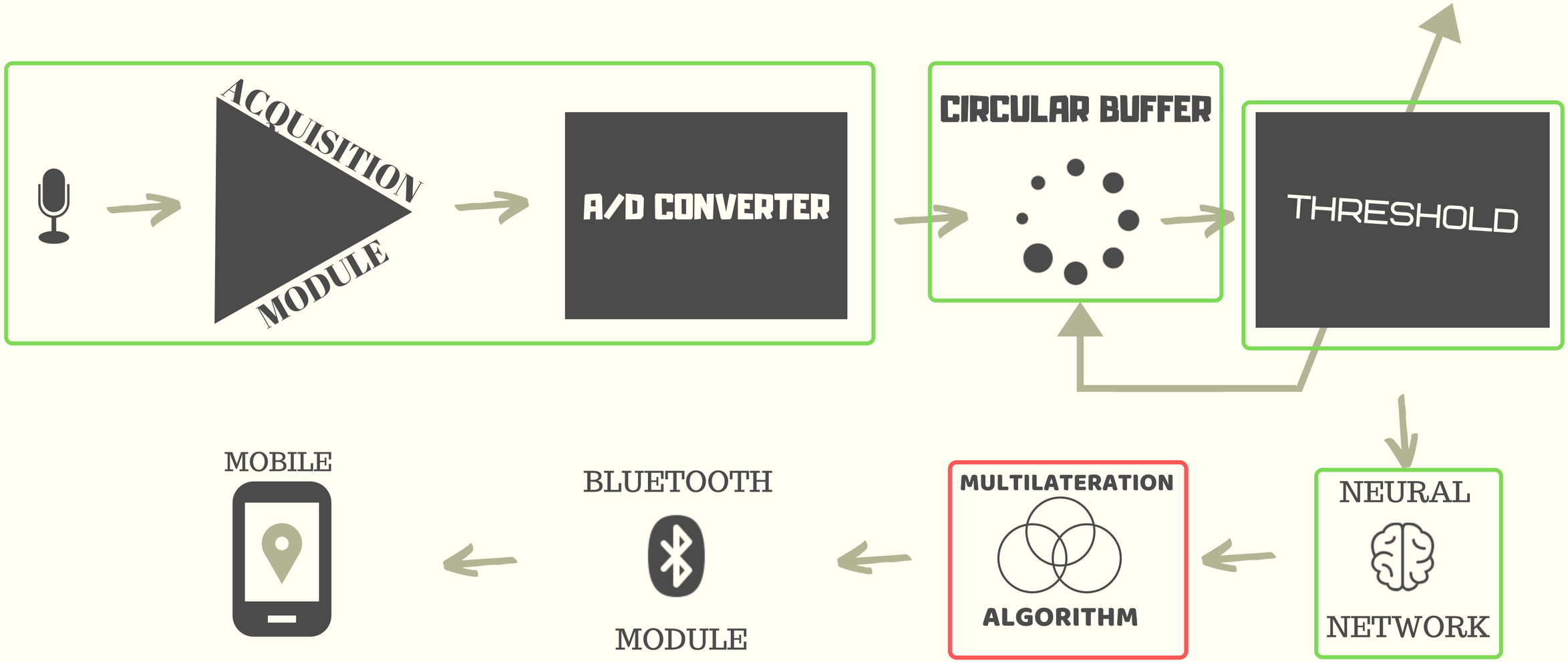
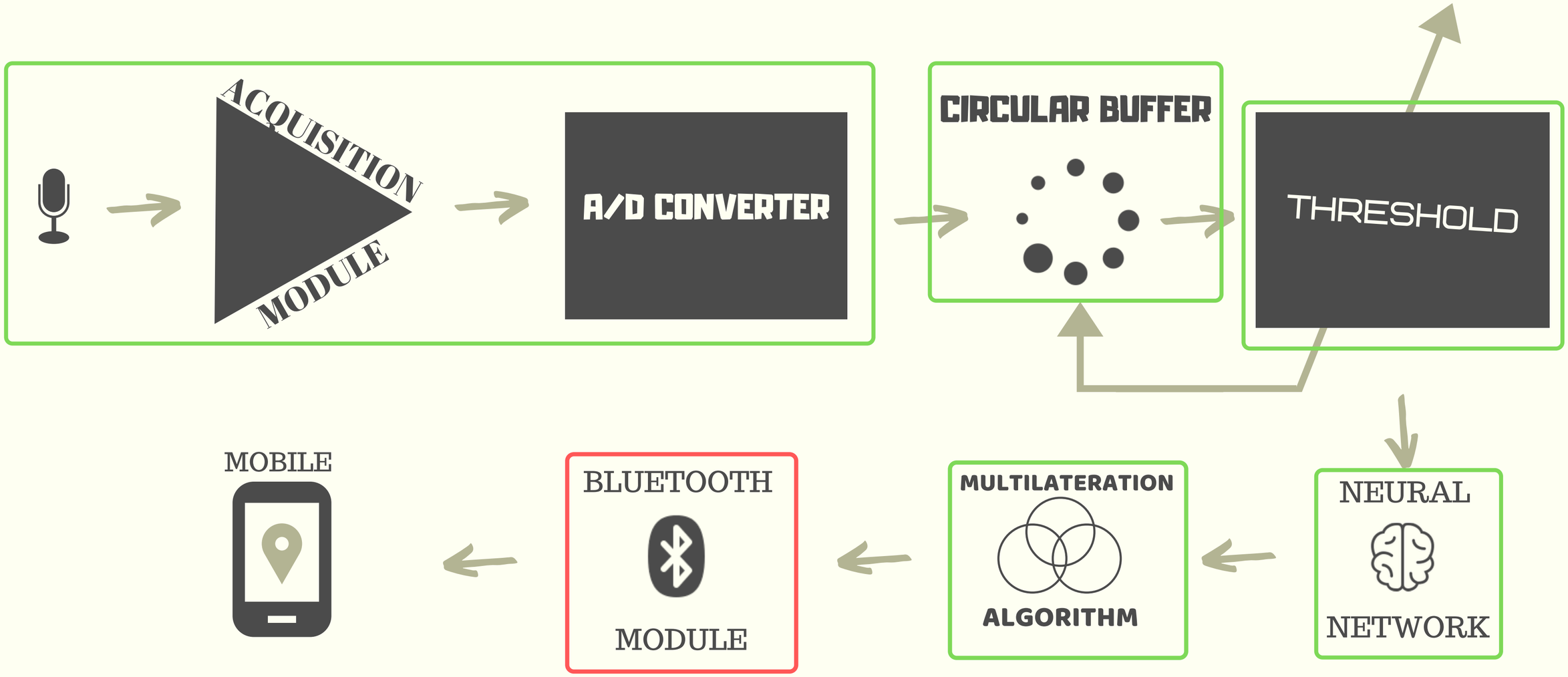


MULTILATERATION

- Linear equation that determines the target position

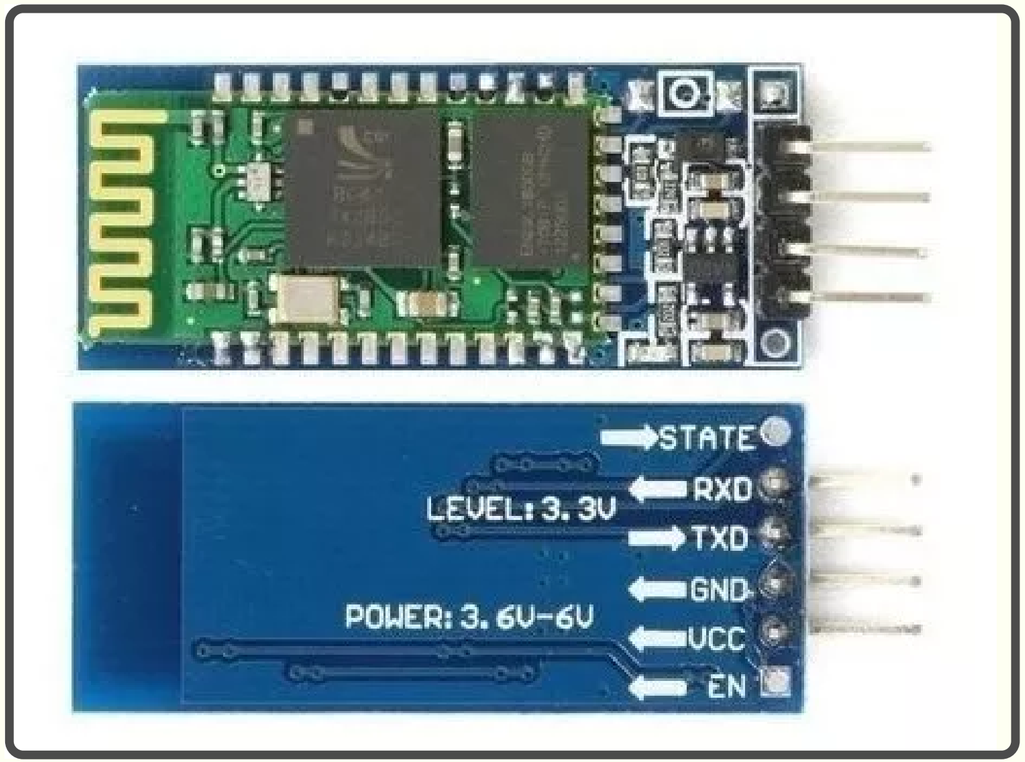
$$\begin{bmatrix} \frac{2x_2}{v\tau_2} - \frac{2x_1}{v\tau_1} & \frac{2y_2}{v\tau_2} - \frac{2y_1}{v\tau_1} & \frac{2z_2}{v\tau_2} - \frac{2z_1}{v\tau_1} \\ \frac{2x_3}{v\tau_3} - \frac{2x_1}{v\tau_1} & \frac{2y_3}{v\tau_3} - \frac{2y_1}{v\tau_1} & \frac{2z_3}{v\tau_3} - \frac{2z_1}{v\tau_1} \\ \frac{2x_4}{v\tau_4} - \frac{2x_1}{v\tau_1} & \frac{2y_4}{v\tau_4} - \frac{2y_1}{v\tau_1} & \frac{2z_4}{v\tau_4} - \frac{2z_1}{v\tau_1} \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} v\tau_1 - v\tau_2 + \frac{x_2^2+y_2^2+z_2^2}{v\tau_2} - \frac{x_1^2+y_1^2+z_1^2}{v\tau_1} \\ v\tau_1 - v\tau_3 + \frac{x_3^2+y_3^2+z_3^2}{v\tau_3} - \frac{x_1^2+y_1^2+z_1^2}{v\tau_1} \\ v\tau_1 - v\tau_4 + \frac{x_4^2+y_4^2+z_4^2}{v\tau_4} - \frac{x_1^2+y_1^2+z_1^2}{v\tau_1} \end{bmatrix}$$

SYSTEM OVERVIEW



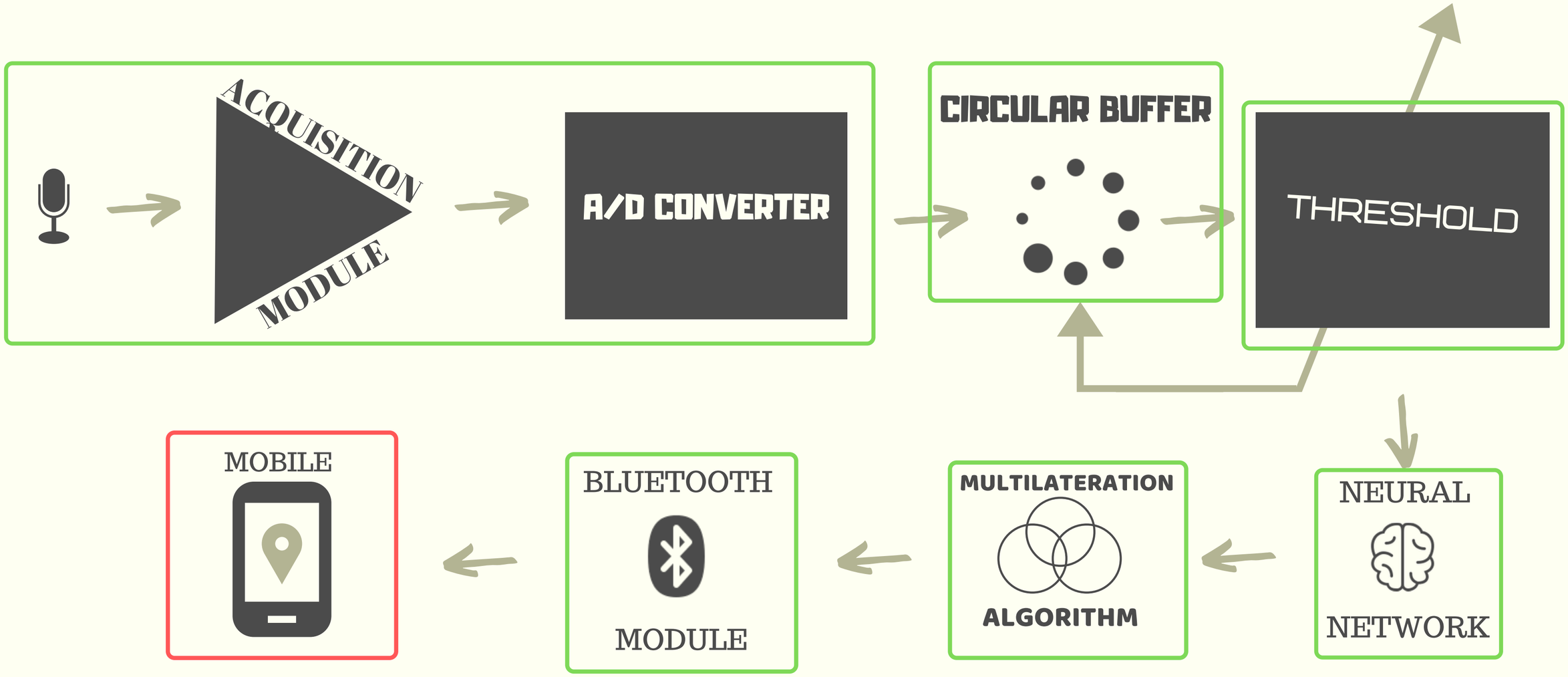
BLUETOOTH MODULE

- The position is sent by Bluetooth



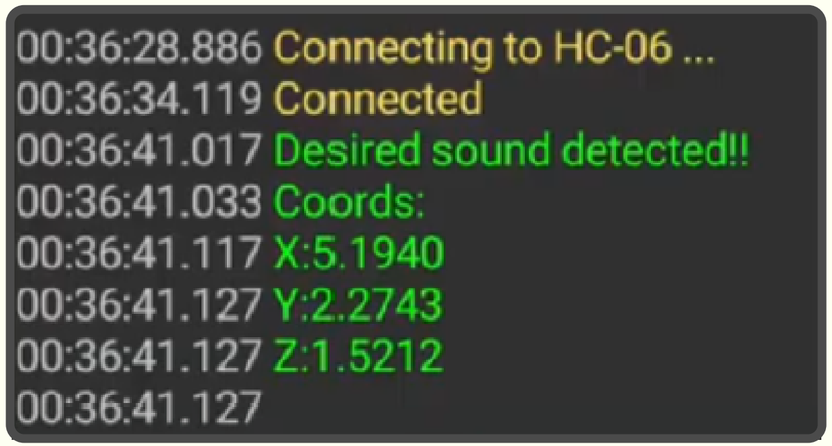
Bluetooth Module HC06

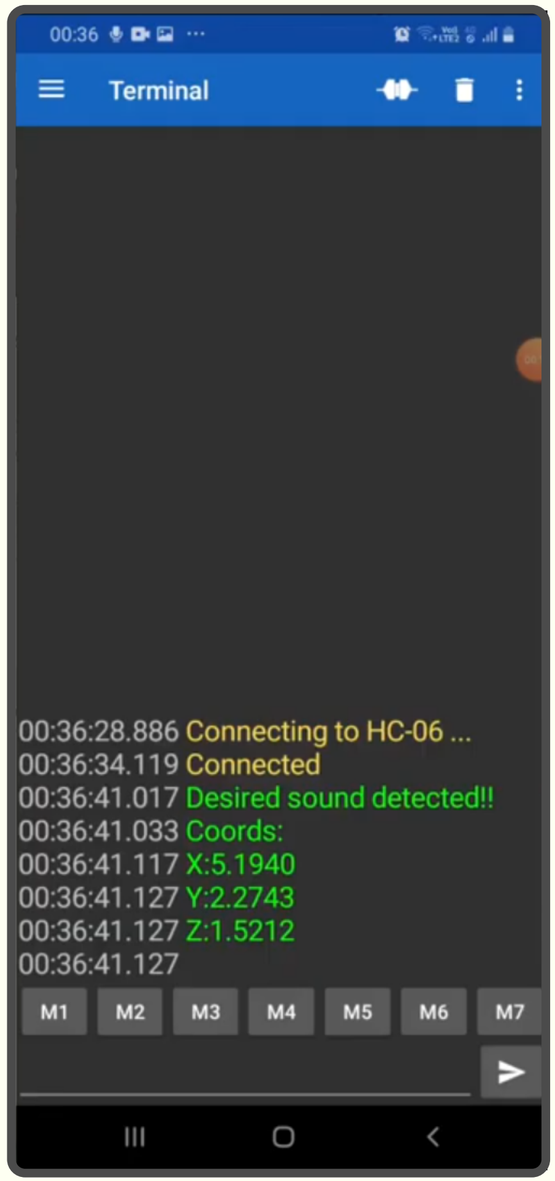
SYSTEM OVERVIEW



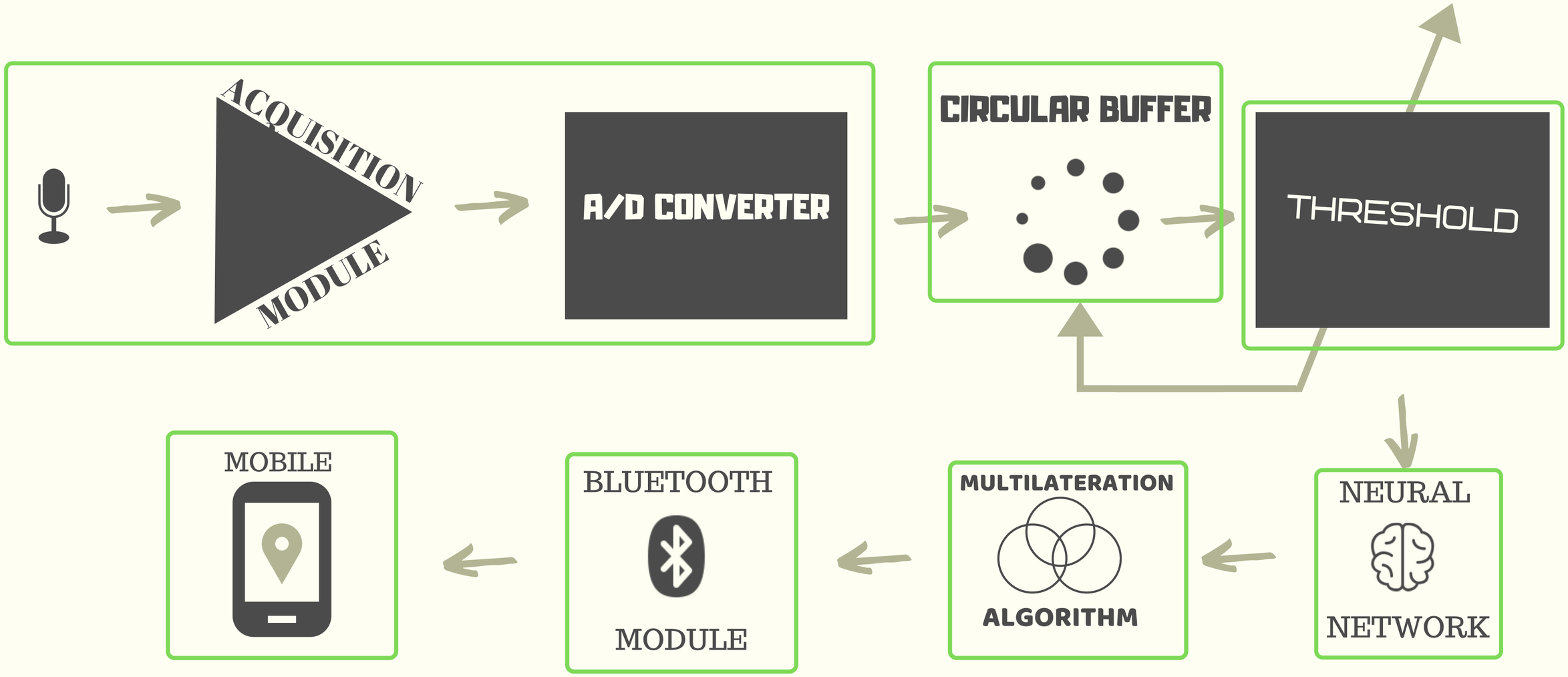
MOBILE

- Bluetooth communication app





SYSTEM OVERVIEW



WHY FPGA?

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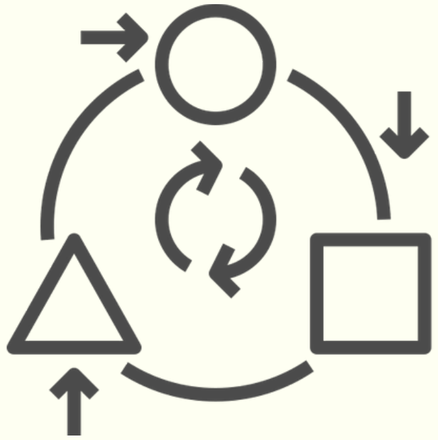
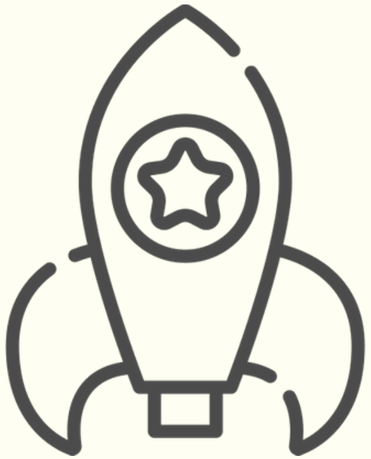
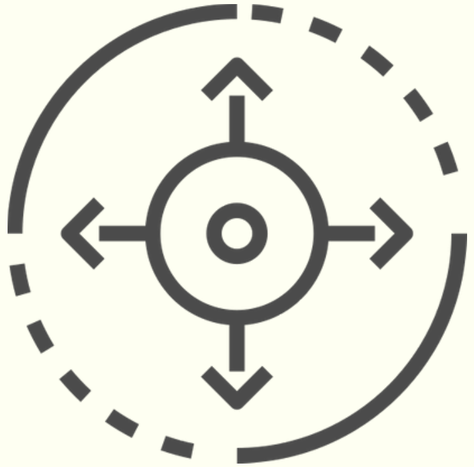
ADAPT TO CHANGES



BOOST PERFORMANCE



EXPANDS I/O



RESULTS

The system's neural network performed **91.38%** accuracy.

The multilateration algorithm performed **97.21%** accuracy on determining the gunshot direction.

The multilateration algorithm performed **88.32%** accuracy on determining the gunshot position.

CONCLUSIONS

The proposed arrangement was capable to determine the target location

The use of FPGA technology is crucial

What is next?

QUESTIONS?

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