

EDTH Paris Hackathon - December 1st, 2024

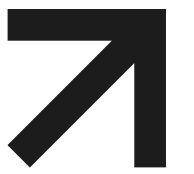


# MAGNETIC NAVIGATION FOR SUB-MARINE DRONES - TEAM 16

Autonomous Underwater Navigation Systems using Magnetic  
Fields and Inertia for Geo-Location

Stefan Agrici, Hugo Biais, Yoan Di Cosmo, Axel Nguyen Kerbel, David Podolskyi

# THE PROBLEM

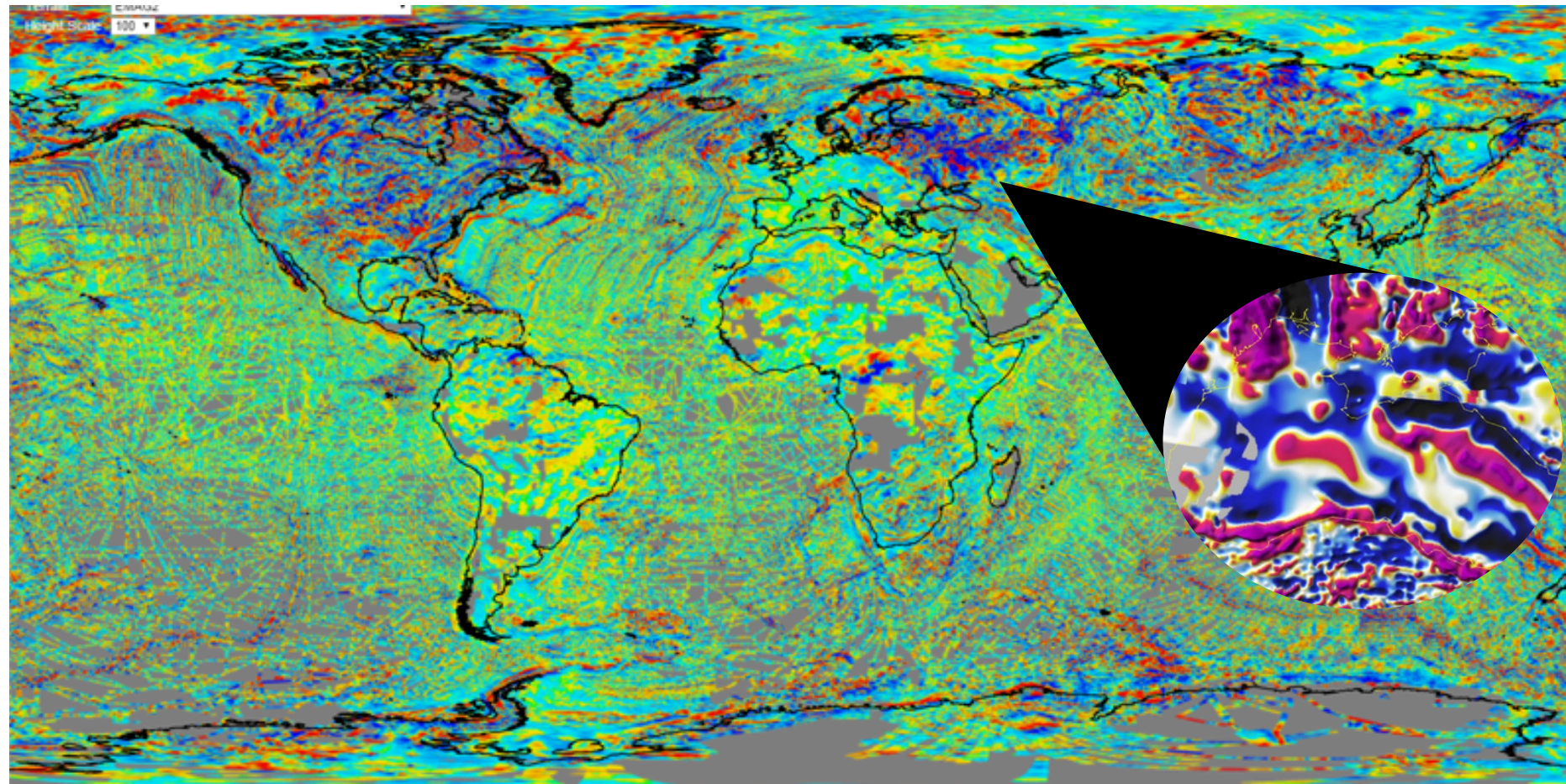




**Autonomous Navigation  
today requires GPS both  
for underwater and  
surface-level naval drones**

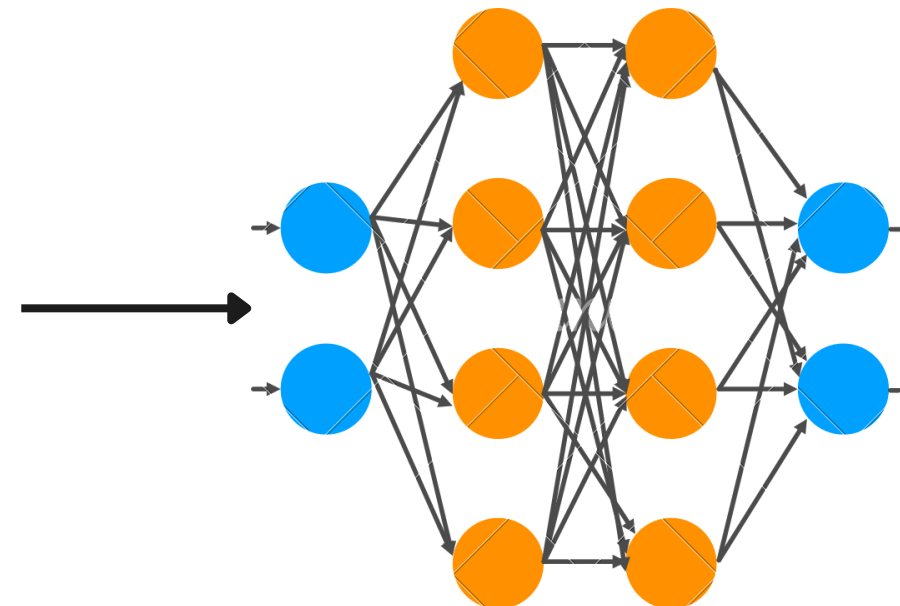
**-> NOT SECURE because  
the enemy can detect and  
shoot them**

# THE SOLUTION



We leverage Magnetic Anomalies and Inertial Navigation to do **GEOLOCATION**

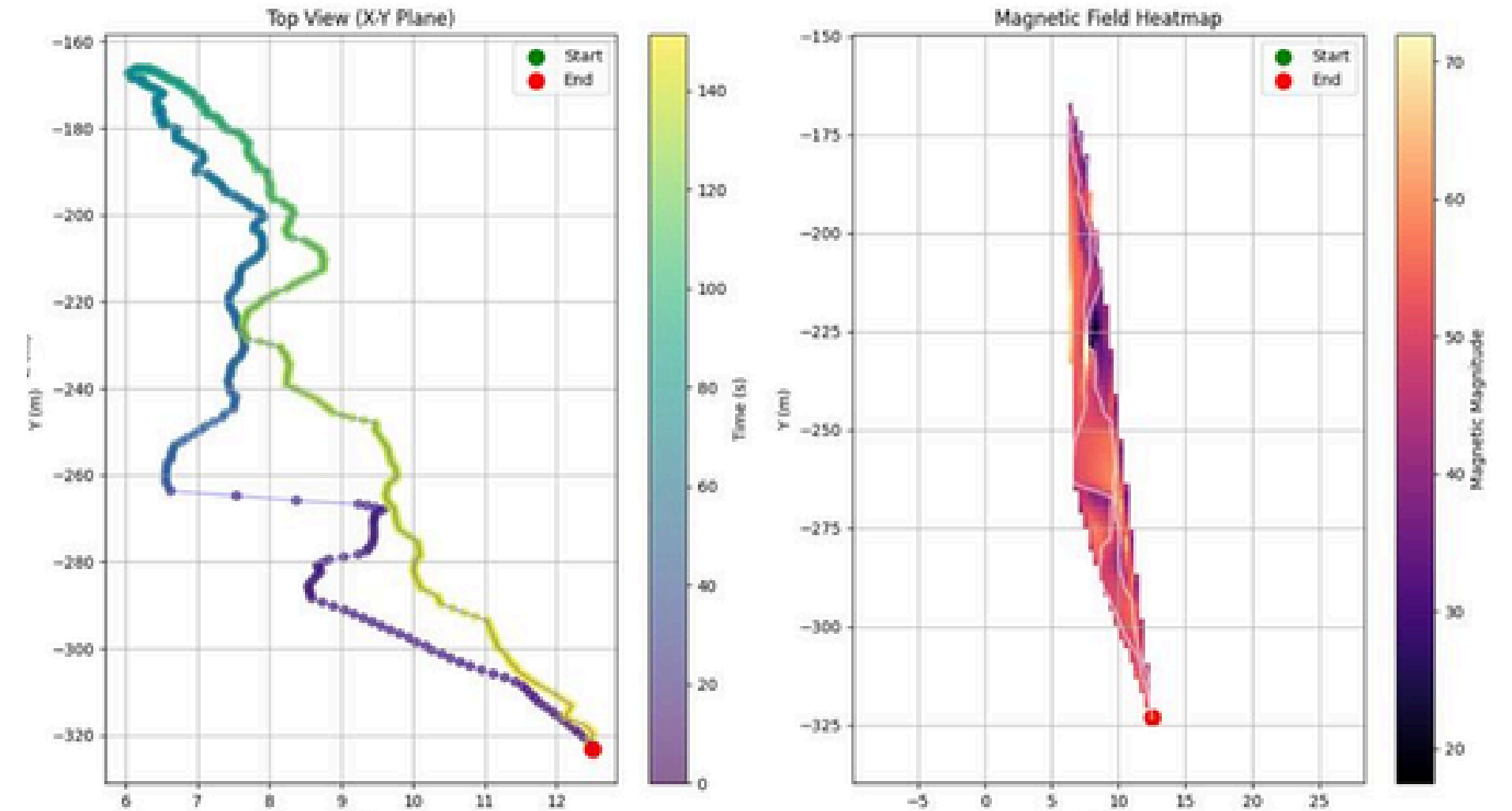
Magnetic Field  
+  
Accelerometer &  
Gyroscope Data  
(INPUT)



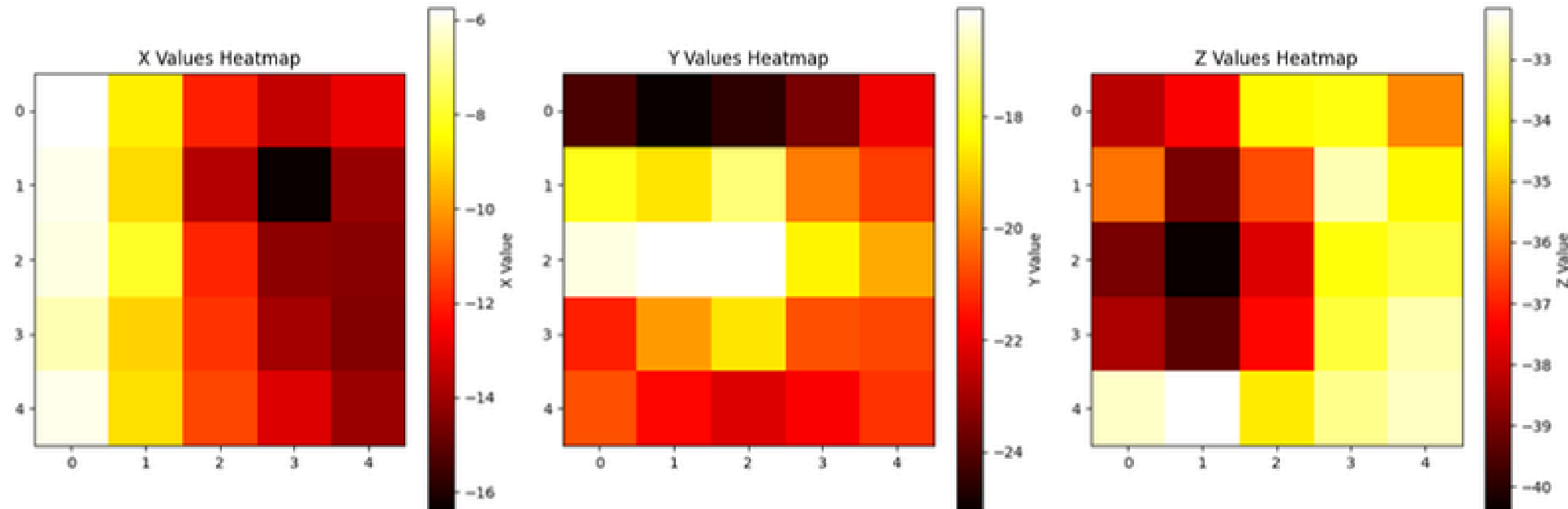
Coordinates  
(OUTPUT)

# HOW IT WORKS

We accurately and reliably reproduce the path that we walked only with data from the accelerometer and gyroscope of an Iphone.

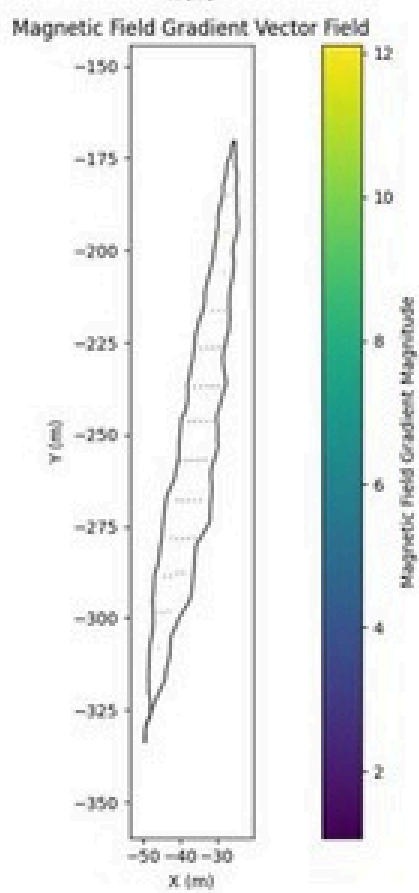
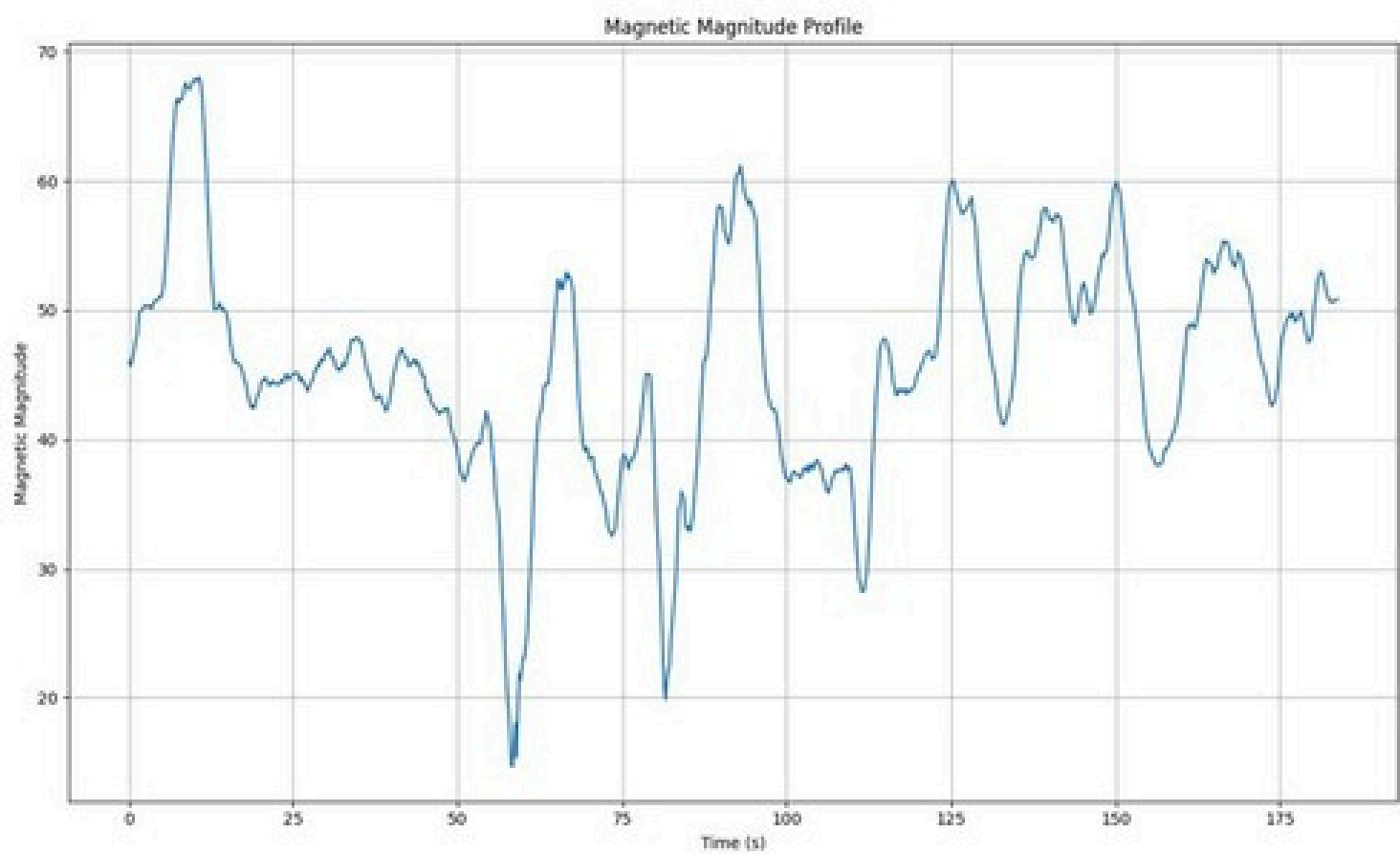
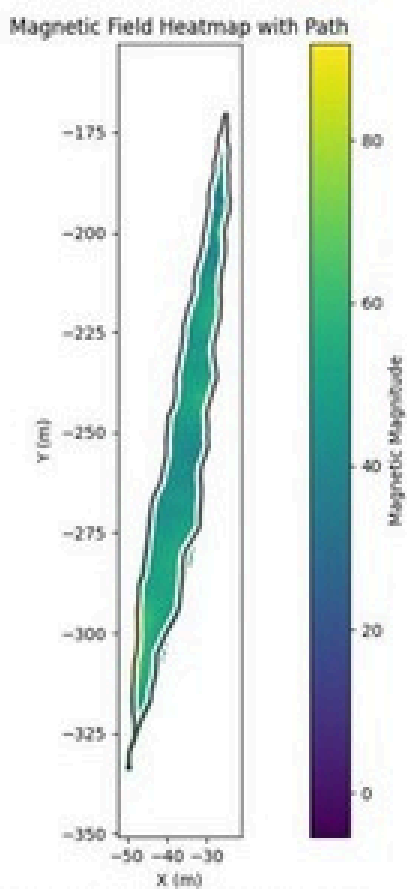
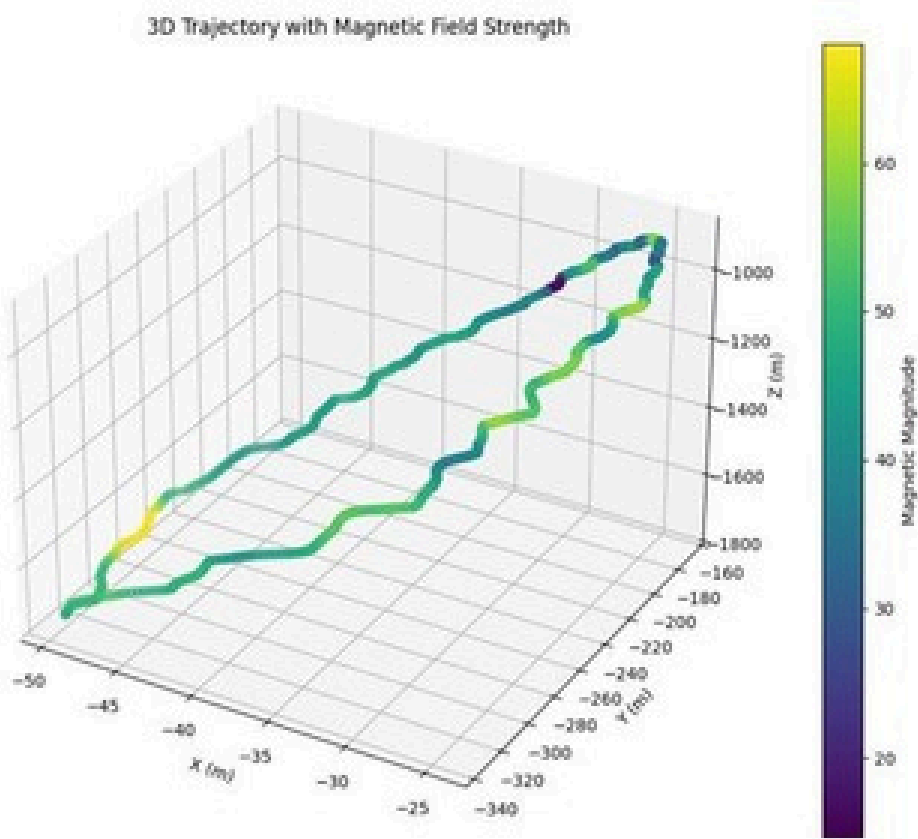


We can then automatically create a magnetic map for a certain area only by walking in it and using the Magnetometer of our Iphone to capture its magnetic field

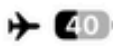


Here is a 5x5 grid that shows the magnetic field in a zone within Station F, for the x, y and z coordinates

# HOW IT WORKS



11:57



## Magnetic Field Mapper

Z: -32.12  
Magnitude: 44.83

**Location:**  
Latitude: 48.834420  
Longitude: 2.370775  
Accuracy:  $\pm 16.781249388495386$  meters  
Altitude: 35.86 meters  
Altitude Accuracy:  $\pm 30$  meters

**Raw Acceleration:**  
X: 0.2074  
Y: -0.4557  
Z: -0.8799

**Orientation:**  
Pitch: 0.4140  
Roll: 0.1006  
Yaw: -0.4899

**Session Name:**  
Station F

Stop Recording

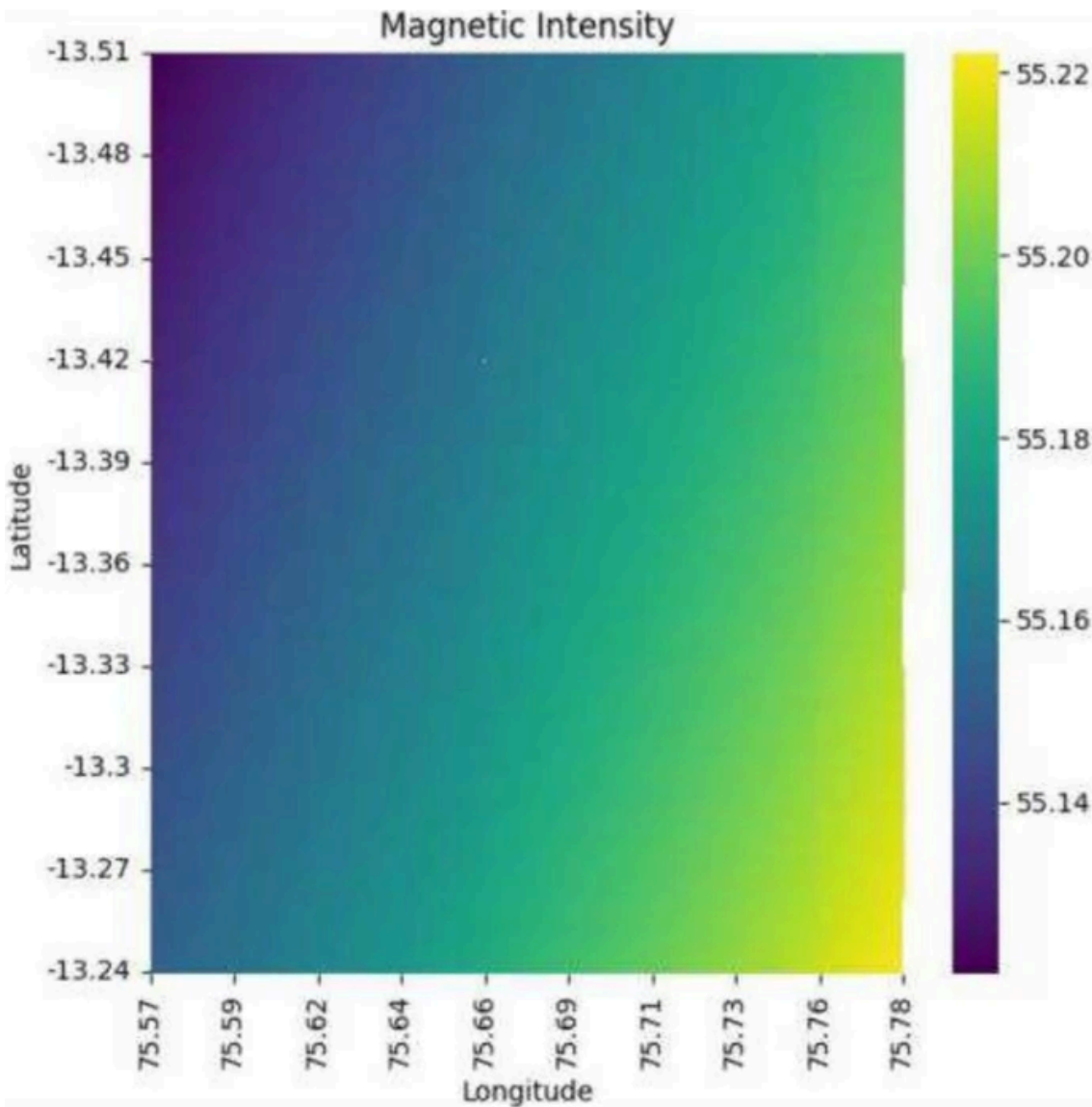
# CAN WE SCALE IT ?

Short answer : we might, yes

Article | [Open access](#) | Published: 02 August 2024

**Bio-inspired machine-learning aided geo-magnetic field based AUV navigation system**

[Ananda Ramadass Gidugu](#), [Bala Naga Jyothi Vandavasi](#) & [Vedachalam Narayanaswamy](#)



## Results

| ML model                  | Min (m) | Mean (m) | Max (m) |
|---------------------------|---------|----------|---------|
| Linear regression         | 480.13  | 1699.09  | 2985.78 |
| Support vector Regression | 324.35  | 1023.28  | 1949.80 |
| KNN                       | 389.22  | 1477.87  | 2360.63 |
| Decision tree             | 124.58  | 534.23   | 890.44  |
| Random forest             | 230.97  | 526.45   | 780.86  |

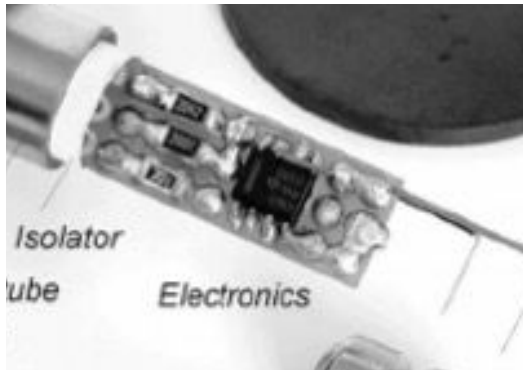
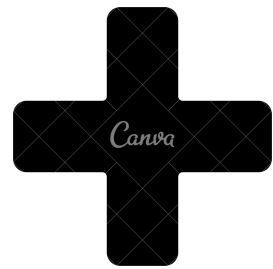
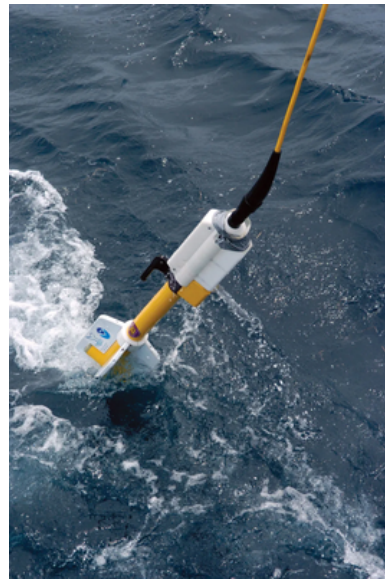
**Table 4.** Position error analysis using 5 ML techniques in the given diagonal trajectory with 0.5 nT sensor.

in a 900km<sup>2</sup> area, with only  
a 0.5nT sensor !

# DEPLOYMENT AND MASS MANUFACTURING



We used an iPhone and proved it could work in a building



Sub MagNav is made of COMPACT components.

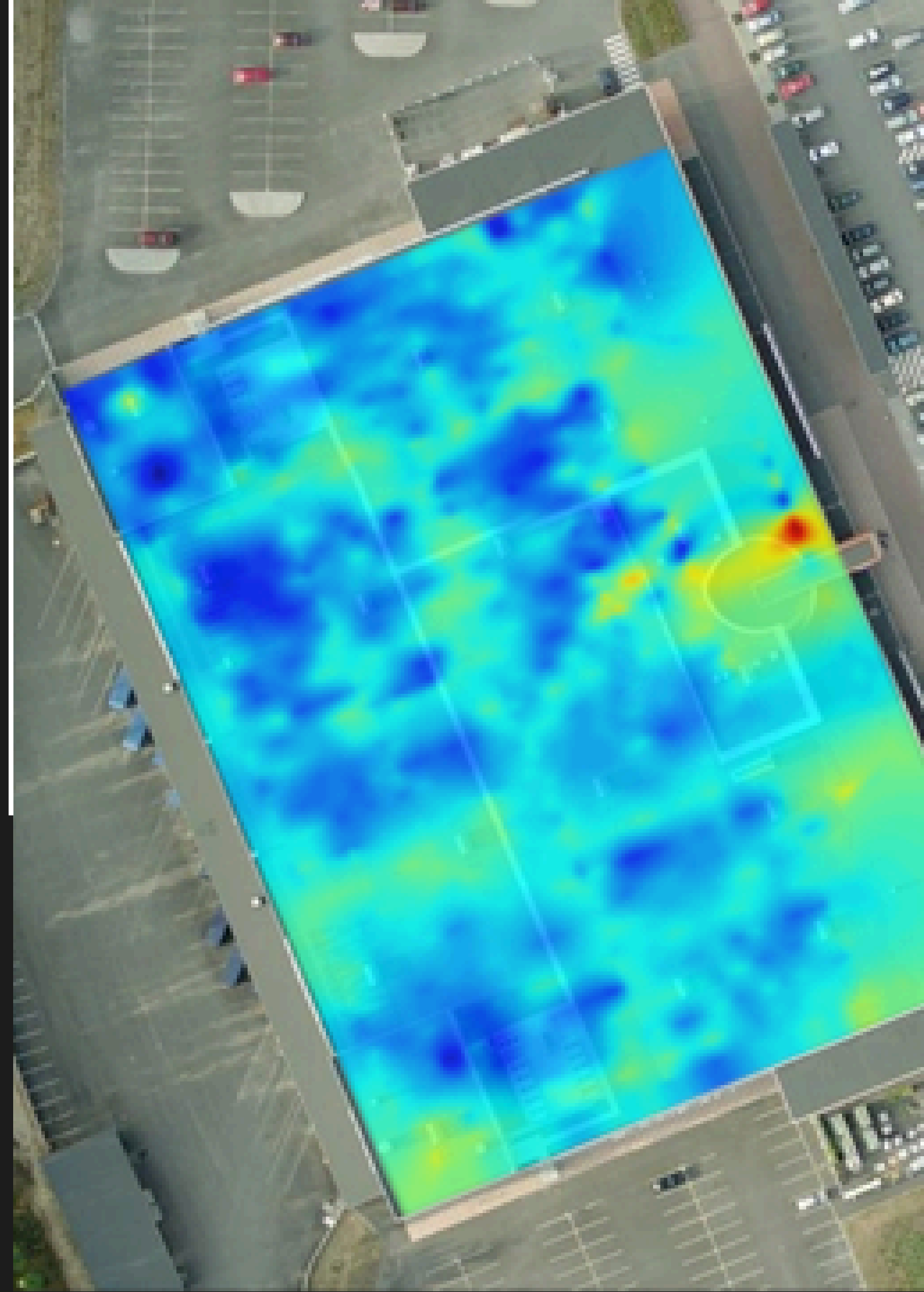
Easily integrable in Submarine drones.



The magnetic perturbances in the Black Sea are strong enough that using a slightly more precise magnetometer and accelerometer, we could reliably reach a target across the Black Sea, with less than a 5 km error, without ever going to the surface and using GPS signal

# WHAT WE HAVE DONE IN 24 HOURS

- ✱ Creation of geo-location algorithms based on data gathered from a SINGLE IPHONE
- ✱ Magnetic Mapping of an Area within Station F
- ✱ Achieved Magnetic-based geo-location with reasonable accuracy and found a way to scale it in the Black Sea



# TEAM



UoBirmingham &  
CTO Ticketnunc



Hugo

Physics at Ulm and  
SWE at Alice & Bob



Stefan

Centrale, MVA &  
AI researcher at INRIA



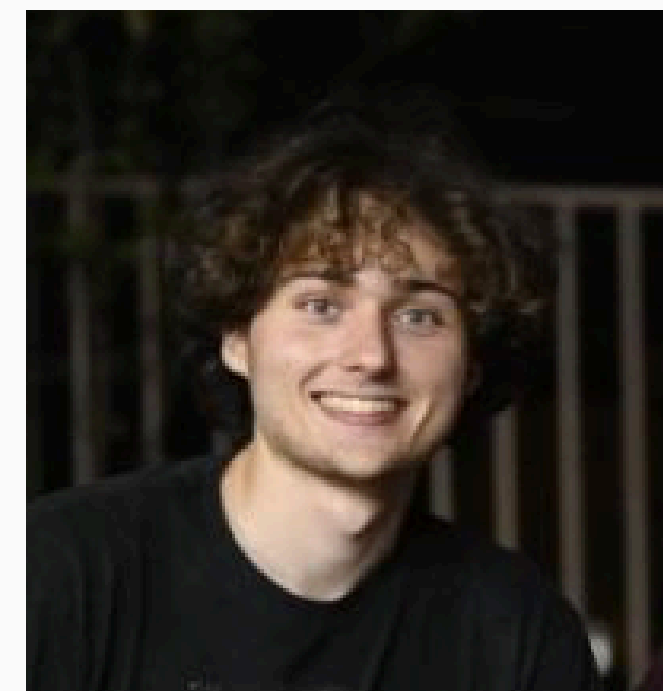
Axel

President of TUM.AI &  
AI PM at Tum Ventures



David

Centrale & ESSEC,  
President of Unaite



Yoan