Activity Summary Report on Re-training of Teachers in EU with an emphasis on Gender Equity

SUSL – NTUA Athens

1 Introduction

I am Dr. AK Rasika Nishamanie Ranasinghe, a Senior Lecturer from Faculty of Geomatics, Sabaragamuwa University of Sri Lanka participated in a training program named “Female Re- training of teachers in the EU with an emphasis on gender equity” under WP 3.8 aligning to the ERASMUS+ project of Curricula Enrichment delivered through the Application of Location-based Services to Intelligent Transport Systems (LBS2ITS) during the period of 15th of September 2024 to 06th of October 2024 in the School of Rural, Surveying and Geoinformatics Engineering, National Technical University of Athens, Greece.

2. Activities Conducted

Several activities were conducted in order to enhance the collaborative research idea and GNSS data collection activities for the evaluation of PNT potential of low-cost devices that are relevant to the scope of LBS2ITS project.

2.1 LBS2ITS Test Data Planning (SUSL/ NTUA/ TUV)

Initial Plan for the Positioning Data Collection

Test Equipment

- Stonex S70 Tablet
- Samsung S23
- Redmi Note 12 Pro 5G

Geodetic receiver serving as a Reference station are used for the baseline processing and CORS network data are used for the error reductions.

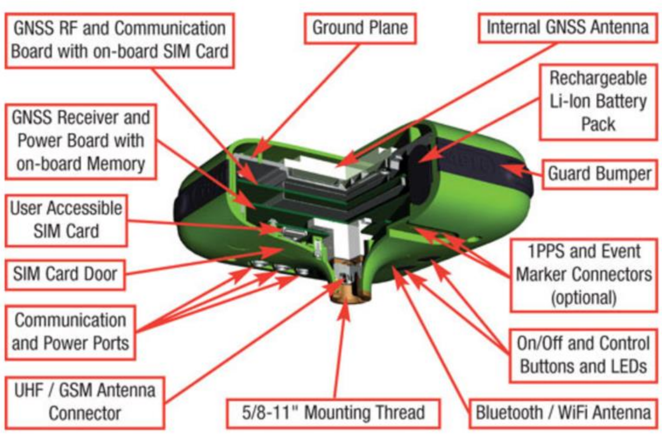
The positional capabilities of Samsung S23, Redmi note 12 Pro 5G, and Stonex S70 Tablet

Equipment	Samsung S23	Redmi note 12 Pro 5G	Stonex S70
			
Dual-Band GNSS	L1 and L5	Only L1	Only L1
Carrier-phase measurements	No	No	No
A-GPS (Assisted GPS)	Yes	Yes	Yes
GNSS Systems	GPS, GLONASS, BDS, Galileo	GPS (L1), GLONASS (G1), BDS (B1I+B1c), GALILEO (E1), QZSS (L1) SBAS facility	GPS (L1), GLONASS (L1), BeiDou (B1), Galileo (E1) SBAS facility GNSS Chip u-blox Neo-M8T
Approximate GNSS Accuracy	1-2 meters (without RTK, with dual band)	5-10 meters (without RTK)	Real Time SBAS < 2m Post processing < 1m
Sensor	Barometer, Accelerometer, Gyroscope, Compass	Accelerometer, Compass, Gyroscope	Accelerometer, Gyroscope, E-compass, Light Sensor
Connectivity	5G	5G	LTE – 4G
Type of OS	Android 13 (API level 33)	Android 12 (API levels 31, 32)	Android 10 (API Levels 29)

Processor	Qualcomm Snapdragon 8 Gen 2 for Galaxy 8 x 2 - 3.4 GHz, Cortex-X3 / A715 / A710 / A510 (Kryo)	MediaTek Dimensity 1080 8 x 2 - 2.6 GHz, Cortex-A78 / A55	SDM632, Octa-core 1.8 GHz
Battery	Li-Ion 3900 mAh, non-removable	Li-Po 5000 mAh, non-removable	Rechargeable and removable 3.8 V – 8000mAh

Capabilities of the **TRIUMPH-1** GNSS Receiver for the Positional Analysis

The **TRIUMPH-1 GNSS receiver** supports multiple GNSS systems (such as GPS, GLONASS, Galileo, and BeiDou), offering high accuracy by using multiple frequencies from different satellite constellations. It provides high accuracy in positioning, especially useful in professional applications like surveying, geodesy, and mapping, with centimeter-level accuracy in real-time kinematic (RTK) positioning. The receiver is equipped with advanced signal processing capabilities, which helps in environments where signals might be obstructed or degraded. It's designed to be durable and reliable in harsh environments, making it suitable for use in challenging conditions such as dense urban areas, forests, or construction sites. Despite its advanced features, the TRIUMPH-1 is designed for low power consumption, making it suitable for extended field operations. This makes the TRIUMPH-1 an excellent choice for applications requiring precise positioning in both static and dynamic environments.



Capabilities of the **Xiomi Mi 8** and **Google Pixel 5** for the Positional Analysis

The **Xiaomi Mi 8** smartphone is notable for its advanced GNSS capabilities, especially in comparison to typical consumer devices. It was one of the first smartphones to support **dual-frequency GNSS**. It can receive signals on both the L1 and L5 bands, which significantly improves positioning accuracy compared to single-frequency receivers. This dual-frequency capability helps reduce errors caused by ionospheric delays and multipath effects (signal reflections), leading to more accurate positioning, especially in challenging environments like urban areas with high-rise buildings. The Xiaomi Mi 8 supports multiple GNSS constellations (GPS, GLONASS, Galileo, BeiDou) at once, providing better positioning accuracy and availability, even in areas with limited satellite visibility.

The **Google Pixel 5** offers notable GNSS capabilities for a smartphone, although it is not specifically designed for high-precision geodetic measurements. The Pixel 5 supports multiple GNSS constellations, including GPS, GLONASS, Galileo, BeiDou. This multi-constellation support allows the Pixel 5 to receive signals from a large number of satellites, which helps in improving accuracy and reliability, particularly in urban canyons or areas with limited satellite visibility. The Pixel 5 has **dual-frequency GNSS** support, meaning it can receive signals on both the L1 and L5 frequency bands. Dual-frequency capability helps reduce errors caused by ionospheric interference and multipath effects, improving positional accuracy in challenging environments. The combination of dual-frequency support and multi-constellation tracking allows for improved accuracy compared to older smartphones with single-frequency GNSS.

Xiomi Mi 8 Phone

Google Pixel 5

Positional Conditions for GNSS Observations

Google GNSS Data Logger Software was used for raw data collection. Test observations from each equipment was carried out in order to check the capability and the applicability of the software for the positional data collection. It was found that the Samsung S23 is not capable of providing Carrier phase measurements. Hence, further data collection was done using the other two devices. In the mean time Google pixel 5 and Xiomi Mi 8 mobile phones were used for the observations.

For different scenarios in static observation, we observed approximately the same time in order to avoid some errors in satellite positioning. GNSS systems rely on signals from multiple satellites to determine accurate positions. When measurements are taken in equal time, it ensures that the same satellites are visible to all receivers, allowing for consistent data collection. Further, GNSS signals pass through the Earth's atmosphere, which can introduce errors due to variations in atmospheric conditions (like ionospheric or tropospheric delays). Measuring at the same time ensures that these atmospheric conditions affect all receivers similarly, minimizing discrepancies in the data. Techniques like Real-Time Kinematic (RTK) or Differential GNSS (DGNSS) rely on measuring the relative position between a base station and a rover. These techniques require simultaneous measurements to calculate the differences in signals accurately, leading to highly precise positioning.

In static observation, all the units were kept in the same direction of the pillors, in order to preserve the antenna position without any additional errors for the measurements.

TEST OBSERVATIONS

Scenarios for Static Observations

Scenario 1 (SS1): Static Observation was conducted on 23rd September 2024 from 1100 hrs - 1330 hrs with Redmi Note 12 Pro 5G at P1 and Stonex S70 tablet at P2 (enabled IMU). Due to some hardware deficiencies of the Stonex S70 tablet, data was not recorded continuously. Hence, repeated all the observations again on 24th for an hour around 1000 hrs to 1100 hrs. As the test was successful, started the observation session in the same day from 1145 hrs to 1345 hrs.

Scenario 2 (SS2): With the arrival of Prof. Gunther, we started static observation again on 30th October 2024. We received fabricated 3D print model for mounting GNSS Receiver and two mobile phones at once.

Observation Procedure – 3D print model at Pillor 1 with Redmi Note 12 Pro 5G and Google pixel 4 and Stonex S70 tablet at Pillor 2 observed for around 30mins from 1100 – 1130 hrs with continuous data from the base station.

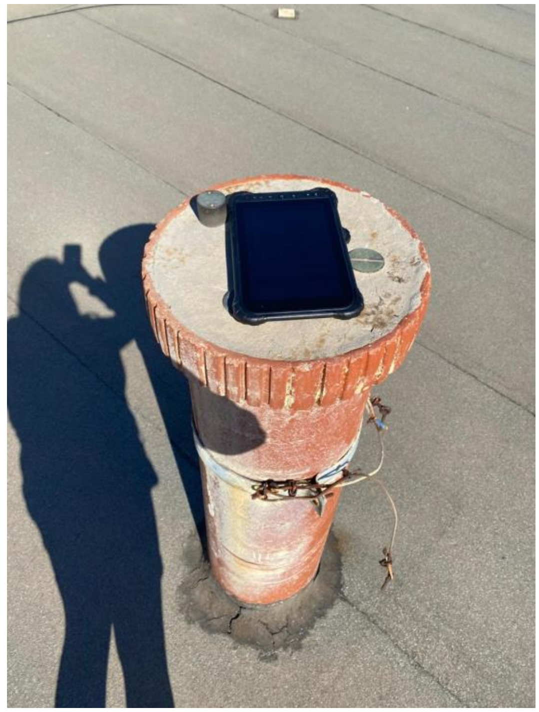
<u>Scenario 3 (SS3)</u>: Started static observation at 01/10/2024 from 1030 – 1230 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2.

<u>Scenario 4 (SS4)</u>: Started static observation at 01/10/2024 from 1340 – 1540 hrs of multiple equipment (3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 2 and Stonex S70 at Pillor 1.

<u>Scenario 5 (SS5)</u>: Started static observation at 02/10/2024 from 0800 – 0915 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2.

Since the Stonex S70 was stopped data recording after 30 mins, repeated the same scenario for next one hour 0930 – 1030 hrs.

Then we swapped the units as 3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover and Stonex S70 at Pillor 1. Observation was continued until 1205 hrs from 1050 hrs.



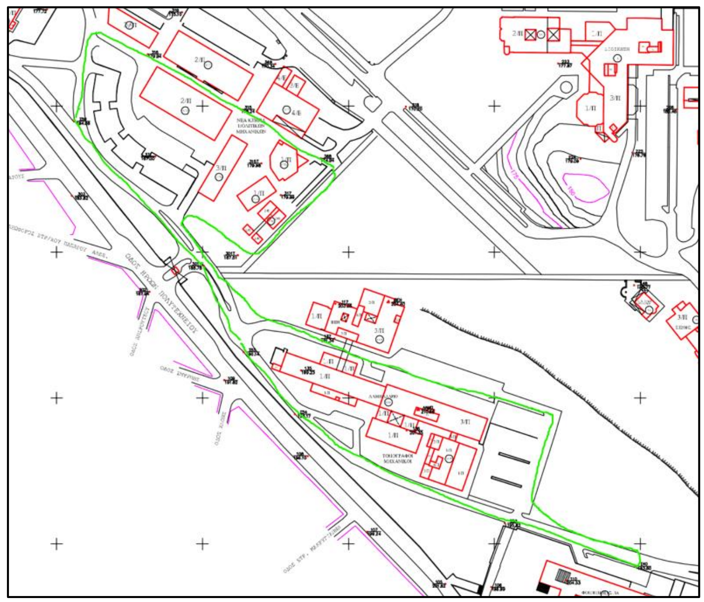
<u>Scenario 6 (SS6)</u>: Started static observation at 03/10/2024 from 0915 – 1035 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2.

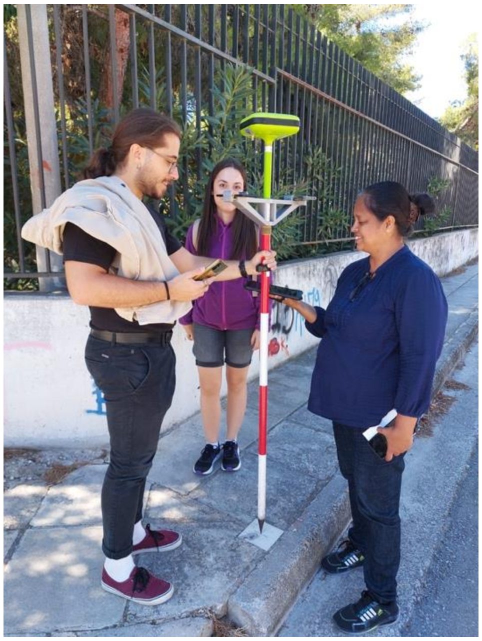
Then we swapped the units as 3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover and Stonex S70 at Pillor 1. Observation was continued until 1200 hrs from 1050 hrs.

Scenarios for Kinematic Observations

Scenario 1 (KS1):

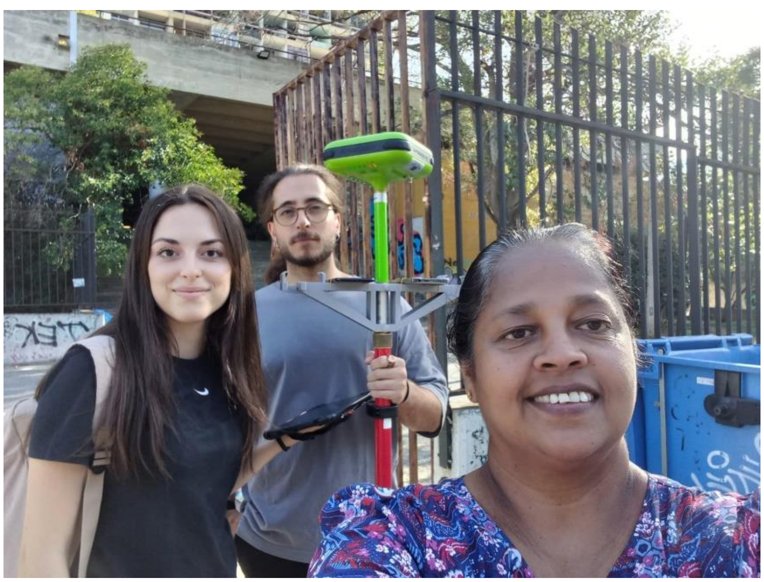
Started Kinematic observations from 1240 – 1440 hrs as stop and go scenarios. With the multiple devices as Redmi Note 12 Pro 5G and Google pixel 5, and GNSS receiver mounted on the one 3D printed model and Stonex S70 carried closely with them covering 15 control points as CP numbers 40, 39, 38, 51, 52, 54, 56, 59, selected fixed points, 39, 40. The path was closed network as indicated in Green of the sketch below. Each control point was observed with around 5 minutes static observations and hold the units in the same direction to avoid the displacement of antenna position. Observed the fixed point for 5 mins, when changing the direction of the trajectory without control points.





Scenario 2 (KS2):

Started Kinematic observations from 0810 – 1005 hrs 04th October 2024 as stop and go scenarios. With the multiple devices as Redmi Note 12 Pro 5G and Xiomi Mi 8, and GNSS receiver mounted on one 3D printed model and Stonex S70 carried closely with them covering similar path as KS1. Since, Stonex S70 is not logging for continuous data more than 20 mins, stopped and restarted the data logging throughout the observation.



File Cording system for the different scenarios of the data collection

Example:

RE_S_P2_D24_T10-12

ST_S_P3_D24_T10-12

RE_K_D26_T10-13

ST_K_D26_T10-13

Where;

RE – Redmi Note 12 Pro 5G

ST – Stonex S70 tablet

GO – Google Pixel 5

Mi8 – Xiomi Mi 8

GN – GNSS Rover

S – Static

K – Kinamatic

P1, P2 – Pillors

D - Day

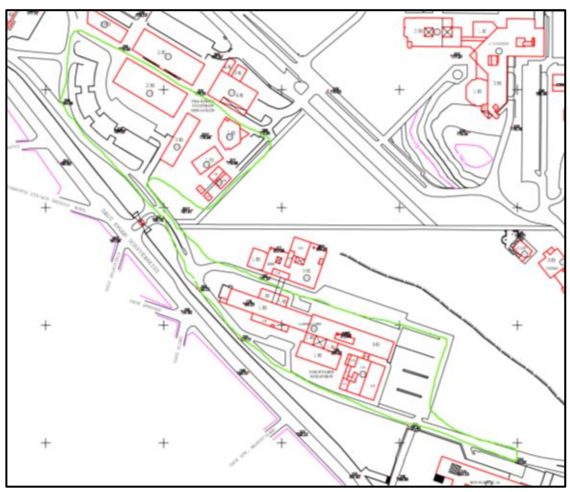
T - Time (24 hours)

SS – Static Scenario

KS – Kinamatic Scenario

Code	Scenarios
SS1 RE_S_P1_D23_T11-1330 ST_S_P2_D23_T11-1330 RE_S_P1_D24_T10-11 ST_S_P2_D24_T10-11 RE_S_P1_D24_T1145-1345 ST_S_P2_D24_ T1145-1345	Static Observation was conducted on 23rd September 2024 from 1100 - 1330 hrs with Redmi Note 12 Pro 5G at P1 and Stonex S70 tablet at P2 (enabled IMU). Repeated all the observations again on 24th for an hour around 1000 hrs to 1100 hrs. As the test was successful, started the observation session in the same day from 1145 hrs to 1345 hrs.
SS2 RE_S_P1_D30_T11-1130 GO_S_P1_D30_T11-1130 ST_S_P2_D30_T11-1130	With the arrival of Prof. Gunther, we started static observation again on 30th September 2024. We received fabricated 3D print model for mounting GNSS Receiver and two mobile phones at once. Observation Procedure – 3D print model at Pillor 1 with Redmi Note 12 Pro 5G and Google pixel 5 and Stonex S70 tablet at Pillor 2 observed for around 30 mins from 1100 – 1130 hrs with continuous data from the base station.
SS3 RE_S_P1_D01_T1030-1230 Mi8_S_P1_D01_T1030-1230 GN_S_P1_D01_T1030-1230 ST_S_P2_D01_T1030-1230	Started static observation at 01/10/2024 from 1030 – 1230 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2.
SS4	

RE_S_P2_D01_T1340-1540 Mi8_S_P2_D01_T1340-1540 GN_S_P2_D01_T1340-1540 ST_S_P1_D01_ T1340-1540	Started static observation at 01/10/2024 from 1340 – 1540 hrs of multiple equipment (3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 2 and Stonex S70 at Pillor 1.
SS5 RE_S_P1_D02_T08 - 0915 Mi8_S_P1_D02_ T08 - 0915 GN_S_P1_D02_ T08 - 0915 ST_S_P2_D02_ T08 - 0915 RE_S_P1_D02_T0930 - 1030 Mi8_S_P1_D02_T0930 - 1030 GN_S_P1_D02_ T0930 - 1030 ST_S_P2_D02_ T0930 - 1030 RE_S_P2_D02_T1050 - 1205 Mi8_S_P2_D02_T1050 - 1205 GN_S_P2_D02_T1050 - 1205 ST_S_P1_D02_T1050 - 1205	Started static observation at 02/10/2024 from 0800 – 0915 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2. Since the Stonex S70 was stopped data recording after 30 mins, repeated the same scenario for next one hour 0930 – 1030 hrs Then we swapped the units as 3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover and Stonex S70 at Pillor 1. Observation was continued until 1205 hrs from 1050 hrs.
SS6	

RE_S_P1_D03_T0915 - 1035 Mi8_S_P1_D03_T0915 - 1035 GN_S_P1_D03_T0915 - 1035 ST_S_P2_D03_T0915 - 1035 RE_S_P2_D03_T1050 - 1200 Mi8_S_P2_D03_T1050 - 1200 GN_S_P2_D03_T1050 - 1200 ST_S_P1_D03_T1050 - 1200	Started static observation at 03/10/2024 from 0915 – 1035 hrs of multiple equipment (3D print model at Pillor 1 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover) at Pillor 1 and Stonex S70 at Pillor 2. Then we swapped the units as 3D print model at Pillor 2 with Redmi Note 12 Pro 5G, Xiomi Mi 8, and GNSS rover and Stonex S70 at Pillor 1. Observation was continued until 1200 hrs from 1050 hrs.
KS1 RE_K_D30_T1240-1440 GO_K_D30_T1240-1440 GN_K_D30_T1240-1440 ST_K_D30_T1240-1440	Started Kinematic observations from 1240 – 1440 hrs 30th September 2024 as stop and go scenarios. With the multiple devices as Redmi Note 12 Pro 5G and Google pixel 5, and GNSS receiver mounted on the one 3D printed model and Stonex S70 carried closely with them covering, 15 control points. Pole height is 1.52 m. 
KS2 RE_K_D4_T0810-1005 Mi8_K_D30_T0810-1005 GN_K_D30_T0810-1005	Started Kinematic observations from 0810 – 1005 hrs 04th October 2024 as stop and go scenarios. With the multiple devices as Redmi Note 12 Pro 5G and Xiomi Mi 8, and GNSS receiver mounted on one 3D printed model and Stonex S70 carried closely with them covering similar path as KS1. Since, Stonex S70 is not logging for continuous data more than 20 mins, stopped and restarted the data logging throughout the observation. Pole height is 1.52 m.

ST_K_D30_T0810-1005	

Detailed information about each Scenarios

Scenarios	Observation Starting Time	Observation Ending Time	Data Recording Parameters	Data file conventions	Unit Placement	Storage	Remarks
SS1 23/09/24	1100 hrs	1330 hrs		RINEX format	RE – P1 ST – P2		Temperature was around 28C
SS1 24/09/24	1000 hrs	1100 hrs		-Do-	RE – P1 ST – P2		Temperature was around 28C
SS1 24/09/24	1145 hrs	1345 hrs		-Do-	RE – P1 ST – P2		Temperature was around 29C
SS2 30/09/24	1100 hrs	1130 hrs	**Two measurements related to the left and right side of the phone**	-Do-	GN, RE, GO – P1 ST – P2		Temperature was around 26C
SS3 01/10/24	1030 hrs	1230 hrs	Offset distance from GN to RE – 3.6 cm – 11.6 cm Mi8 -12 cm – 4.8 cm At P1	-Do-	GN, RE, Mi8 – P1 ST – P2		Temperature was around 25C

SS4 01/10/24	1340 hrs	1540 hrs	Offset distance from GN to RE - 4 cm – 11.8 cm Mi8 - 11.5 cm – 4.5 cm At P2	-Do-	GN, RE, Mi8 – P2 ST – P1		Temperature was around 25C
SS5 02/10/24	0800 hrs	0915 hrs	Offset distance from GN to RE - 4 cm – 11.7 cm Mi8 – 12 cm – 4.5 cm At P1	-Do-	GN, RE, Mi8 – P1 ST – P2		Stonex tablet was stopped recording after 30 mins. Temperature was around 16C
SS5 02/10/24	0930 hrs	1030 hrs		-Do-	GN, RE, Mi8 – P1 ST – P2		Temperature was around 22C
SS5 02/10/24	1050 hrs	1205 hrs			GN, RE, Mi8 – P2 ST – P1		Temperature was around 22C
SS6 03/10/24	0915 hrs	1035 hrs	Offset distance from GN to RE – 3.5 cm – 11.2 cm Mi8 – 3.5 cm – 11 cm At P1	-Do-	GN, RE, Mi8 – P1 ST – P2		Temperature was around 22C
SS6 03/10/24	1050 hrs	1200 hrs		-Do-	GN, RE, Mi8 – P2 ST – P1		Temperature was around 25C

Challenges in the Field Observations

- ### Capability of the equipment

The positional capabilities of low-cost equipment, such as mobile phones, have not been extensively explored in current research perspectives. As a result, it was challenging to identify suitable devices for mobile phone-based positioning by examining their technical specifications and performance in both static and kinematic observation scenarios.

- ### Challenges due to Heat weather

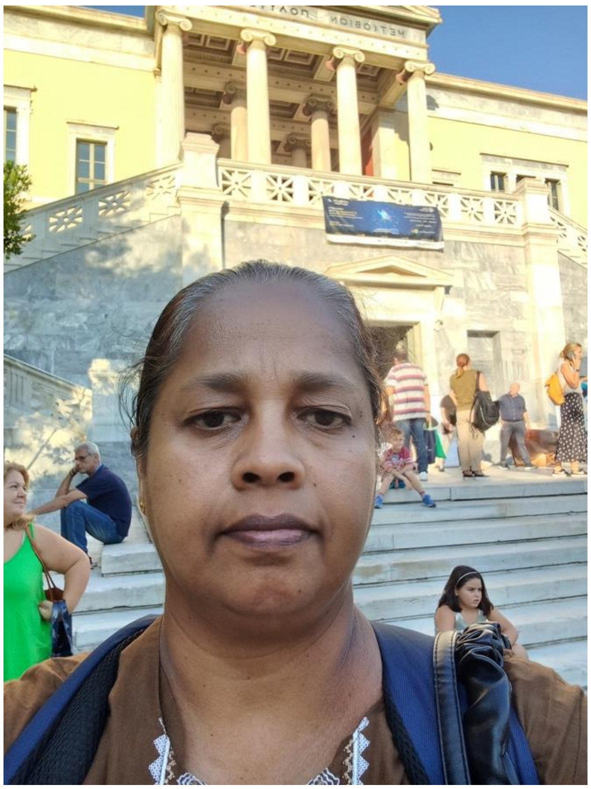
The heat from sunlight can present several challenges for GNSS equipment, especially when operating in harsh outdoor environments. Direct exposure to sunlight can cause GNSS equipment to overheat, which may lead to reduced performance or even permanent damage to internal components such as circuit boards, batteries, and processors. Prolonged heat exposure can degrade electronic components, reducing their lifespan and increasing the likelihood of malfunctions. GNSS devices often rely on batteries for power in the field. High temperatures can cause batteries to degrade faster, reducing their charge capacity and potentially causing premature failure. Excessive heat can also cause battery swelling, leakage, or even fire hazards in extreme cases.

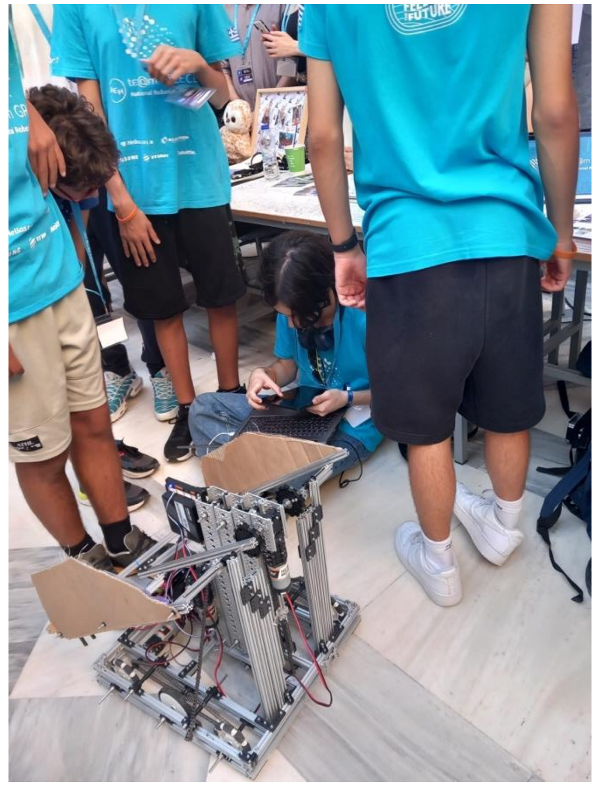
- ### Incomplete data recording

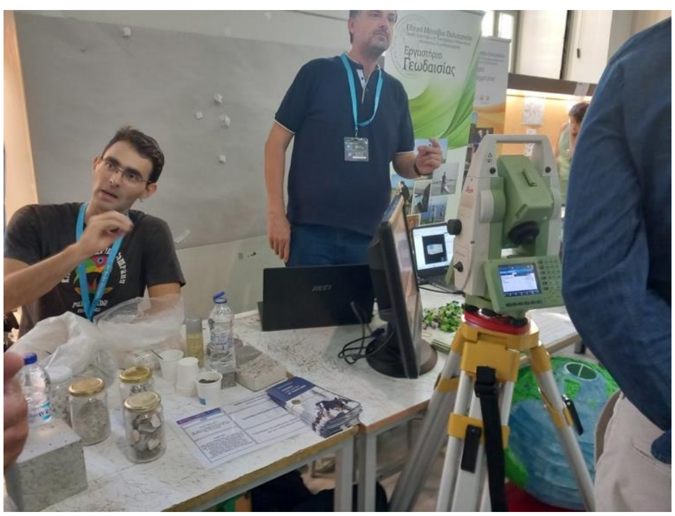
Many high-precision GNSS applications, such as surveying or geodetic monitoring, require continuous data for post-processing. Missing data points can make it impossible to correct errors like satellite biases, atmospheric delays, or multipath effects using methods such as Differential GNSS (DGNSS). Incomplete datasets may reduce the ability to apply baseline corrections, leading to less reliable or inaccurate results during post-processing. Without continuous data, it's harder to detect and filter out multipath errors (signal reflections from buildings or terrain) and other signal interference problems. A steady data stream allows the receiver to identify patterns in the data that indicate multipath and apply corrections or filters accordingly.

2.2 Attended the Research Celebration of NTUA 2024

The National Technical University of Athens, consistent with its appointment for the eleventh consecutive year, was organized the Researcher's Night for all the Universities and Research Centers of Attica on Friday, September 27, 2024 from 5 pm to 10 pm in the emblematic Averof building of the Patisia Historical Complex. It was open for all publics, mainly pupils, students, and teachers, in a festive mood. All could meet and discuss with the researchers and their achievements, and play and chat with them. I was fortunate to visit and to enjoy with the research achievements in different applications.






Εργαστήριο
Γεωδαισίας


Soft finger tests – experimental setup
High-speed camera-based system used to record the finger's response against step and sinusoidal input current commands
Micro QR Code attached at the fingertip to detect bending angle
ΠΡΟΣΟΧΗ!!!
ΠΡΟΣΟΧΗ!!!

2.3 Collaborated with MSc Research Thesis of Theodosia Makri

Ms. Theodosia Makri is a recent graduate with a degree in Geography from Harokopio University in Athens, Greece. She completed her thesis about ground-based meteorological radars and their application in extreme rainfall studies in her bachelor. Theodosia possesses skills in various software applications, including QGIS, MATLAB, Python, and IDV for creating geophysical data maps. She is proficient in English (C2 level) and has experience in data analysis, particularly in meteorological radar data. Her work experience includes an internship at the National Observatory of Athens, where she analyzed and visualized rainfall data using MATLAB.

She also completed a teaching internship as a Geography teacher at a middle school. Theodosia has worked on several projects during her studies, including burn area mapping, spatial inequality investigation in Attica, obesity prevalence research, and climate data visualization. These projects showcase her abilities in using various geospatial tools and conducting data analysis.

Theodosia's MSc thesis is based on the positioning capabilities of Low-cost devices as different types of mobile phone devices. Preliminary investigations and the test observations were conducted together. Detail discussions were carried with her to organize all the testing observations.