GPS-LESS (INDOOR) TRACKING

INTRODUCTION

Thesia is a localisation system for pedestrians, designed to pinpoint and track the elements of a squad of operators, seamlessly passing through mixed GPS-denied/available areas, in unknown environments.

Thesia has the following key features:

- zero-touch operation, wear-and-forget use;
- no need of external location-aiding infrastructures, deployed in the environment;
- no need of a prior knowledge of the environment, pre-operation setup or calibration, operator-dependent training phases;
- seamless use of GPS information, if any;
- it can be used to estimate the floor plans of unknown buildings and underground areas;
- its processing is light enough to be hosted in a commercial smartphone or in a small box.

The system is made up of two small devices; the first one is placed on the user foot and the second is located at the belt. This device can store internally the mission data or send it to a remote station in charge of the Command and Control task. The communications protocol between the two devices can be adapted to virtually any radio standard suitable for the customers.

Thesia is an "open system" and the user can use any standard or custom communication device on the WAN (Wide Area Network) communication channel that supports over the PAN (Personal Area Network) at least one of these standard (RS232, WIFI, BT40) to be connected to our device.

SMART SENSOR

The Thesia SmartSensor is an autonomous device that internally implements all the algorithms to follow the walker behaviour and reconstructs the full path.

ON PERSON

ON BOOT/SHOE
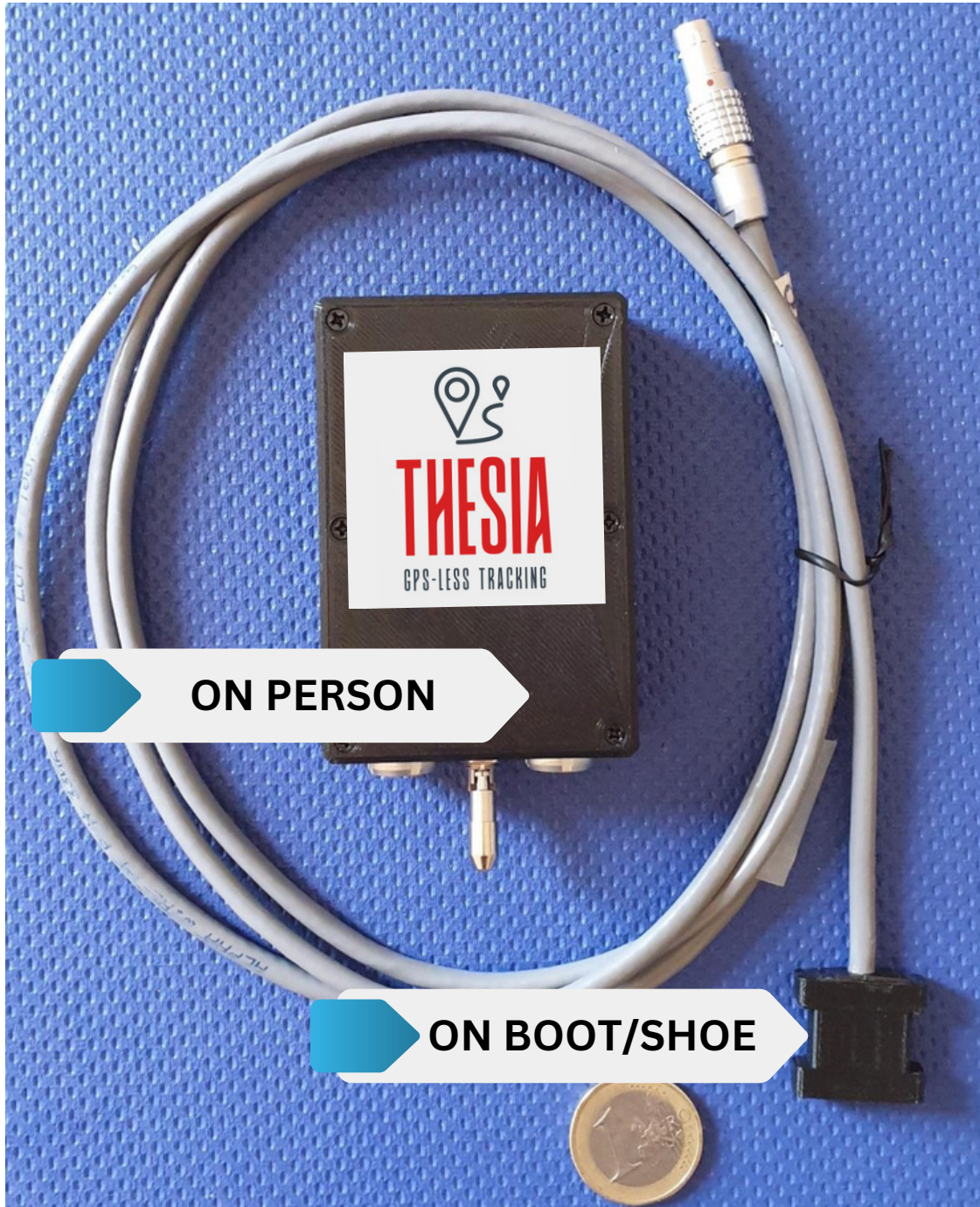
SMART SENSOR TECHNICAL DETAILS

Technical characteristics of smart sensor	
Battery capacity	2300 mAh
Battery voltage	3.7 V
Battery consumption	250 mA
Battery life	8 hours
Charging time	8 hours
Localization precision on the horizontal plane	0.5 – 1% of the trip length
Internal memory	Till 8.5 hours of both raw data and reconstructed track recording
Connection	Bluetooth 4.0
	WIFI 2.4GHz
	RS232
	USB (serial over USB)
Thesia device dimensions.	(MCU) 72 x 50 x 21 mm (standar version)
	(MCU) 90 x 56 x 25 mm
	(single sensor) 25 x 26 x 9 mm
	(multi sensor) 28 x 30 x 9 mm

After the start up, it continuously emits characters messages with a rate of 1Hz. Any message contains the last estimated position (X, Y, Z) related to the starting point (0, 0, 0) in decimetre (MKS) plus some auxiliary information (see # format description).

All the mission data are stored into the internal memory capable of more than 8 hours.

The payload of each transmission is less than 74byte@1sec. The transmission is a point to point channel that does not involve any server in the middle.

AUXILLARY DEVICES

The Thesia SmartSensor device could be connected to any device capable of managing the RS-232 connection, BT4.0 or WIFI connection. Any device used to perform data transmission should be like a "wireless wire" that brings to the local or remote user the "# formatted" messages.

Examples of these devices are:

- Smartphone using BT4.0 connection and the dedicated app, user can collect and transmit data to a remote computer by using the standard internet 3G/4G connection.
- Portable HotSpot using the WIFI connection the device can directly transmit the mission data to a remote computer by using the standard internet 3G/4G connection.
- WiFi area if the mission is all inside an area covered by a WIFI connection the device can directly send the data to a computer to visualise the track over a map in real time (ThesiaMap).
- Thesia RF Radio modem communication equipment (black box). These devices are at least a couple of Master / Slave devices. Moreover, a system needs at least a master device and between 1 and 10 slave devices. The master device can be connected to a standard Windows PC that "sees" an RS-232 device and manages the data request. It sends to PC the "# formatted" messages, one for each user at a rate of 1Hz. The standard window PC can collect these messages and save them into the HD and/or display the results on a plot/map. Like for the Thesia Bluetooth device it behaves as a "wireless wire" between the SmartSensor and the final user.
- IP Mesh Radio with WiFi capability.

This transmission is a point to point channel that does not involve any server in the middle and pathway is shown on map software in realtime.

Thesia developed its personal SW solution ThesiaMap / Thesia3DMap to manage the real time data collection over a team of maximum 5 users.

N.B.: The ThesiaMap SW can also act as a repeater over the TCP/IP connection. Indeed, it implements both a Server to let the Thesia device establish a remote connection to the ThesiaMap computer and an optional TCP/IP client to send the received and improved track to a secondary "Command and Control" computer for any further need.
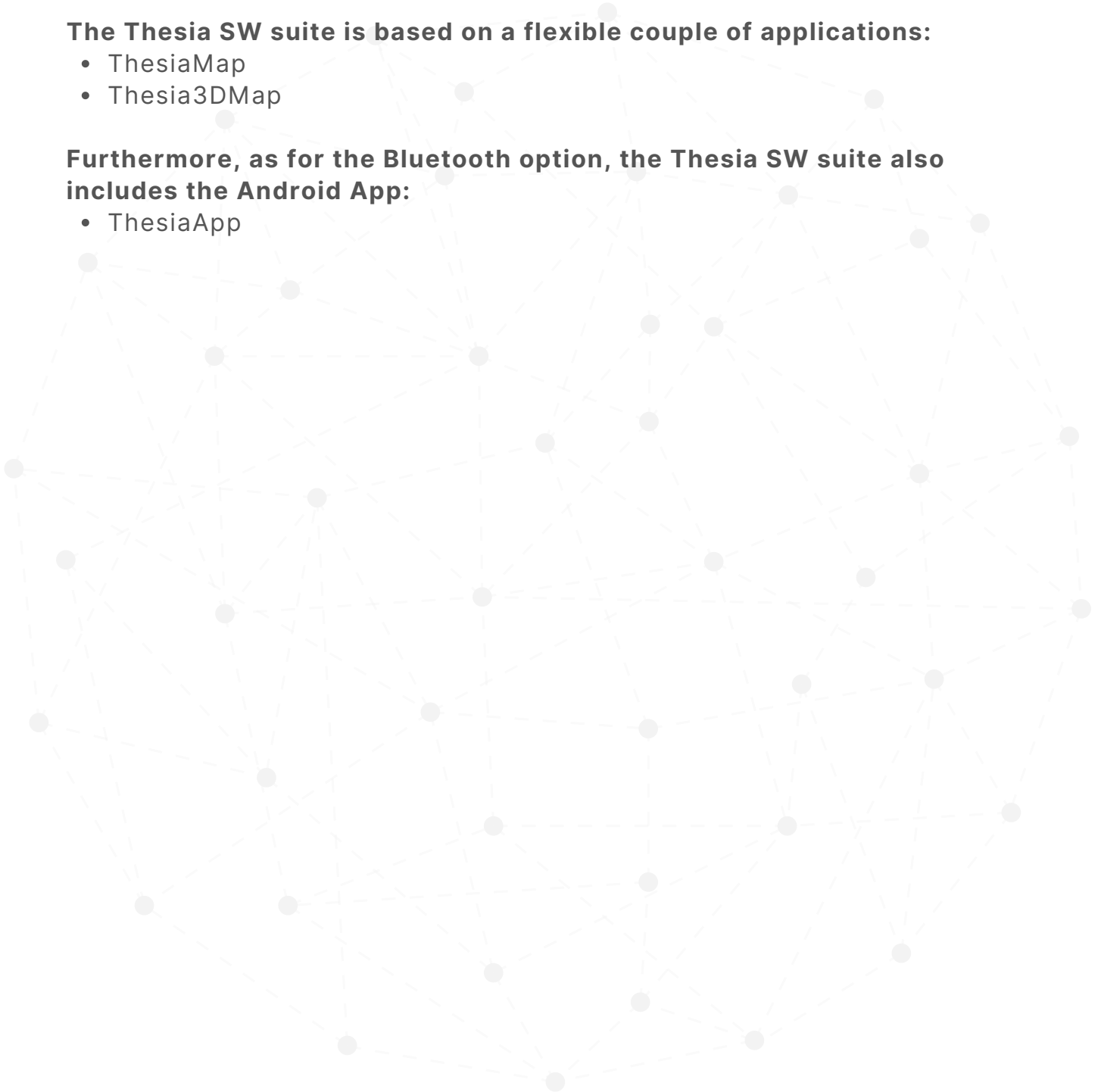
THESIA SW SUITE FOR TRACK DISPLAY

SOFTWARE LIST

The Thesia SW suite is based on a flexible couple of applications:

- ThesiaMap
- Thesia3DMap

Furthermore, as for the Bluetooth option, the Thesia SW suite also includes the Android App:

- ThesiaApp

THESIA SW SUITE FOR TRACK DISPLAY

THESIAMAP PC SOFTWARE

ThesiaMap is the main software and implements the following features:

- It manages the real time data collection from the sensors and saves this data to a mission file. This data collection can be managed in the following ways:
    - RS232 connection to the sensor (by using any kind of wireless "bridge")
    - TCP/IP connection.
- The ThesiaMap SW behaves as a server. The client (for example the ThesiaApp on a smartphone) opens a connection to the Computer IP address at Port 13000. The TCP/IP connection should simply transfer the # messages to the server. Any other character present into the stream but not belonging to the messages, will be discarded.
- It manages up to five contemporary tracks (team).
- It manages the plot of the track over a 2D map background in order to see it on a map scenario.
- It manages the plot of the track elevation vs time in order to see the track elevation and its floor segmentation.
- It manages the floor plan import and edits (move, rotate and resize) over the map view in order to have a further layer of information over the map. The floor plan formats supported are standard jpg/png images file like a photo of a floor plan. The imported floor plan can easily be adapted to the ground constraint.
- It manages the import of the photos. If a photo is taken during the mission, it is related to the track and gives again a further layer of information on the track.
- It implements the real time processing algorithm to estimate the best reconstructed path.
- It allows the user to move and rotate the track in post processing.
- It let the user to improve the starting position and the track rotation, also in real time.
- It can export the corrected track in different formats (Text file, XML file, KML file) to import into different programs (like for example into Thesia3DMap).

THESIA SW SUITE FOR TRACK DISPLAY

THESIAMAP PC SOFTWARE

- It manages the Map server selection (Bing, Google, OpenStreetMap, etc) in order to change the map background.
- It manages the project creation (SQLite format) to save all the information (tracks, floor plans, photos) in a single file. The project file can be later re-opened to restore the last saved scenario.
- It let the user to see in real time a 3D track snapshot in the Thesia3DMap SW.

THESIA SW SUITE FOR TRACK DISPLAY

THESIAMAP PC SOFTWARE
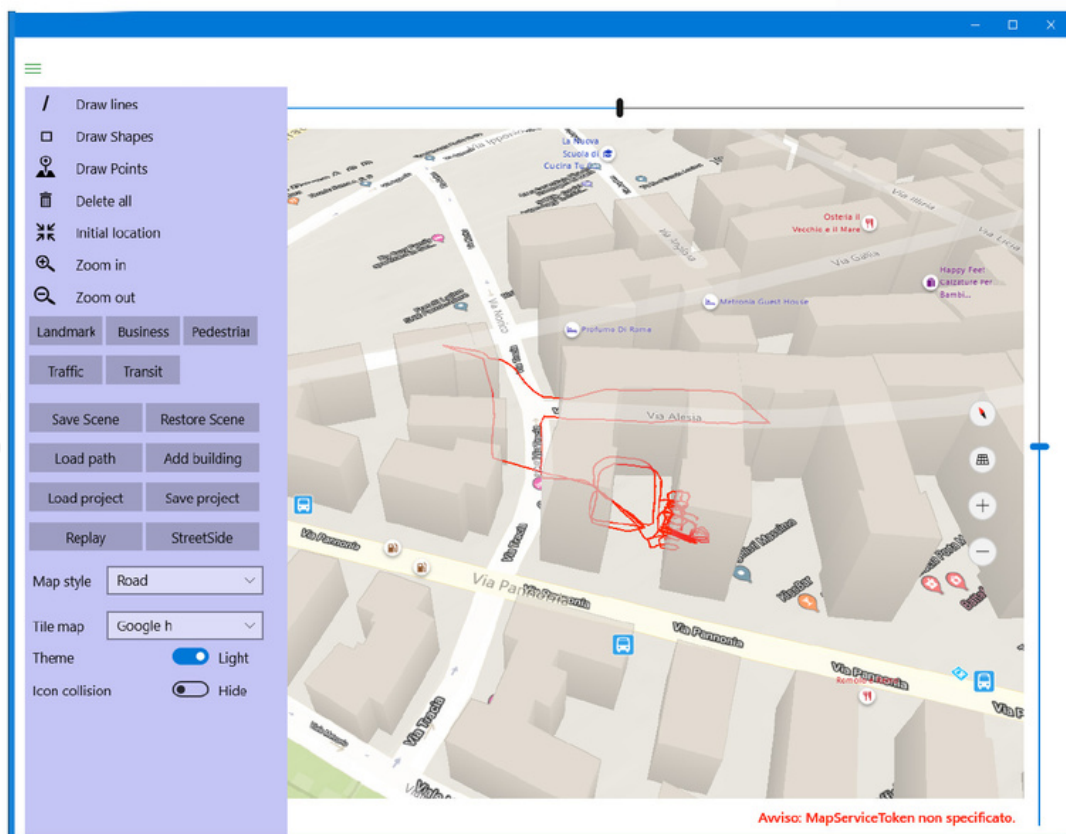
THESIA SW SUITE FOR TRACK DISPLAY

THESIAMAP PC 3D SOFTWARE

Thesia3DMap is an auxiliary software to explore the tracks into a 3D map environment. It implements the following features:

- It let the user to import an ThesiaMap exported track.
- It allows the user to select different map views: o None o Aerial with semi-transparent 3D schematic building from the Bing 3D Map server. o Non transparent 3D building with the photographic tile style.

To any map selection, the user can also apply a texture taken from a different map provider like Google to improve the visual information.

- It can import 3D building CAD models in the format.3MF. This building can have the transparent texture to look into. The user can also move and rotate the CAD models on the map to better fit the track/ground physical constraint.
- It allows the user to perform a mission Replay in the 3D scenario.
- It allows the user to save and load 3D track projects in a SQlite format.

THESIA SW SUITE FOR TRACK DISPLAY

THESIAMAP ANDROID SOFTWARE

The ThesiaApp application implements these features:

- It manages the SmartSensor connection over Bluetooth 3.0.
- It opens a connection to a remote Computer at its IP address (Port 13000). The TCP/IP connection should simply transfer the # messages to the server. Any other character present into the stream but not belonging to the messages, will be discarded.
- It opens the connection and sends to the SmartSensor the commands to let it start.
- It collects the SmartSensor stream data (# message @1HZ).
- It saves this data to the internal memory.
- If a connection with a remote server is opened, it sends this data remotely.
- It can show a real time track plot in order to have a rough view of the track.
- It can also collects information from the smartphone (if the smartphone is capable of) like GPS info, Barometric info, Wifi hotspot, NFC tag, QRCode tag, user actions. All this extra information is saved internally and can also be sent to the remote server for adding a further information layer to the map.

NOTE: This application is intended as a "data collector" that does not need any user interaction in order to avoid user distraction during the mission. Anyway, the user can interact with the application in order to add some extra information. Specific future requirements could be evaluated.

MINIMUM HARDWARE REQUIREMENTS

PC

There are no significant minimum required characteristics for the Thesia
SW suite but we suggest these minimum requirements for the SW
practical usability.
- Last Window 10 Build (for Thesia3DMap)
- i5 intel processor (or equivalent)
- 8GB Ram
- Display 24 inches Full HD (1920x1080)

SMARTPHONE

There are no particular constraints related to the Android Smartphone.
The ThesiaApp is able to run on a standard Android Smartphone.

The minimum suggested characteristics are:
- Android based (minimum version 7)
- Bluetooth 4.0
- 1GB Ram
- 16GB Rom
- 5 inches display

It could be useful but not required in order to collect auxiliary information,
that the smartphone is equipped with some internal sensors to collect
other data, as:
- GPS
- Barometer
- NFC
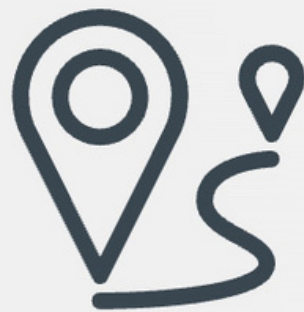- Camera
- Compass
- Temperature
- Humidity

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