

Marvelmind Ultrasound + IMU sensor fusion post-processing

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1. Executive summary

Marvelmind Ultrasound + IMU sensor fusion post-processing feature allows smooth 100 Hz tracking based on recorded ultrasound and IMU data from the Marvelmind positioning system.

The Basic Marvelmind navigation system provides a typical ~1-20 Hz update rate depending on the distances between beacons, the number of stationary and mobile beacons, and other factors.

2. Basics of the system

To use the Ultrasound + IMU sensor fusion post-processing feature, you need the following:

- Regular Marvelmind navigation system with [IA architecture](#) and 3D tracking, using [Super-Beacons](#) as mobile beacons. For example, you can use [Starter set Super-MP-3D](#) for this
- Additional [Modems HW v5.1](#) with special firmware of “Radio Head USB” (RHU) – one per mobile device – placed near the computer and connected to its USB port or its USB hub
- Licenses [MMSW0005](#) for all beacons in the system
- Licenses [MMSW0009](#) for all mobile beacons used for IMU sensor fusion post-processing

You need one RHU for each mobile beacon in the system.

Software for this configuration is placed in the “02_Ultrasound_IMU_post_processing” of the Marvelmind [software package](#).

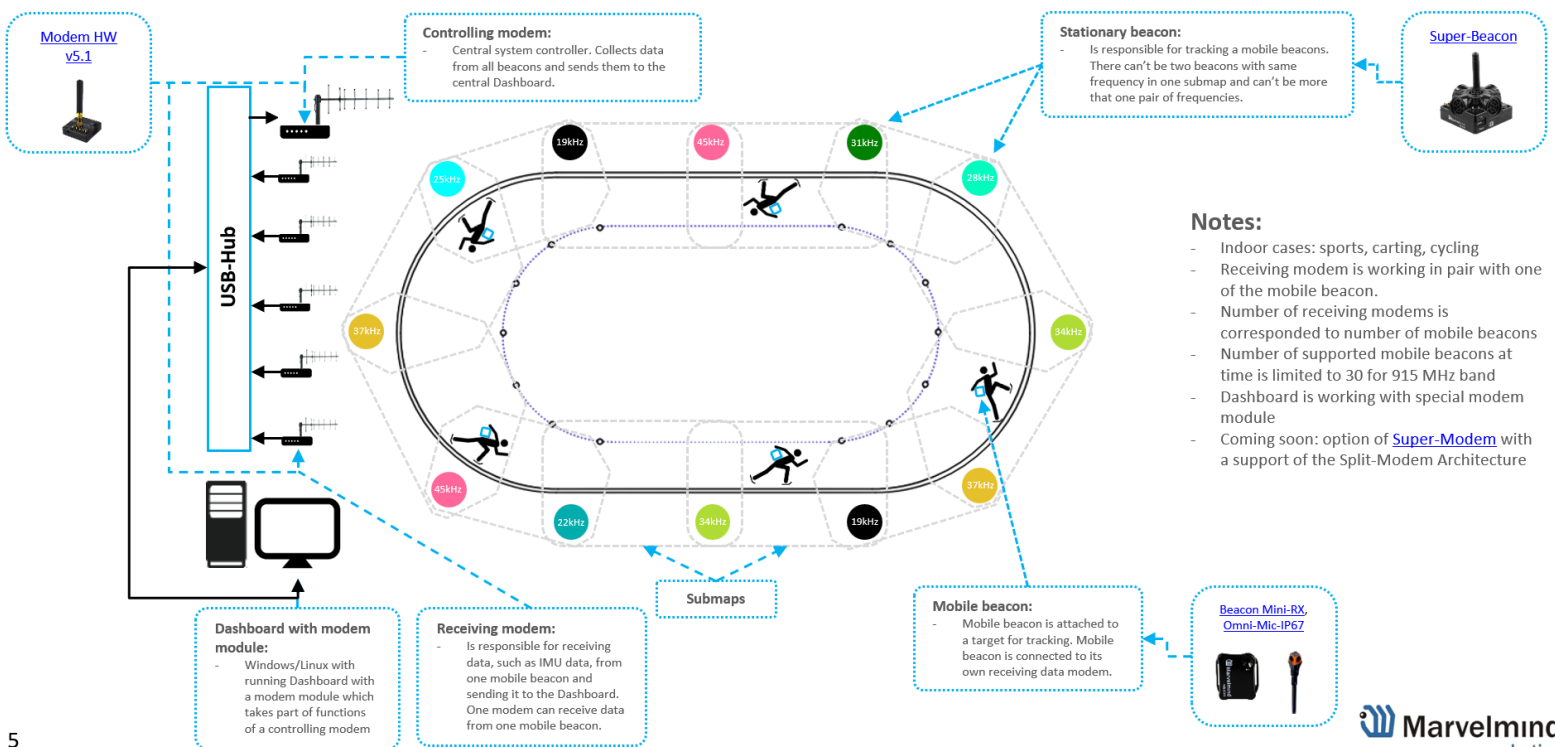
Each mobile beacon (Super-Beacon or Mini-RX) connects to its RHU via a separate radio channel and transmits location and IMU data via this channel.

Each RHU should be connected via USB to the same PC as the modem controlling the Marvelmind navigation system.

The whole scheme of connections looks as in the below picture.

Split-Modem architecture for fast-moving objects

Ice skating example for fast-moving tracking



The picture shows the whole system in action. With multiple mobile beacons, each mobile beacon establishes a radio connection via a separate radio channel to separate RHU. Every RHU is connected to the PC with a Dashboard with modem module via USB-Hub.

3. Preparing the system for use

- Connect each device (stationary beacons, mobile beacons, controlling modem, receiving modem (RHU)) to the PC with the Dashboard via USB and upload firmware from the latest [software package](#). Take the software from the “02_Ultrasound_IMU_post_processing”. Note that mobile beacons should be uploaded by separate firmware (not same as for stationary beacons).
- After uploading firmware to mobile beacons and RHU, assign their addresses and radio channels according to the following rules:
 - Each RHU should have same address as its mobile beacon
 - For each pair of mobile beacon and RHU should be assigned an equal radio channel (parameter “Base frequency” in the “Radio settings” section of settings). Each mobile beacon/RHU radio channel should differ at least by 1 MHz from other mobile beacon/RHU channels and at least by 3 MHz from the main Marvelmind navigation system radio frequency (919 MHz by default).
 - Note that mobile beacon has two sets of radio settings – “Parameters of radio: RX” is related to communication with RHU, “Parameters of radio: TX” is related to communication with controlling modem of Marvelmind navigation system.
- Build the Marvelmind navigation system map and successfully track mobile beacons. See the [Placement Manual](#) and the [Operating Manual](#) for details.
- Connect RHU to the same PC where the modem is connected, and the dashboard is running, showing tracking of mobile beacons. Make sure LED on the RHU is blinking with high frequency (20 Hz); this means RHU receives data from the mobile beacon. RHU should appear as a device on the button on the bottom side of the dashboard.
- Apply the required licenses (MMSW0005 and MMSW0009). Copy license files to the ‘licenses’ subfolder of the dashboard folder. Select the “Licenses/Update all licenses” menu to update the licenses in the dashboard. MMSW0009 licenses can be time limited. To activate the license right, click on the button of the mobile beacon (or on its icon on the map) and select the “View/activate licenses” item. Find the MMSW0009 item in the list and press the blue “Not activated” button if the license was not previously activated. After activation, the button shows remained the time of the license.
- Select menu “View/Ultrasound+IMU sensor fusion post-processing”. In the center column of the window appeared in the list of mobile beacons. They can be marked by the green color – ready to use, yellow color – not calibrated, or red color – if no IMU data is received from this beacon.
- Select yellow (not calibrated) beacons in the list and press “Calibrate” in the right column to calibrate the gyroscope. The beacons in the list should become green. After 24 hours, the calibration will become obsolete, and the beacons in the list will become yellow again. You can also repeat the calibration even when the beacon is green in the list.

After the above, the system is ready to use, and you can record and process the tracking.

4. Use the Ultrasound + IMU sensor fusion post-processing.

After the steps from the previous chapter, you have a system ready for recording the IMU and ultrasound tracking data. When prepared to track, press the “Start log record” button and execute all actions with the mobile beacon to be recorded.

After finishing the wanted actions, press the “STOP LOG RECORDING” button, now the raw log is saved into the “logs” subfolder of the dashboard with the current date and time in the file name and “_IMU” at the end of the file name.

Now you can press the “Search track” button to find the 100 Hz IMU+ultrasound sensor fusion track. The progress of the operation is shown below the button. The estimation time of the calculation is $10+0.12*T$ seconds, where “T” is the time of the source tracking in seconds.

If you don’t need to search track for some mobile beacons, you can uncheck the list before starting the search.

During the search, you will see current intermediate result tracking. After the finish of the search, you will see the final result.

The result is automatically saved into the new log file in the “logs” folder. You can also save its copy by using the “Save” button.

You can open the previously saved log by the “Load” button and see the resulting track or repeat the search track procedure.

Saved files in the logs folder differ by their suffixes:

- “*_IMU.log” – raw log file after recording
- “*_IMU_post_processing_autosave.log” – files with intermediate results saved during the search. It saved every 3 seconds. A new file is created every 1 minute.
- “*_IMU_post_processing_interrupted.log” – latest intermediate result after interrupting the search process by the button
- “*_IMU_post_processing_final.log” – file with the result after the successful finish of the search process

5. Contacts

For more information about company check: [About us](#)

For additional support, please send your questions to info@marvelmind.com