CASE STUDY

HORIBA MIRA

Indoor positioning solution for the development of Autonomous Valet Parking (AVP) and other ADAS systems.

≤ 5 cm indoor position accuracy with AB Dynamics integration

Summary

Company:
HORIBA MIRA

Industry:
Automotive product development

Country:
United Kingdom

Website:
www.horiba-mira.com

"Having a first-of-its-kind facility, we needed a first-of-its-kind solution. OxTS delivered the robustness that our clients expect from HORIBA MIRA's ASSURED CAV Parking"

Needing accurate indoor position data for their new, purpose-built multi-storey car park test facility, HORIBA MIRA's ASSURED CAV team looked for a bespoke solution.

They worked with the OxTS Engineering team, OxTS channel partner, Datron Technology, and OxTS technology partner, Pozyx. The result is a robust, ultra-wideband-aided solution that offers indoor positioning accuracy, to within five centimetres, complete with AB Dynamics integrations.

This is how they did it...

Who is HORIBA MIRA?

HORIBA MIRA is a global provider of automotive engineering, research and test services, with 75 years of experience in developing some of the world's most iconic vehicles. Working in collaboration with vehicle manufacturers and suppliers around the world, they provide comprehensive support ranging from technology development and individual product tests through to full-vehicle design, development and build programmes. Their new, world-leading connected and automated vehicle test ecosystem, ASSURED CAV, provides the latest facilities to support the design, development and testing of self-driving technology.

The ASSURED CAV Parking facility is just one of the new physical testbeds available. The purpose-built multi-storey car park supports the development of self-parking solutions by replicating real-world situations in a fully configurable, safe and controlled environment.

The ASSURED CAV Parking facility is the first of its kind.

What was the overall aim of the project?

The aim of this project was to provide the ASSURED CAV Parking facility with an indoor localisation solution that could output centimetre-level position accuracy in the absence of GNSS signals, such as GPS.

Ashley Patton, Lead CAV Test Engineer at HORIBA MIRA, and his team, needed a solution that would offer clients the ability to conduct **safe, accurate and repeatable testing** in their representative car park environment.

With the facility set to open in early 2021, the initial requirement was for this solution to operate on one of the car park's five levels. Floor-to-floor and outdoor-to-indoor transitions would be supported over the coming months, giving full floor, ramp and transitional coverage.

The initial requirement was full coverage on the second of five levels.

Challenges

Ashley's main challenge was to find an indoor localisation solution that could output accurate position data in the absence of GNSS signals, such as GPS. Most position measurement devices used for automotive testing rely on GNSS signals in position calculations, owing to their ubiquity and centimetre-level accuracy. However, GNSS-aided solutions were inappropriate for HORIBA MIRA's facility, as the signals would be obstructed by the physical infrastructure.

It quickly became apparent that a suitable off-the-shelf product did not exist and so HORIBA MIRA turned to its trusted supplier of automotive testing equipment, and OxTS channel partner, Datron Technology, to discuss a custom solution.

The first step was to set the scope and detail the specific requirements of the custom solution, so that the OxTS R&D team, led by Ioan Cleju, Navigation Manager, could develop a viable proposal.

OxTS' Ioan Cleju (left) and Charlie Marshall (right) led the solution's development.

Given that the solution would be used for the sole purpose of developing, validating and verifying AVP, Park Assist and other related systems, there was a particular focus on low speed manoeuvres with small vehicle-to-target distances.

The final requirements stated that the solution must:

- Provide full coverage of the ~650 m^2 space
- Output position data in the absence of GNSS signals
- Output position data with a minimum accuracy of 5 cm
- Output heading data with a minimum accuracy of 1°
- Provide coverage for the Vehicle Under Test (VUT) and one moving target
- Retain accuracy up to speeds of 30 kph
- Integrate with AB Dynamics' driving robots for accurate path following
- Avoid making any infrastructure changes (bright lights, obvious markers, etc.) that would confuse relevant perception systems, such as radar, camera or lidar

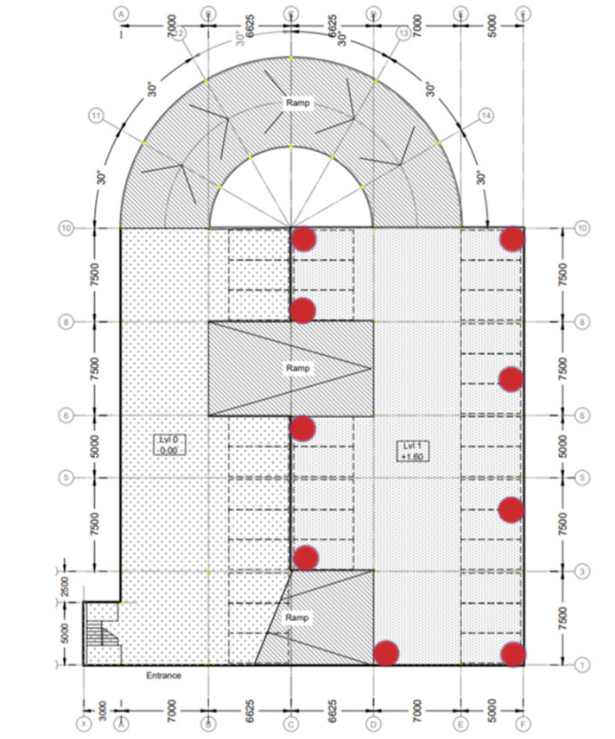
As Ashley explains, "OxTS already had a reptutation for achieving, and often exceeding, these specifications with GNSS, so we were confident that they could do the same without it". The OxTS R&D team set out to find an aiding source that could deliver.

Solution

The agreed upon solution uses ultra-wideband (UWB), from OxTS technology partner, Pozyx, as an aiding source for the RT3000 v3. UWB was the ideal candidate owing to accuracy comparable with camera and LiDAR at a cost comparable with Wi-Fi and Bluetooth Low Energy (BLE). The Pozyx UWB system also avoided the need for any obvious changes to the physical infrastructure of the test area.

There are two main components that enable the Pozyx UWB system to provide position aiding to the RT3000 v3: anchors and tags.

Anchors are a series of modules dispersed around the testing area. They each have a known position and they are static, so the relative position between them does not change. A minimum of four are needed to trilaterate position; nine of them are used in the HORIBA MIRA installation, as indicated below:



Floor plan of test area with anchor positions (red)

Tags are devices that transmit short pulses to the anchors, and are placed on the exterior of the test vehicle(s). HORIBA MIRA use two tags on each vehicle. The tag's relative position to each fixed anchor changes throughout a test manoeuvre, as does the time-of-flight for each pulse.

The Pozyx system could use these raw time-of-flight measurements to trilaterate position, achieving an accuracy of < 30 cm. However, in this instance, the raw measurements are passed onto the RT3000 v3, via additional processing hardware, where they are coupled with OxTS inertial measurements. By doing this, erroneous position updates, caused by reflections etc., can be filtered out. The resulting position accuracy increases to ≤ 5 cm.

The output from the RT3000 v3 is delivered at a high data rate, with low latency, and is unchanged from that which is provided when using GNSS-aiding. This means that existing integrations with other testing equipment, such as AB Dynamics driving robots, remain in place, and function as required.

"To achieve position accuracy of 5 cm, or better, across the test area, we combine the raw time-of-flight measurements with the RT3000 v3 Inertial Measurement Unit data. The navigation engine can then identify and remove erroneous data points, resulting in a more accurate positioning solution."

Ioan Cleju, Navigation Manager, OxTS.

HORIBA MIRA solution specification	
Position accuracy* **	≤ 0.05 m (1D RMS)
Heading accuracy	1° RMS
Data output rate	100 Hz (optional 250 Hz)
Positioning technique	Two-way ranging (TWR)
Integration with AB Dynamics	Yes

*Tested below 30 kph, performance will degrade as speeds increase

**RMS performance will vary depending on environment setup

Products used

OxTS RT3000 v3

The heart of the solution: the RT3000's navigation engine fuses generic aiding data from the Pozyx tags with it's inertial measurement unit (IMU) to produce a single position solution; one with greater accuracy than either input could achieve in isolation.

This is achieved using OxTS' proprietary Generic Aiding interface which facilitates the use of different types of sensors (such as Pozyx' UWB) with inertial measurements.

The output of the system is unchanged from that produced from GNSS-aiding, delivered at a high data rate (100 Hz or 250 Hz), with low latency, ensuring that existing integrations with AB Dynamics' driving robots work as normal.

Pozyx anchors/tags

The Pozyx system is split into two main components; the tags and anchors. The anchors are permanently installed on site and their coordinates accurately surveyed. The Pozyx tags are placed on the vehicle(s) of interest, similar to fitting GNSS antennas. The tags are able to determine their range to each individual anchor. This information is then passed to the processing box.

Processing box

This device trilaterates the position of each tag and then generates the generic aiding data that allows the RT3000 v3 to navigate without a valid GNSS position. Data from multiple tags is processed concurrently to generate a generic aiding stream. The processing box also powers the Pozyx tags.

Results

In March 2021, the team at HORIBA MIRA signed off that the solution met their requirements. OxTS Engineers, Ioan Cleju and Charlie Marshall, completed a demonstration of HORIBA MIRA's new indoor localisation capability at the ASSURED CAV Parking facility, which included a series of path following manoeuvres, using AB Dynamics' driving robots and Soft Pedestrian Target (SPT). The accuracy of the system was demonstrated using OxTS IMU+ reflective strip technology which provided absolute position reference points along the path.

Ashley commented that he was "impressed, but not surprised, by the quality of the solution that OxTS has delivered. In my experience, they never promise more than they can deliver, so when they presented their proposal, I was pleased and I was confident. Having seen the system in action, it offers the robustness that the ASSURED CAV brand requires and I'm looking forward to extending the capability further".

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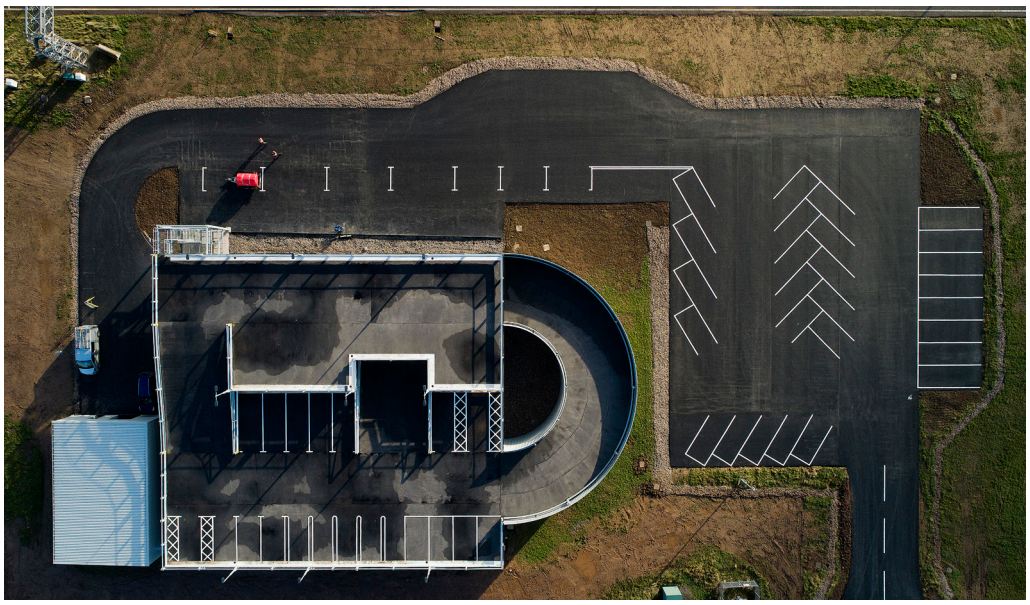
Ashley Patton, Lead CAV Test Engineer, HORIBA MIRA.

In the coming months, HORIBA MIRA will continue to work with OxTS, Pozyx and Datron Technology to include floor-to-floor and indoor-to-outdoor transitions; allowing the team at HORIBA MIRA to offer clients an enhanced Automated Valet Parking test facility.

The project was completed in March 2021. Further development work is underway.



Considering your own indoor testing requirements?

Contact OxTS with any questions you have about this indoor positioning solution. Together with Pozyx, and your local OxTS channel partner, our team are happy to help.

The global leaders in accurate position, orientation and dynamics measurements since 1998

At OxTS we're passionate about inertial navigation and how we can help our customers with our technology. With over two decades of experience in combining the best of high precision aiding sources and world-class inertial navigation expertise, OxTS' products have become the industry standard for automotive testing and are widely used in other industries.

Our products provide position, roll, pitch, heading and other measurements of vehicles on land, sea and in the air. Our world-renowned RT3000 is used throughout the automotive industry for vehicle dynamics testing, validating advanced driver assistance systems (ADAS) and developing automated driving technologies.

Find out more

To find out more about this indoor positioning capability please visit www.oxts.com

For more information on HORIBA MIRA's ASSURED CAV ecosystem, please visit www.horiba-mira.com/assured-cav/

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