AAEON's PICO-TWL4 Powers Researchers' Deep Dive into Ocean Exploration

Overview

Seabed mapping is a vital area of academic research with utility across disciplines such as geoscience, marine biology, and climate change research. Global awareness of the changes that the marine ecosystem has undergone in recent decades has increased, while the impact that such exploration can have on shaping environmental initiatives is also profound.

One group contacted AAEON to find an embedded computing platform capable of powering an autonomous underwater vehicle (AUV) for academic research, including seabed mapping and sample analysis. After careful consideration of the project parameters, the customer found that AAEON's PICO-TWL4 held the key to unlock the secret of the seas.

Project Requirements: A Deep Dive

Maximizing Mission Duration

Central to the customer's need was that their AUV be able to cover large areas, which meant the unit would be in operation for long stretches of time. Given the AUV would be unmanned, the option of incorporating hot-swappable battery units was not feasible, and so the focus turned to maximizing power efficiency.

Stable, Precise Navigation

Studying previously unexplored places presents a plethora of challenges, being able to navigate them being top of the list. Unlike autonomous vehicles that operate in settings such as factories where the vehicle's surroundings are largely predictable, AUVs must navigate a complex 3D environment.

Motor Control for Sample Collection

The purpose of the AUV's deployment was to collect samples from the seabed across different areas, and so the platform chosen to power it would not only require support for object detection and avoidance to avoid hazards during missions, but be able to issue motion control commands to payloads.

Steering the Ship: The PICO-TWL4

Given the delicate balance of functionality and environmental stability required, AAEON's PICO-TWL4 stood out as the perfect platform to help the customer on their journey.

Quad-Core Processing with Low-Power States

The PICO-TWL4 is available in models powered by either the Intel® Core™ 3 Processor N355 or ® Processor N150, both part of the efficiency-focused Intel® Processor N-series (formerly Twin Lake). For their project, the customer opted for the model featuring the Intel® Processor N150, as it offered both the processing power required for the AUV to function reliably while also maintaining a low power footprint.

Despite the Intel® Processor N150 operating at a base power of only 6W, its four cores and relatively high clock frequency made it more than sufficient when it came to executing parallel tasks like sensor fusion from peripherals, payload control, and handling navigation data.

In addition to this, the PICO-TWL4's BIOS enables CPU C-states by default and supports S3 mode, allowing the board to dramatically reduce its power draw when the AUV did not require active processing, and seamlessly resume operation when needed.

Environmentally Sound Customization

The PICO-TWL4's low-power, efficiency-focused processing platform boosted the distances the AUV could travel while also extending the time it could continuously operate, allowing researchers to undertake more ambitious projects. However, AAEON also customized the board, replacing the standard lithium battery with a supercapacitor.

While this customization was initially requested due to the fact that supercapacitors can be charged and discharged almost endlessly without major degradation, which suited the use scenario of the AUV, it also drastically reduced the downtime of the AUV. Charging speeds for supercapacitors hover at around 300 seconds, while lithium batteries often take several hours, representing a major barrier to research expeditions in largely remote places.

Multi-Sensor Support

While the PICO-TWL4 measures in at only 100mm x 72mm, it provided a variety of interfaces to support the sensors required by the AUV to acquire navigation and positional data. Chief among these features was a 40-pin header that provided four COM port connectors, two offering RS-232/422/485 protocols and two offering RS-232.

To ascertain the AUV's dead reckoning and altitude in relation to the seabed, two of the COM port connectors supported an Attitude and Heading Reference System (AHRS) and an altimeter, respectively. The former ensured the AUV could be accurately tracked, providing 3D orientation and both absolute and relative heading data in real-time, while the latter enabled the vehicle to avoid collision with nearby obstacles and the seabed itself.

A third COM connector from the header was used to install a sonar, facilitating safe movement by identifying objects in the AUV's path and contributing to local mapping for path planning.

Additional sensors were incorporated into the AUV through the PICO-TWL4's two USB 3.2 Gen 2 ports and four internal USB 2.0 connectors. These included auxiliary peripherals for more mission-focused data acquisition, such as sensors to monitor temperature, water pressure, and distance.

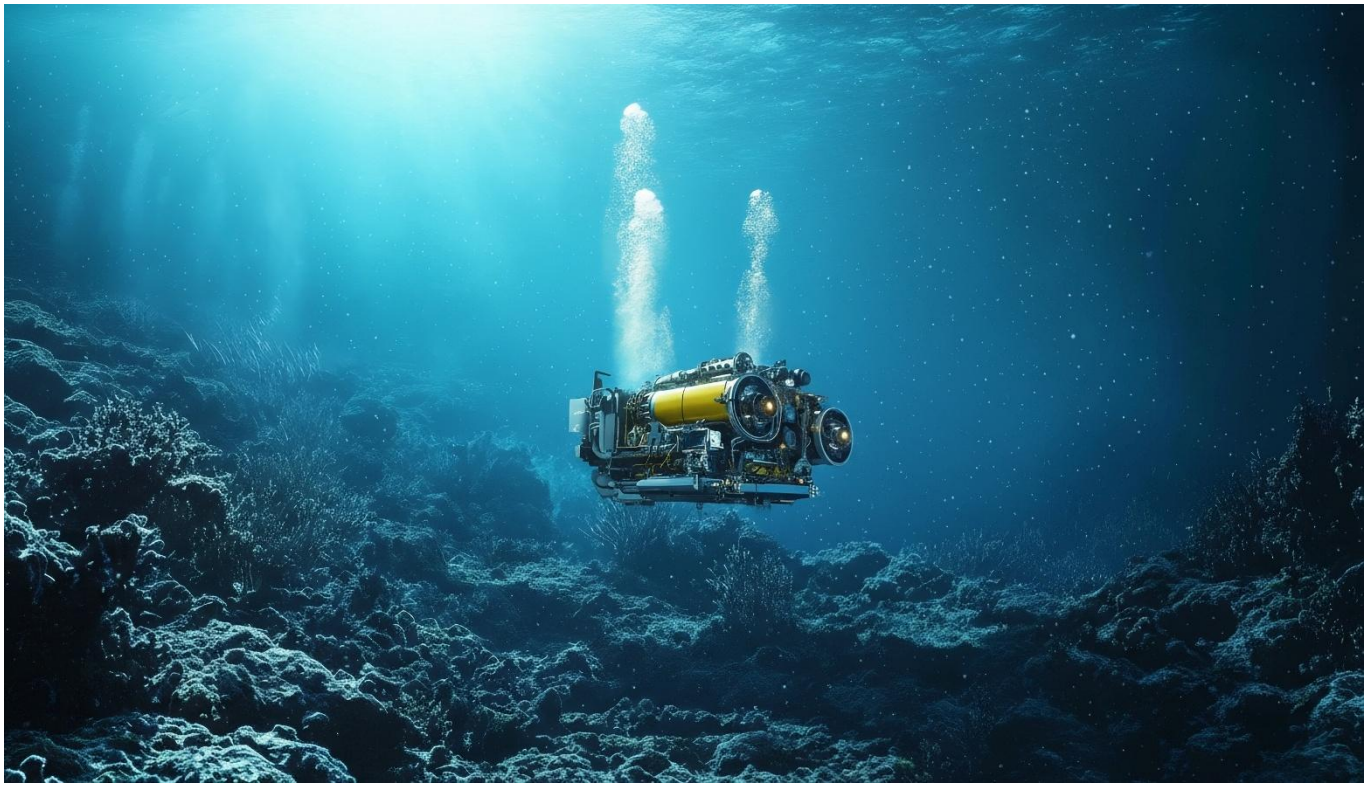
Real-Time Payload Control

In order to collect samples from the seabed, the AUV's central computing unit needed to have a method of communicating with motion-control devices. This is where the PICO-TWL4's dual LAN ports came into play. Boasting two RJ-45 ports running at 1GbE and 2.5GbE speeds, the PICO-TWL4 could issue commands to the AUV's water samplers and suction pumps.

These commands needed to be incredibly precise, given the critical nature of positioning accuracy. The primary interface used to issue motion commands was the PICO-TWL4's RJ-45 powered by the Intel® Ethernet Controller I226 driver package.

This was because the port's Time-Sensitive Networking (TSN) capabilities, which include functions such as Precision Time Protocol (IEEE 1588) which executed instructions with precise timing relative to navigation sensors, synchronizing 3D positioning data across all inputs. As a result, the AUV was able to implement coordinated multi-payload operation to obtain samples while accounting for other variables tracked by the system's AHRS, altimeter, and sonar.

Impact



By successfully deploying their AUV with AAEON's PICO-TWL4 as its primary controller, the customer was not only able to effectively carry out a variety of academic research projects, but also experienced incidental benefits as a result of their product choice.

One such benefit was the extended operation time that could be achieved through a combination of the PICO-TWL4's low power processing base and dynamic power management.

Overall system downtime was also reduced to a matter of minutes thanks to the speed with which its supercapacitor could be recharged. This customized component inadvertently contributed to the longevity of the AUV as a whole, given its tolerance for continuous charge/discharge cycling. Moreover, lithium batteries are susceptible to overheating or even explosion under extreme temperatures, making the use of a supercapacitor safer and more thermally stable given the demanding environment the system would be operating in.

Adding to this longevity are the variety of interfaces available on the board itself. Rather than relying on a narrow, yet specialized method of communication between the board, sensors, and payloads, the application utilized a variety of both established modern and legacy communication protocols, a fact that serves to future-proof the board as more sophisticated technologies emerge.

Ultimately, the PICO-TWL4 not only allowed the customer's project to set sail, but to reach new depths in academic seabed exploration and guide what will hopefully become a wave of new insights into the utility of autonomous vehicles in marine research.

About AAEON

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