Developing a smart device

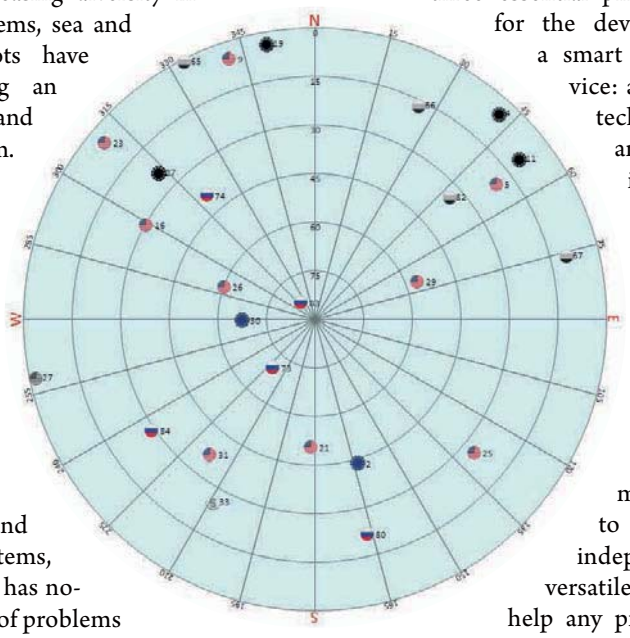
PILOT EQUIPMENT Over the course of more than two years, Trenz AG has cooperated with the German sea and harbours pilots to develop a smart piloting device with advanced connectivity, built-in sensor capabilities, and cloud-connected applications. In the following article, Adrian Drechsel, chief developer, and Klaas Engels, app developer, describe its functionalities.

Pilotage is a highly responsible task which gets more challenging as vessels get larger and harbours become more complex. Handling many different vessels and increasing diversity in onboard systems, sea and harbour pilots have been seeking an independent and reliable system.

Since Trenz AG is collaborating closely with the German sea and harbour pilots as it develops supporting hardware and software systems, the company has noticed a range of problems with the pilot plugs that are currently available and in use. This is partly because of a lack of support and partly because of an inadequate wireless range, especially on post-Panamax vessels. A pilot plug is a device which connects to the Pilot-Port aboard to provide automatic identification system (AIS) data relating to vessels in the proximity.

AIS is based on a mesh network, which most recently gained publicity as a result of new Internet of Things (IOT) using this communication technology. The network itself does not use a simple access point and client structure, but is based on nodes where all nodes in a network can send and receive the data stream while appending own data.

When Trenz AG started developing its pilot plug, the company analysed the majority of use cases and the challenges that were often experienced in the use of shared devices. Despite the fact that most devices just act as an ordinary AIS repeating device, the lack of logic was evident in almost every tested or considered device. As a result, the company defined three essential pillars required for the development of a smart pilotage device: a well-proven technical design and concept; intuitive user interfaces; and an easy, lightweight app with IOT features based on cloud services. The main goal was to develop an independent and versatile device to help any pilot with the most essential manoeuvre in harbour or open sea.

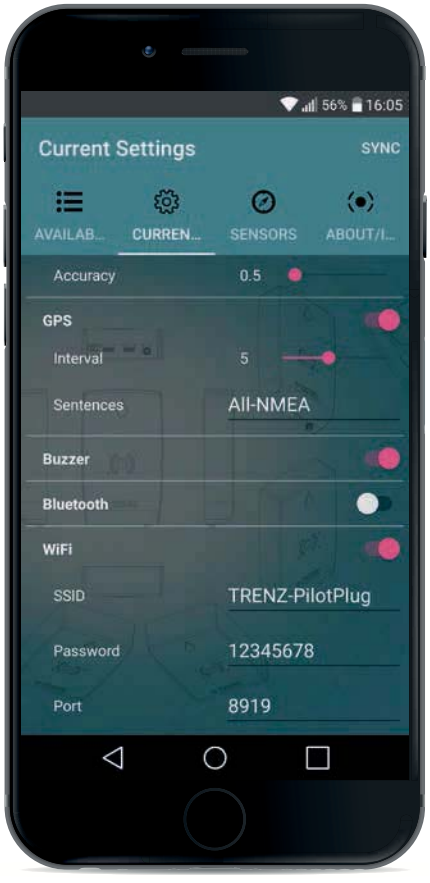


GNSS coverage

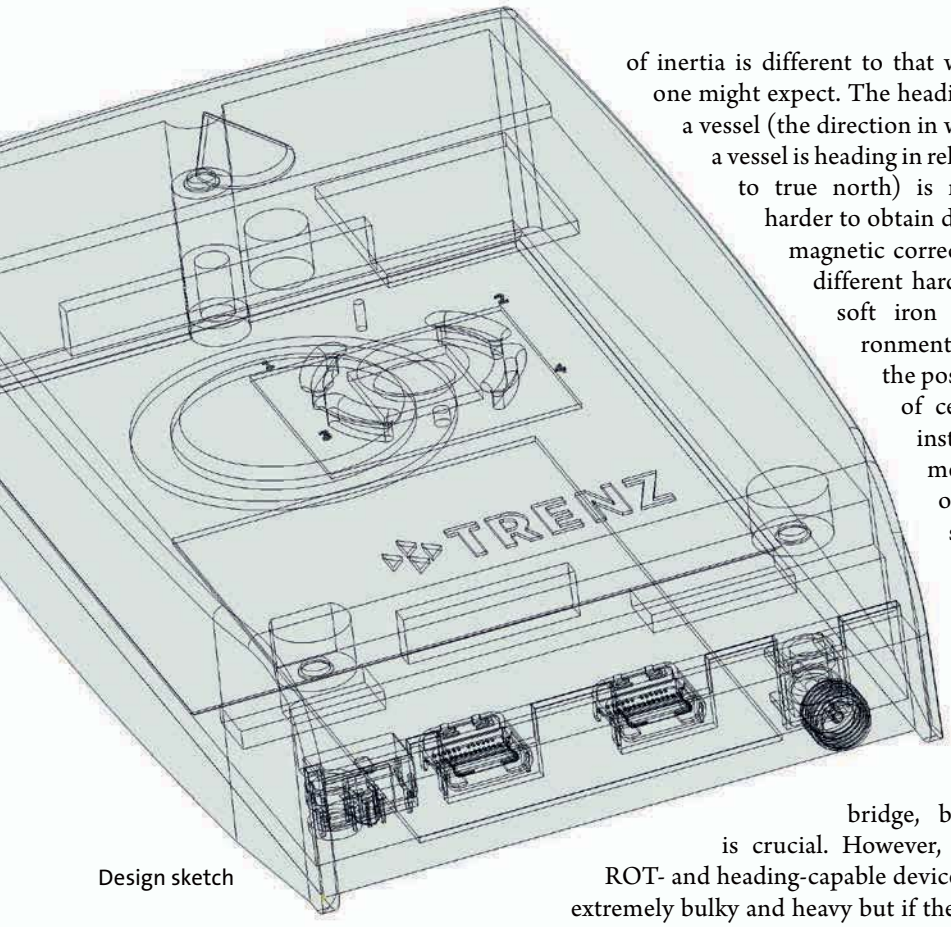
The AIS still contains most of the necessary information for navigating a vessel. All surrounding vessels are present with name, position, length and destination. This potentially provides the ability to guide any vessel in almost every stretch of water whilst also viewing the surrounding ships and determining which route should be chosen from a navigational perspective. The goal was to develop an AIS parser, based on a hardware polarity correction. A device parses each AIS sentence autonomously, while determining and checking for the consistency of each term. Proximity ship and own-ship sentences are read and the checksum is calculated, the own-ship data is saved and checked against own sensors to give the user feedback of the vessels sensor quality. This makes a self-calibrating device, which determines data quality by its own logic.

Due to the support of multiple global positioning standards, every device should be capable of deployment anywhere in the world. Beside the most common standards GPS and Glonass, a clever device should be equipped with standards like the European Standard Galileo, the Chinese Version Beidou and D-GPS sources like SBAS.

It is necessary to equip the GNSS module with a reliable internal antenna instead of a bulky external antenna. However, the possibility to connect any active external antenna should also be considered. A crucial feature regarding harbour docking is the rate of turn (ROT), which is the current rate a vessel is turning on the z-axis also known as yaw, given in degrees per minute. While vectorising and adding ›



App screenshot of cross platform application



Design sketch

more sensor data from different axes to the gyroscope z-axis, it is possible to calculate a steady ROT value even if a vessel is affected by roll and pitch.

The ROT value is very important when keeping in mind that a ship of 400m length and a mass of a few thousand tonnes has to be navigated, the moment of inertia is different to that which one might expect. The heading of a vessel (the direction in which a vessel is heading in relation to true north) is much harder to obtain due to magnetic correction, different hard and soft iron environments or the position of certain instruments on a ship's bridge, but it is crucial. However, most ROT- and heading-capable devices are extremely bulky and heavy but if the data is filtered according to tested algorithms, much smaller devices and sensors may be used. The fusion of nine axes of data (accelerometer, magnetometer and gyroscope each on X/Y/Z axes) does offer much more than just plain data. The ability to use absolute orientation data from sensors and by adding these values to the positional source means that any user can benefit from a much higher accuracy in positioning.

Cloud-connected services are now

Applications for mobile devices have evolved from being a nice-to-have gimmick to an essential companion. So instead of just controlling the pilot plug by tilting a joystick or pushing a button, the user interaction with the device is enhanced by a mobile app. By developing a multiplatform app with database stored configurations and managed toolkits, each pilot or organisation can access this dataset location independently.

The functionality of such piloting devices can be expanded by adding external cloud services like positioning services for example. In times of autonomous vehicles, it is a key feature to offer a high accuracy position with reliability over time. Instead of calculating with the standard NMEA (National Marine Electronics Association), GPS data gives the user the ability to send raw satellite and absolute orientation data to the cloud, to calculate positions and forecasts with even more parameters. This could be, for example, calculation of position based on satellite, movement, tide and wind data. Another approach is to offer a localised worldwide AIS stream via the internet to keep redundancy in case the AIS abroad is affected by malfunction. Due to the position fix, the device is capable of determining the exact position, and a server can send any AIS data in a range of a few sea miles in addition to the local sensor data.