Safer shipping with high-tech radar

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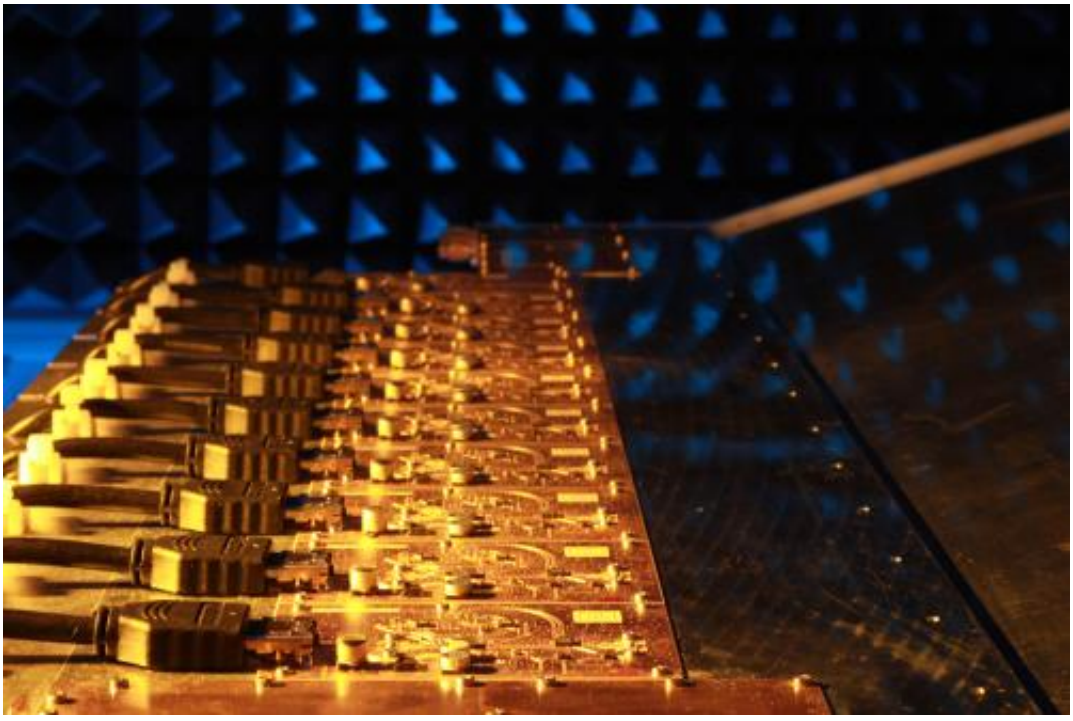

The phased array's transmit/receive modules are equipped with silicon-germanium mixed-signal integrated circuits. Credit: Fraunhofer FHR

Traffic volumes are increasing, not only on our roads but also at sea. A new marine radar system with improved antenna technology is set to meet the growing demands of navigation – and protect ships against pirate attacks.

Marine safety has been at risk for many years. One of the biggest risk factors in international shipping is piracy. Pirates attack container ships

and tankers, especially off the coasts of Somalia and West Africa. The sorry figures for 2012 show that 174 ships were boarded, 28 hijacked and 28 fired upon last year, with 585 people taken hostage on board around the world. The International Maritime Board (IMB) reports that 26 mariners were taken prisoner in Nigerian waters and six crew members were killed. There are rich pickings for pirates operating in these risky waters: they simply use small, agile speedboats to approach freighters and seize control of them. Traditional marine radar systems with their mechanical rotating antennas cannot reliably detect these small vessels. But a new generation of radar systems with higher resolution is now able to spot the attackers' boats well in advance, and the extra warning time this provides is enough to allow assistance and rescue measures to be taken.

Researchers from the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg are aiming to replace conventional marine radar systems – and their rotating antennas and high-power transmit signals – with devices that feature electronically scanned arrays as well as improved generation and processing of signals. "Our radar transmits signals that are reflected by buoys and by the objects being observed. It relies on coherent signal processing, which is to say that the shape and phase of each transmit pulse is essentially identical to the others. There is a certain phase shift between the signal transmitted and the echo received; this makes it possible to measure the elapsed time with great accuracy, which means an object's distance, size, position and speed can all be calculated," explains Dr. Thomas Bertuch, a scientist at the FHR. What is more, this stable phase shift allows a comparison of phases between consecutive pulses, such that interfering echoes produced by wave crests, weather fronts bringing rain or hail can be suppressed more effectively. The FHR researchers' solution operates with low-power transmitting in the frequency range of 2.9 to 3.1 GHz in the S band. In contrast, while conventional radar systems operating on the basis of magnetron tubes offer high transmit power, they are less

accurate because the shape and phase of each pulse are random. This is known as incoherent signal processing.

Positioning system can also detect small boats

The FHR's marine radar, with its extremely agile modular phased array and coherent – or pulse-Doppler – signal processing, is able to detect many more and much smaller objects with great accuracy. Unlike systems featuring a rotating antenna, which sweep their environment with circular scans, its beam can be steered very quickly and in any direction. This makes it suited not only to ensuring navigation safety in heavy traffic but also to monitoring ports and sections of coastline. Since the FHR solution is a linear array comprising a large series of antenna elements in a row, it is still able to function even when a number of elements have failed. Another advantage of phased array radar systems are their low maintenance costs compared to conventional radar systems, in which the magnetron's susceptibility to wear means it must be replaced on an annual basis.

To date, the high manufacturing cost of phased arrays has led to them being used predominantly in military applications. However, new shipping regulations permitting the operation of radar equipment with low transmit power bring inexpensive semiconductor components and technologies into play, which will make phased array systems affordable for use in civilian shipping navigation in future. Each of the FHR array's transmit/receive modules features a silicon-germanium based mixed-signal integrated circuit developed by the Chair of Integrated Analog Circuits (IAS) at RWTH Aachen University according to the FHR's specifications. These chips contain amplifiers, a phase shifter and all digital components needed to control the antenna. The radar also features a patented serial feed network that transfers the signals of individual antenna elements to the receiver. A functioning demonstrator has already been produced. Bertuch and his team are aiming to present

their radar system in September 2014 at the biennial SMM maritime trade fair in Hamburg.

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