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Improvement of an inspection robot design through modelling and experimentation of the ACFM probe location.

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Introduction

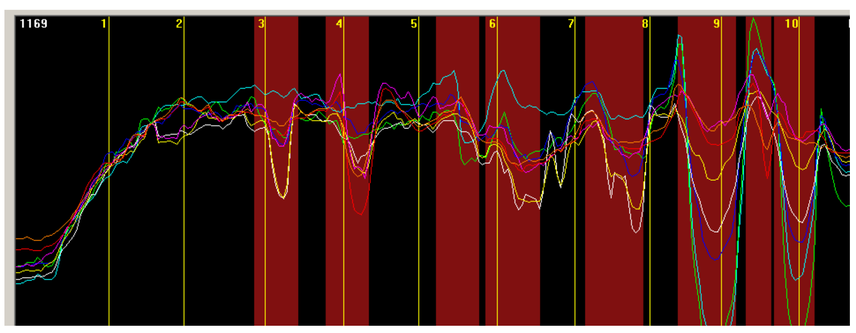
Marine structures are repeatedly subjected to severe loads and harsh conditions which aggressively induce the onset of structural failure. To reduce remedial maintenance and avoid catastrophic events it is essential to provide a rapid accurate cost-effective method to detect incipient surface breaking cracks, map corrosion and provide volumetric inspection of welds within the carbon steel plates used for the construction of naval vessels.

The ShipTest project consortium has developed a robot which can crawl on such surfaces using magnetic wheels and incorporates ACFM and PAUT techniques to provide this vital service to asset owners.

ShipTest Robot

Experimental Results

Experiments were carried out using the ACFM array probe at a static magnetic field which will be experienced by the probe in the robot. The experiments were carried out on a 20 mm thick carbon steel plate with surface breaking defects. Experiments showed the magnetic field at the position of the probe will not distort the defect signals.

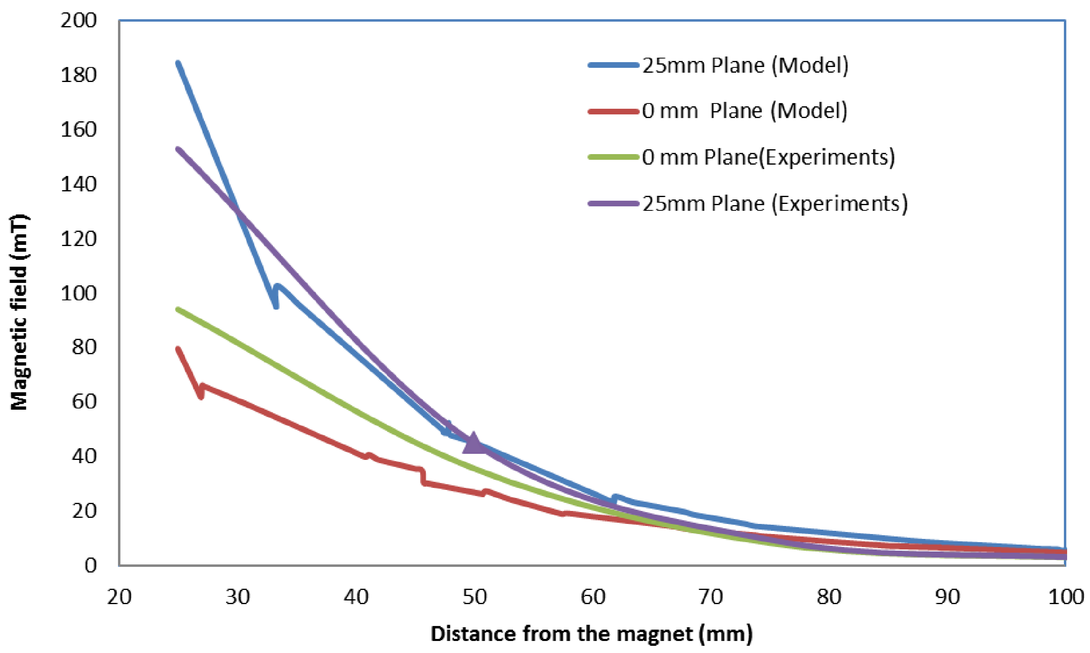


ACFM array probe results of the 20 mm thick carbon steel plate with 7 surface breaking indications

ACFM array probe on in the robot

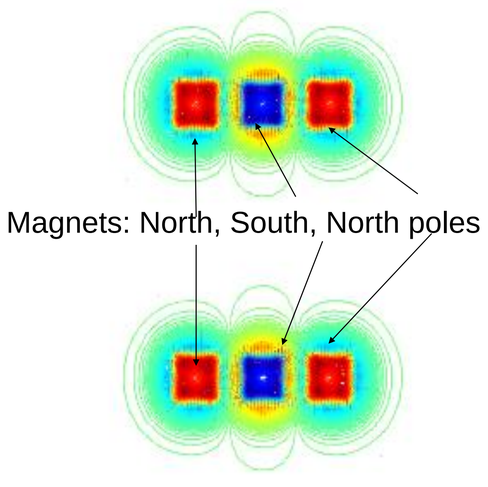
Finite Element Analysis

Alternating Current Field Measurement (ACFM) is an electromagnetic inspection method capable of detecting and sizing of surface breaking cracks primarily in carbon steel material. Due to the electromagnetic nature of the technique, presence of other magnetic fields where the probe is being operated can cause disturbance to the inspection and distort the defect signals. This can cause an issue when employing ACFM inspection using robots with magnetic wheels. Finite Element Models were used to simulate and predict the possible interactions of the magnetic field produced by arrays of rare earth magnets with respect to the placement of the ACFM probe.

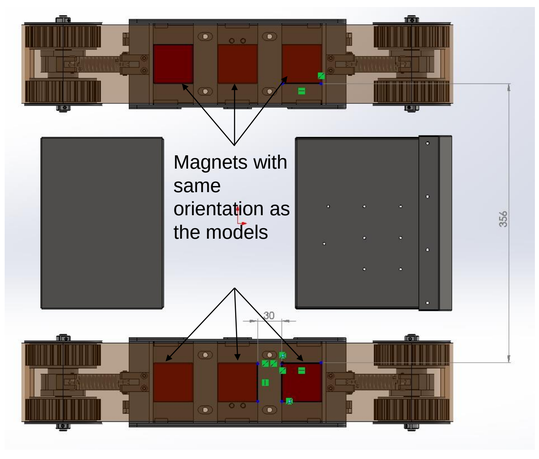


Model and experimental results comparison for one magnet

The figures below shows the position of the magnets at distances and polarities used in a known robot (X-scan, 2012) and a view of the model results.



Simulation results, magnetic field



Bottom view of the X-Scan robot

Conclusion

The results of these models and experiments were used to position the ACFM array probe at a location in adjacent to the robots magnets to reduce the size of the robot. The models developed are used in other crawlers design to improve the capability of the system.

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