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MIRA- Ultrasonic Concrete Tomography



INTRODUCTION

The MIRA uses a low-frequency linear ultrasonic antenna array to produce high resolution tomographical images of concrete.

The MIRA is suitable for imaging of the internal structure of objects constructed of concrete and reinforced concrete using pulse-echo technique of testing. This technique only requires access to one-side of the object in order to search for foreign inclusions, holes, flaws, cracks, honeycombs, positioning of ducts and other inside the material and also to assess the state of reinforcement bars in concrete.

FEATURES

Real-time Imaging of the internal structure of the object- for easier understanding of testing results.

Focusing antenna array of 40 elements (DDF-principle) – better resolution and higher sensitivity of the system, at that the focusing in every point of volume is provided.

Automatic calibration on the object from 8 positions

- Automatic measurement of average ultrasonic velocity in the object
- Compensation of surface SH-wave providing clearer image in near surface area

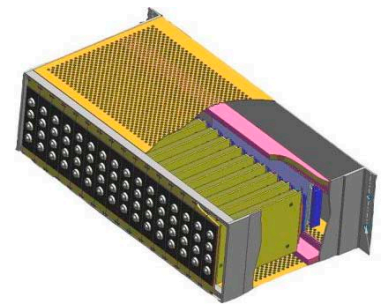
Tomographic data procession (SAFT-algorithm)

SPECIAL FEATURES

- Dry point contact (DPC) transducers
- Pulse-echo testing technology
- Adaptation of antenna array to the rough object surface.

DESCRIPTION OF THE SYSTEM

The MIRA consists of 10 measuring units, combined into a focusing antenna array. Also included in the probe array is a control unit, data collection unit and wireless access point.



Each measuring unit consists of 4 low-frequency broadband DPC transducers with the nominal operation frequency of 50 kHz. These produce shear waves using only a dry point contact. The transducers have wear-resistant ceramic pin, which prolongs the lifetime of the transducer even when operating on rough, unprepared surfaces.



Each transducer features an independent spring load, which allows performing testing on uneven surfaces with 100mm of travel in each transducer.

A PC laptop with the SAFT software, downloads the information from the probe wirelessly. It then displays the collected information in several Tomographic images. Changes to the way data is collected and displayed are made using the software on the Laptop.

DATA ACQUISITION FROM ANTENNA ARRAY

The data received at one position of the array is an accumulation of signals collected from every pair of measuring units of antenna array. The received



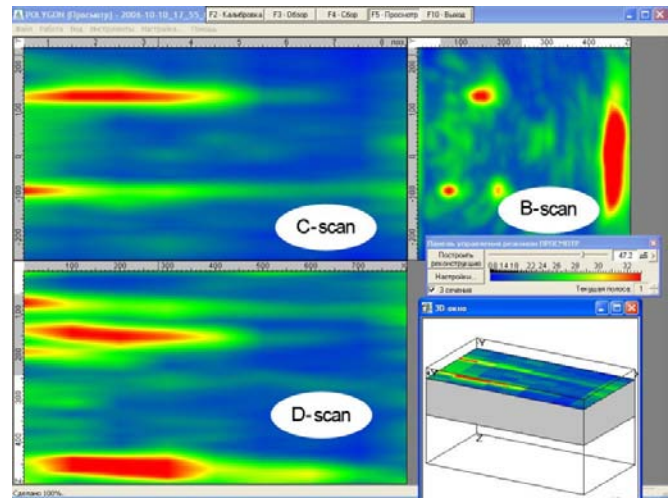
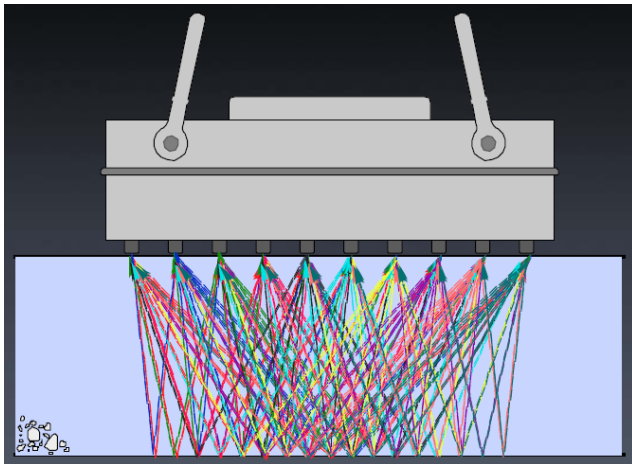
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signals are processed in controlling unit and then transmitted to PC, where special software constructs an image of the internal structure of the object. This operation principle provides focusing in every point of the half-space. The time for data collection, processing and image reconstruction is only 3 seconds.



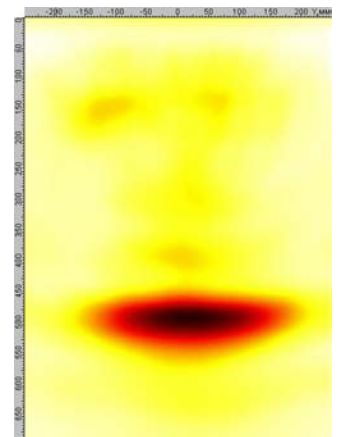
OPERATION MODES

CALIBRATION mode

In CALIBRATION mode the system is calibrated for site specific parameters, such as: ultrasonic pulse velocity and signal amplification. Any testing of object is started with calibration. Also during the calibration the surface SH-wave is compensated hence providing the better imaging in the difficult near surface zone.

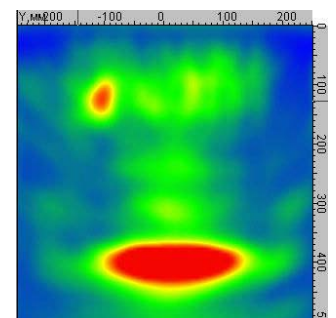
VIEW mode

In this mode the data is reconstructed as B-Scan from one position of the array. It is used for quick estimation of the internal structure of testing object in random positions. The operator places the antenna array in the area subjected to testing and receives the B-Scan image of the structure under the antenna array.



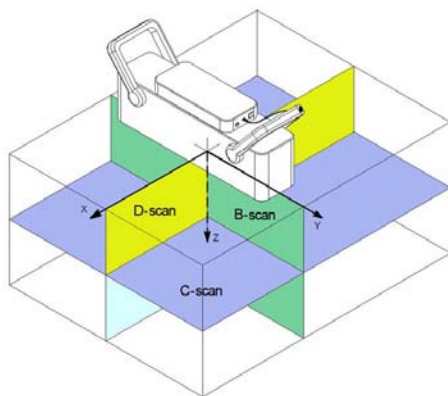
DATA COLLECTION mode

This mode is for data acquisition and automatic saving to the hard disk with all the current parameters, setups and calibration results. Multiple scans can be "fitted" together to better represent a single element. The operator can also view the received B-scans in every position. On the display only B-scan in current position of the array is available.



SOFTWARE CAPABILITIES

- Imaging of internal structure;
- Data representation as B-Scan, C-Scan, D-Scan, 3D volume image reconstruction;
- Localization of defects;
- Measurements of signal levels in any point of tomogram;
- Threshold and smoothing filtering of tomogram;
- Half-tone or color representation of signal levels;
- Manual or automatic modes of threshold image processing;
- Choice of tomogram on 3D image of reconstructed volume;
- Saving of the initial data massive and of synthesized reconstructed images in the memory of the PC
- Printout.





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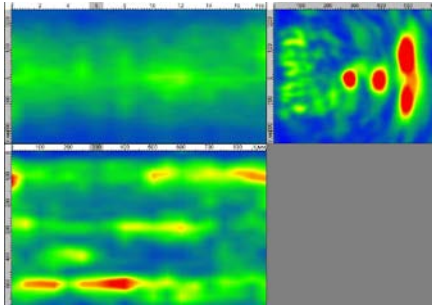
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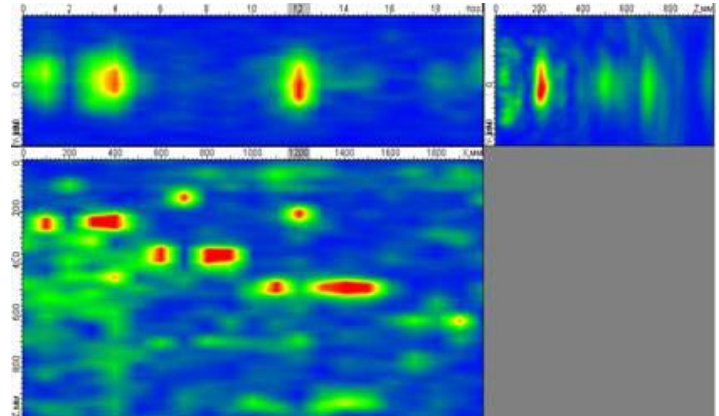
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REVIEW mode

Review mode is for detailed analysis of testing results, received in data collection mode. The testing results in different scans are represented in the Graphical Results Review window. Which is a combination of different sections B-, C-, D-scans (see image to the right).



area below ducts. This shows that this is not a local though prolonged reflector.



APPLICATION EXAMPLE

Testing object

Concrete slab below was made in the form of steps with different thicknesses:

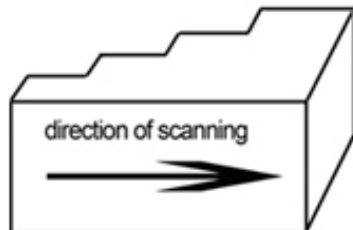
- Length of each step along the testing line - 500 mm. The total length of the object – 2000 mm
- Slab thickness of steps – 210, 330, 450 mm
- Scanning step - 50 mm
- Velocity, measured at calibration – 2872 m/sec



Results of testing

Testing was made along the length of the object with the constant step of 50 mm.

On the D-scan of reconstructed image all four steps and of three ducts in each step. The forth duct is also on the tomogram, though its image is not so clear. At the same time the forth duct can be seen and studied on the B-scan (the corresponding B-scan is given below the main tomogram). On the D-scan the back-wall reflection is disappearing in the



SPECIFICATIONS

Parameter	Value
Number of channels	10
Frequency range	20 - 100 kHz, average frequency 50 kHz
Min. thickness of testing object	50 mm
Min. dia. of defect type cylindrical drilling	12 mm
Size of reconstructed image on the display of PC	1 m x 2.5 m
Power supply	9 - 15 V
The average consumption current	2,5A
Operation temperatures range	-15°C to 45°C
Weight of antenna array	6.5 kg
Total weight of the system, inc antenna array, PC, power source and other	15 kg

DELIVERED FORM

- Antenna array
- Controlling unit of Laptop type in bag
- Net adaptor with cable
- Power supply unit and wireless connection unit
- Cable for connection of START button
- Passport
- Operation manual
- CD with software and user's manual
- Transportation case