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SELECTING PARAMETERS FOR A TRIVIAL FLAW DETECTOR TO IMPLEMENT EXPRESS ANALYSIS OF DAMAGED OBJECTS

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Abstract. The work of the expert assessment system is logically divided into the following stages: examination of structural elements using non-destructive testing methods; automated computer analysis of data obtained using methods developed for assessing the condition of materials and structures; preparation of an expert opinion on the condition of the object under study and its preservation; and development of recommendations for its further operation. However, an important factor is to correctly select the means and parameters of non-destructive testing of damaged objects.
Keywords: non-destructive testing, ultrasonic sensors, structural elements; crack-like defects.

To properly design and adapt the signal or correctly read the data, it is necessary to perform a series of laboratory tests to determine the sensor's response. In this sense, we must observe its behaviour, that is, its response as a sensor and its response as a receiver (transceiver). The materials used in these experiments were: switching power supply, signal generator, oscilloscope, breadboards, resistors, ceramic capacitors, ultrasonic transceiver, HC-SRO4 ultrasonic sensor, connectors (alligator clips and oscilloscope connectors), cables, test tubes, tape measure or other type of length measurement device and Arduino screw shield Uno R3.

In this regard, two tests were performed with two ultrasonic sensors: one dual-type, meaning it has a transmitter and receiver integrated into a motherboard, and the other with a transceiver, a device that has transmission and reception in a single encapsulation, or in a single device.

For the transceiver test, a description of the transceiver's output signal was obtained to understand the response of these types of sensors to acoustic stimuli. In other words, the sensor projects a signal onto an oscilloscope.

And the test with the HC-SRO4 sensor allowed us to make external descriptions of two specimens, to obtain a description of their shape, using the round-trip distances of the ultrasonic waves (Doppler effect). It should be noted that for this work the latest results obtained from the second experiment will be taken into account in order to verify the theory proposed on the effect that ultrasonic waves have when describing the different types of defects in materials (internal or external defects), so the external form of two metal test specimens or plates that were worked with destructive tests will be described in detail.

For this test, jumper connectors, an Arduino Uno R3, an ultrasonic sensor, two metal test tubes, a ruler, a set square, and a tape measure were used. To prepare for this experiment and work, the connections were made as follows. First, we proceeded to learn about the ultrasonic sensor, specifically this model. We know that we need to quantify the transmission time; to do this, we need to know the distance. From the sensor's data sheet, we find the following:

The processing speed and signal travel time are in microseconds, so we have the speed of sound.

$$V_{sound} = 343{,}3\ \frac{m}{s} = 0{,}0343\ \frac{cm}{\mu s}$$

Once we have solved the unknown of the speed, we can deduce the distance with the typical physics formula.

$$d = v * t$$

Now, we know that due to the Doppler effect we have two times, a time for the sending signal and a time for the receiving signal, therefore, the time is divided by two, resulting in the following form.

$$d = v * \frac{t}{2}$$

Now developing the equation, we have that

$$d = 0{,}0343\ \frac{cm}{\mu s} * \frac{t_{medido}}{2}.$$

We know that 0,0343 $\frac{cm}{\mu s}$ is a constant in our formula that when divided by two gives the result, from the data sheet we obtain that $\frac{0{,}0343\,\frac{cm}{\mu s}}{2} = \frac{1}{58.31}$

We can mention that due to the type of sensor and the types of commands, a stable and reliable measurement is not always possible. Therefore, programming methods such as linear regression, arithmetic means, and all kinds of numerical methods or algorithms can be used to obtain a more stable and accurate reading. Therefore, at this stage, I can say that we can now build a method to extract data on defects on the surface of a material.

In this regard, the tests are carried out. It is worth noting that the graphs were created with the help of Excel, and this was the formula used to obtain the data: $Defecto = V_0 - V_m -$ Thicknesss, where V_0 is the initial value (the first measurement) and V_m is the measured value. Of these values, V_m is the only value that will not be a constant but will change as the piece is scanned.

Now, from this table, we obtain an image of our part based on the scan performed. The graph helps us distinguish the deformities. In this sense, it was proposed to play with scales. The first graph shows the values scaled according to the thickness measurement; this results in the image of the deformation of our specimen (Figure 43).

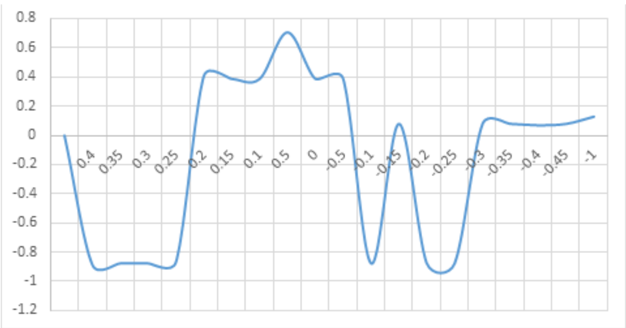

Figure 43. Graph of defect magnitude per millimetre

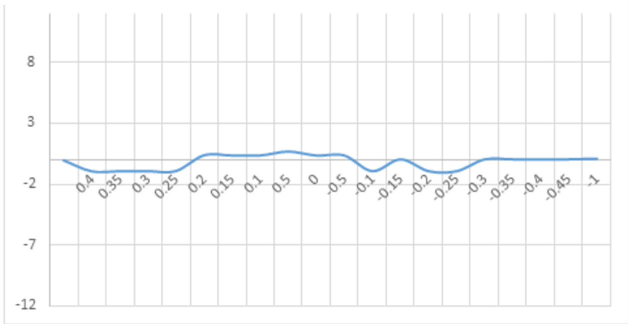

Figure 44. Graph of specimen shape

In the same way we can obtain at a more distant scale what the shape of our test specimen really is (Figure 44).

As we can see, we analysed only one section of this test object. In theory, it should measure 4.79 at both ends, since the material's external structure is flat, except for the central section, which shows wear. This measurement error is caused by a measurement error due to the sensor's firing angle. This measurement error is reflected in the graph. However, future projects aim to improve this equipment by acquiring a more powerful sensor and achieving a narrower firing angle.

An important feature of the flaw detector is its ability to connect it to a personal computer, including a laptop. This allows the scan results to be automatically transferred to a computer and stored in a centralized database for subsequent analysis and processing. By having the results of measurements and analyses obtained at different times during a given monitoring period, the operator can track changes in the characteristics and condition of the structure over time, allowing them to predict the development of degradation processes and the duration of preservation of the working properties of certain areas, as well as of the structure.

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Вибір параметрів тривіального дефектоскопа для реалізації експрес-аналізу пошкоджених об'єктів

Анотація. *Робота експертної системи оцінювання логічно поділена на такі етапи: обстеження елементів конструкцій методами неруйнівного контролю; автоматизований комп'ютерний аналіз даних, отриманих за допомогою розроблених методів оцінки стану матеріалів та конструкцій; підготовка експертного висновку про стан досліджуваного об'єкта та його збереження; та розробка рекомендацій щодо його подальшої експлуатації. Однак важливим чинником є коректно вибрати засоби та параметри неруйнівного контролю пошкоджених об'єктів.*

Ключові слова: неруйнівний контроль, ультразвукові датчики, елементи конструкцій; тріщиноподібні дефекти.

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