Proposal of Ultrasonic Crack Detection

Crack detection is a method to detect internal defects (such as hidden cracks, trachoma, impurities, etc.) of metal by using the crack detector. When the ultrasonic beam passes from the probe to the inside of the metal from the surface, it will generate reflected waves respectively when it meets the defect and the underside of metal, forming pulse waveforms on the fluorescent screen. From these pulse waveforms, I can get some properties of the crack, for example, the depth of the crack, the length of the crack. This is the ultimate target of the project. I decide to solve the problem of ultrasonic crack detection through mechanistic data science.

The first module is data collection. I will collect the waveforms of metal articles without cracks and the waveforms of metal articles with internal cracks. These cracked metal parts have cracks of different lengths at different depths. Besides, I also look for some data about these cracks’ Ultrasonic detection waveform image. I can look for some data from online resources.

Then, the waveforms of metal parts with cracks and without cracks are not the same. In this module, the feature is extracted. According to compare the perfect metal parts and metal parts with crack, I can find some differences from their waveforms. For example, the reflected wavelength, frequency, and amplitude may be the difference between those metal parts. In this module, I should extract these data from the original database that I researched online.

As for knowledge-driven dimensional reduction, I will integrate and analyze the data obtained in the second module. I will only consider certain features, such as wavelength, amplitude, etc. According to this module, I can narrow down the range of research paraments.

Next, based on the principle and order from data graphs in the third module, I can build the relationship between these variables. Then, develop a model for this problem. For example, I assume that the relationship between the crack length and wavelength is linear.

Module 5 is neural networks for regression and classification. In this step, the goal is that find the relationship between the features and cracks’ properties. Use regression to determine the paraments. Look for features with strong relationships through statistical graphs.

The last module is system and design. I can integrate all steps. Then, find the relationship between the cracks and the properties of reflected ultrasonic waveforms. This project's final goal is to judge the position and size of cracks intuitively by the reflected waveforms.