A NOVEL TECHNIQUE FOR DETERMINING THE QUALITY OF CRANKSHAFT THROUGH SVM IN MATLAB

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ABSTRACT: A crank shaft is integral part of the engine and its manufacturing defects are quite important to industry. This paper has to focus on finding the crack and any manufacture error in crank shaft through SVM. The problem is considered in this works consists of estimating the existence, location and extent of stiffness reduction in structure which is indicated by the changes of the structural static parameters such as deflection and strain. The neural network was trained to recognize the behavior of static parameter of the undamaged structure as well as of the structure with various possible damage extent and location which were modeled as random states. The proposed techniques were applied to detect damage in a simply supported beam. The structure was analyzed using finite-element-method and the damage identification was conducted by a neural network using the change of the structural strain and displacement. The results showed that using proposed method the strain is more efficient for identification of damage than the displacement. Here we have analysis the crank shaft by use of ultrasonic technique with the help of SVM. This is predictive mechanics that will calculate approximate crack detection in crank shaft and the quality of metal. This thesis predicts the cracks and the length of crack in predictive manner. The result in this thesis gives the good predictive analysis of the crank shaft.
Keywords: Crank, Crankshaft, AI, Neural Network, Ultrasonic, SVM

I. INTRODUCTION

1.1 Introduction of Artificial Intelligence

Artificial intelligence (AI) is the human-like intelligence exhibited by machines or software. It is also an academic field of study. Major AI researchers and textbooks define the field as "the study and design of intelligent agents", where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1955, defines it as "the science and engineering of making intelligent machines". AI research is highly technical and specialised, and is deeply divided into subfields that often fail to communicate with each other. Some of the division is due to social and cultural factors: subfields have grown up around particular institutions and the work of individual researchers. AI research is also divided by several technical issues. Some subfields focus on the solution of specific problems. Others focus on one of several possible approaches or on the use of a particular tool or towards the accomplishment of particular applications.The central problems (or goals) of AI research include reasoning, knowledge, planning, learning, natural language processing (communication), perception and the ability to move and manipulate objects. General intelligence (or "strong AI") is still among the field's long term goals. Currently popular approaches include statistical methods, computational intelligence and traditional symbolic AI. There are a large number of tools used in AI, including versions of search and mathematical optimization, logic, methods based on probability and economics, and many others. The AI field is interdisciplinary, in which a number of sciences and professions converge, including computer science, psychology, linguistics, philosophy and neuroscience, as well as other specialized field such as artificial psychology

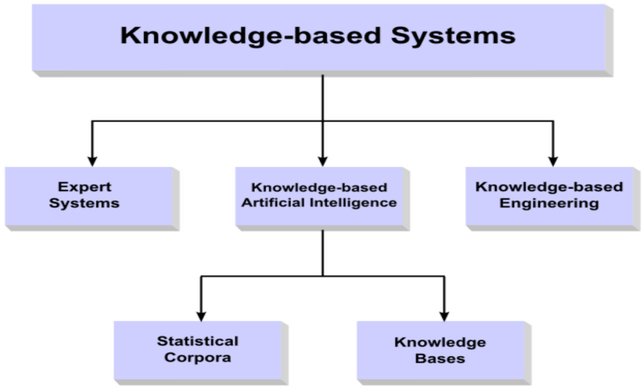

Fig1.1 : AI Chartateristic

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1.2 Brief History

Throughout human history, people have used technology to model themselves. There is evidence of this from ancient China, Egypt, and Greece that bears witness to the universality of this activity. Each new technology has, in its turn, been exploited to build intelligent agents or models of mind. Clockwork, hydraulics, telephone switching systems, holograms, analog computers, and digital computers have all been proposed both as technological metaphors for intelligence and as mechanisms for modeling mind. About 400 years ago people started to write about the nature of thought and reason. Hobbes (1588-1679), who has been described by Haugeland (1985), as the "Grandfather of AI," espoused the position that thinking was symbolic reasoning like talking out loud or working out an answer with pen and paper. The idea of symbolic reasoning was further developed by Descartes (1596-1650), Pascal(1623-1662), Spinoza (1632-1677), Leibniz (1646-1716), and others who were pioneers in the philosophy of mind.

The idea of symbolic operations became more concrete with the development of computers. The first general-purpose computer designed (but not built until 1991, at the Science Museum of London) was the Analytical Engine by Babbage (1792-1871). In the early part of the 20th century, there was much work done on understanding computation. Several models of computation were proposed, including the Turing machine by Alan Turing (1912-1954), a theoretical machine that writes symbols on an infinitely long tape, and the lambda calculus of Church (1903-1995), which is a mathematical formalism for rewriting formulas. It can be shown that these very different formalisms are equivalent in that any function computable by one is computable by the others. This leads to the Church-Turing thesis: Here effectively computable means following well-defined operations; "computers" in Turing's day were people who followed well-defined steps and computers as we know them today did not exist. This thesis says that all computation can be carried out on a Turing machine or one of the other equivalent computational machines. The Church-Turing thesis cannot be proved but it is a hypothesis that has stood the test of time. No one has built a machine that has carried out computation that cannot be computed by a Turing machine. There is no evidence that people can compute functions that are not turing computable. An agent's actions are a function of its abilities, its history, and its goals or preferences. This provides an argument that computation is more than just a metaphor for intelligence; reasoning is computation and computation can be carried out by a computer. Once real computers were built, some of the first applications of computers were AI programs. For example, Samuel (1959) built a checkers program in 1952 and implemented a program that learns to play checkers in the late 1950s. Newell and Simon (1956) built a program, Logic Theorist, that discovers proofs in propositional logic. In addition to that for high-level symbolic reasoning, there was also much work on low-level learning inspired by how neurons work. McCulloch and Pitts (1943) showed how a simple thresholding "formal neuron" could be the basis for a Turing-complete machine. The first learning for these neural networks was described by Minsky (1952). One of the early significant works was the Perceptron of Rosenblatt (1958). The work on neural networks went into decline for a number of years after the 1968 book by Minsky and Papert (1988), which argued that the representations learned were inadequate for intelligent action. F These early programs concentrated on learning and search as the foundations of the field. It became apparent early that one of the main problems was how to represent the knowledge needed to solve a problem. Before learning, an agent must have an appropriate target language for the learned knowledge. There have been many proposals for representations from simple feature-based representations to complex logical representations of [McCarthy and Hayes (1969)] and many in between such as the frames of Minsky (1975). During the 1960s and 1970s, success was had in building natural language understanding systems in limited domains. For example, the STUDENT program of Daniel Bobrow (1967) could solve high school algebra problems expressed in natural language. [Winograd (1972)]'s SHRDLU system could, using restricted natural language, discuss and carry out tasks in a simulated blocks world. CHAT-80 [Warren and Pereira (1982)] could answer geographical questions placed to it in natural language. During the 1970s and 1980s, there was a large body of work on expert systems, where the aim was to capture the knowledge of an expert in some domain so that a computer could carry out expert tasks. For example, DENDRAL [Buchanan and Feigenbaum (1978)], developed from 1965 to 1983 in the field of organic chemistry, proposed plausible structures for new organic compounds. MYCIN [Buchanan and Shortliffe (1984)], developed from 1972 to 1980, diagnosed infectious diseases of the blood, prescribed antimicrobial therapy, and explained its reasoning. The 1970s and 1980s were also a period when AI reasoning became widespread in languages such as Prolog [Colmerauer and Roussel (1996)][Kowalski (1988)]. During the 1990s and the 2000s there was great growth in the subdisciplines of AI such as perception, probabilistic and decision-theoretic reasoning, planning, embodied systems, machine learning, and many other fields. There has also been much progress on the foundations of the field; these form the foundations of this book.

1.3 How AI works?

There are various forms of artificial intelligence (AI) out there today. It is a tough question what to even call an AI and what to merely call a software program. There is a tendency in software, where when something that used to be called "AI" matures and integrates itself into the technological backdrop, it doesn't get called AI anymore. The programmers of the 1950s might call numerous embedded software in our world "artificial intelligence" - for example, the microchip in your car that regulates fuel injection, or the database at the supermarket which stores records of all sales, or the Google search engine. But the field that calls itself "Artificial Intelligence" tends to be slightly different than the much larger group of "software developers in general". AI researchers tend to be looking at more complex, adaptive, capable, or even vaguely human-like forms of software. Workers in AI also tend to be interdisciplinary and well-versed in areas of science and math foreign to the typical programmer, including but not limited to: formal statistics, neuroscience, evolutionary psychology, machine learning, and decision theory.

1.4 Hyper-spectral Image Processing

The most significant recent breakthrough in remote sensing has been the development of hyper-spectral sensors and software to analyze the resulting image data. Fifteen years ago only spectral remote sensing experts had access to hyper-spectral images or software tools to take advantage of such images. Over the past decade hyper-spectral image analysis has matured into one of the most powerful and fastest growing technologies in the field of remote sensing. The "hyper" in hyper-spectral means "over" as in "too many" and refers to the large number of measured wavelength bands. Hyper-spectral images are spectrally over determined, which means that they provide sample spectral information to identify and distinguish spectrally unique materials. Hyper-spectral imagery provides the potential for more accurate and detailed information extraction than possible with any other type of remotely sensed data. Hyperspectral Imaging is a field of great importance due to its discrimination ability, it can be applied with day light or technical source of light with small amounts of energy, so it does not affect the tissues or specimens under investigation. It provides a vast source of information and besides the challenges found in evolving the technology itself, there are many fields where Hyperspectral Imaging can be applied such as mineralogy, medicine, agriculture, sea sciences. Using a Hyperspectral Imaging System on plants, we aim at first on clarifying our perceptual knowledge regarding plants health status. We know that a plant is healthy through the color of their leaves. It is common to think that the greener the plant is, the healthier it is. On the same time, color acts as an indicator when something is wrong, and informs the gardener, farmer or agriculturalist. Then, they only realise the damage providing the color difference between health and damaged leaves, is notable enough. Experience and con- stant monitoring is crucial to be able to identify in time the danger through the visible symptoms and apply the necessary treatment. The color of the leaves if formed due to the absorption of certain wavelenghts of light, because of the plant's chromophores. Chlorophyll and carotenes are the most basic chromophores and their role in the process of photosynthesis is to be clearified later on. Since color of the leaves is linked to chlorophyll and carotenes and these chromophores are crucial to the process of photosynthesis, we could assume that there is a link between health status and chromophores concentration. Light is a form of electromagnetic wave. As such it can be also seen both as a particle and as wave as Einstein indicated. The key features of electromagnetic wave are the frequency and the wavelength.

1.5 Fuzzy Logic

The past few years have witnessed a rapid growth in the number and variety of applications of fuzzy logic (FL). FL techniques have been used in image-understanding applications such as detection of edges, feature extraction, classification, and clustering. Fuzzy logic poses the ability to mimic the human mind to effectively employ modes of reasoning that are approximate rather than exact. In traditional hard computing, decisions or actions are based on precision, certainty, and vigor. Precision and certainty carry a cost. In soft computing, tolerance and impression are explored in decision making. The exploration of the to understand distorted speech, decipher sloppy handwriting, comprehend nuances of natural language, summarize text, and recognize and classify images.

With FL, we can specify mapping rules in terms of words rather than numbers. Computing with the words explores imprecision and tolerance. Another basic concept in FL is the fuzzy if–then rule. Although rule-based systems have a long history of use in artificial intelligence, what is missing in such systems is machinery for dealing with fuzzy consequents or fuzzy antecedents. In most applications, an FL solution is a translation of a human solution. Thirdly, FL can model nonlinear functions of arbitrary complexity to a desired degree of accuracy. FL is a convenient way to map an input space to an output space. FL is one of the tools used to model a multi input, multi output system.

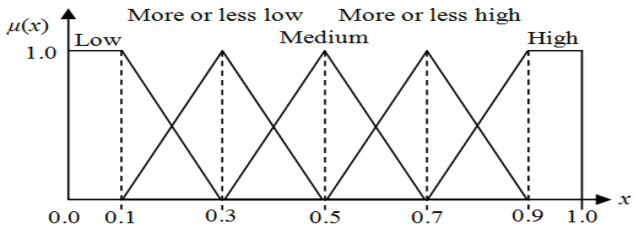

Fig1.2 : Membership Function

1.6 Ultrasonic Testing

Ultrasonic Testing (UT) uses high frequency sound waves (typically in the range between 0.5 and 15 MHz) to conduct examinations and make measurements. Besides its wide use in engineering applications (such as flaw detection/evaluation, dimensional measurements, material characterization, etc.), ultrasonics are also used in the medical field (such as sonography, therapeutic ultrasound, etc.).

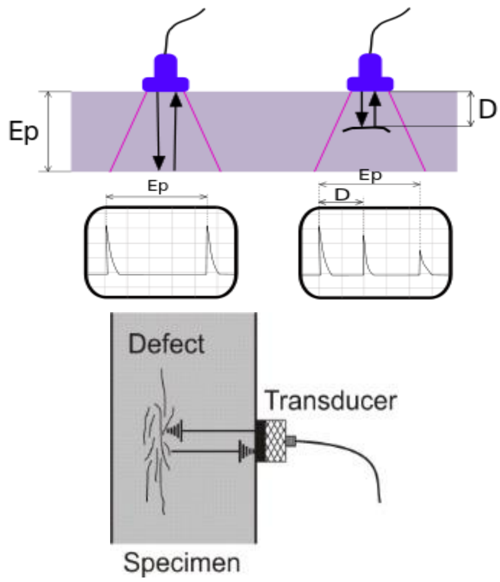

Fig1.3: Ultrasonic Testing

II. DAMAGE DETECTION AND MATERIAL ASSESSMENT

2.1Damage Detection

In the previous years, some proposed defect detection methods have been proposed to find out the image defects. But they have some limitations that can be described briefly as follows: In H. Elbehiery et al. presented some techniques to detect the defects in the ceramic tiles. They divided their method into two parts. In the first part, Existing method consisted with the captured images of tiles as input. As the output, they showed the intensity adjusted or histogram equalized image. After that, they used the output of first part as input for the second part. In the second part of their algorithm,

We have basically four methods by which detection can be identify.

- Perceptron Neural Networks Damage Assessment
- Probabilistic Neural Networks Damage Assessment
- Image Analysis for Damage Assessment.
- Fuzzy C-Means Clustering Damage Assessment.

Damage detection and health monitoring are classified into two methods. The first method is based on vibration measurement, and the other one is based on phenomena such as cracking or heat. Each method has its strong points and its weak points. A damage identification system based on vibration measurements is effective for damage detection of whole structures or the story of a structure but it is not effective for damage detection of a specific portion of a building such as its structural members. On the other hand, damage detection based on phenomena such as cracking or heat is effective for damage detection of a specific portion of a building such as its structural members. By combining these two methods, it becomes possible to monitor structural health precisely. A damage identification system based on vibration measurements has a possibility to find out the process of damage, but in such system, maintenance of sensor and data acquisition system costs very much. In some cases, it is not economical to measure for all time. It is very difficult to install such data acquisition system to many buildings because of high costs.On the other hand, the techniques which grasp the local damage by use off-line system(Wood, S.L. and Neikirk, D.P.(2001)), such as carbon fiber lattice sensor or maximum value memory sensor are much more economical than vibration measurement system. In this study, crack detection sensor using Radio Frequency Identification (RFID) tag and electrically conductive paint and printed Sample s is proposed because of its low costs and easiness of the measurement. The RFID tag is generally used for distinction or management of human or products. By using this RFID tag and transmitter, radio communication is possible.

2.2 SVM Support Vector Machine for damage detection

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.The concept of SVM is given by Vapnik et al., which is based on statistical learning theory . SVMs were initially developed for binary classification but it could be efficiently extended for multiclass problems. The support vector machine classifier creates a hyper plane or multiple hyper planes in high dimensional space that is useful for classification, regression and other efficient tasks. SVM have many attractive features due to this it is gaining popularity and have promising empirical performance. SVM constructs a hyper plane in original input space to separate the data points. Some time it is difficult to perform separation of data points in original input space, so to make separation easier the original finite dimensional space mapped into new higher dimensional space. Kernel functions are used for non-linear mapping of training samples to high dimensional space. Various kernel function such as polynomial, Gaussian, sigmoid etc., are used for this purpose. SVM works on the principal that data points are classified using a hyper plane which maximizes the separation between data points and the hyper plane is constructed with the help of support vectors. Figure 6 shows the working of SVM classification algorithm.

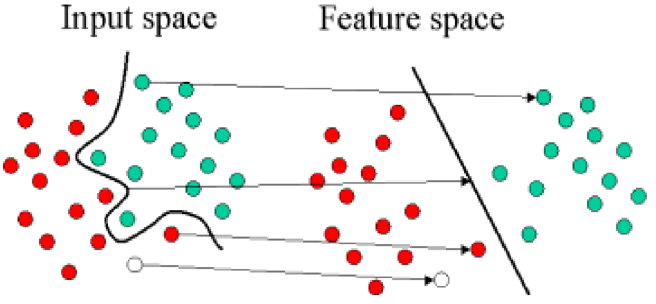

Fig 2.1: SVM Algorithm

2.3 C-Scan

The C-scan presentation is a type of presentation that is possible for automated two-dimensional scanning systems that provides a plan-type view of the location and size of test specimen features. The plane of the image is parallel to the scan pattern of the transducer. C-scan presentations are typically produced with an automated data acquisition system, such as a computer controlled immersion scanning system. Typically, a data collection gate is established on the A-scan and the amplitude or the time-of-flight of the signal is recorded at regular intervals as the transducer is scanned over the test piece. The relative signal amplitude or the time-of-flight is displayed as a shade of gray or a color for each of the positions where data was recorded. The C-scan presentation provides an image of the features that reflect and scatter the sound within and on the surfaces of the test piece.

High resolution scans can produce very detailed images. The figure shows two ultrasonic C-scan images of a US quarter. Both images were produced using a pulse-echo technique with the transducer scanned over the head side in an immersion scanning system. For the C-scan image on the top, the gate was set to capture the amplitude of the sound reflecting from the front surface of the quarter. Light areas in the image indicate areas that reflected a greater amount of energy back to the transducer. In the C-scan image on the bottom, the gate was moved to record the intensity of the sound reflecting from the back surface of the coin. The details on the back surface are clearly visible but front surface features are also still visible since the sound energy is affected by these features as it travels through the front surface of the coin For the C-scan image on the top, the gate was set to capture the amplitude of the sound reflecting from the front surface of the quarter.

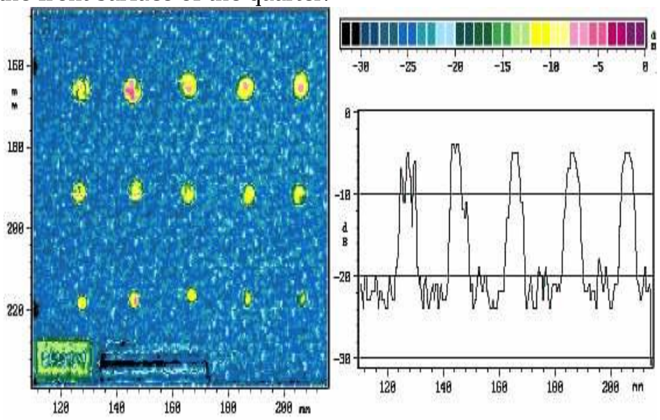

FIG 2.2 :C-Scan Technique

Comparison of all three scanning techniques to check which gives us best result in the tabular form. A-Scan is scanned in the vertical form, B scan is scanned in horizontal form and C-Scan is scanned in the both direction.

III. METHODOLOGY AND DATA COLLECTION

In this thesis we are implementing hyper-spectral image processing for crank shaft inspection. For this we use UT ultrasonic testing technique for finding cracks and uses Support Vector Machine for scanning the image taken by high resolution camera.

- Surveying of simple Sample : Collection if data survey of crank shaft industry for automatization of of quality of crank shaft. I was visited in industries like Bansal Trading Company, Amit crank company and saw different crank shafts to finalize for use.
- Problem associated with crank shafts: There are different problems with each crank shaft cracks in Sample. I found there is minor crack in crank shaft which is necessary to detect for quality of Sample. This type of problem is faced by every industry.
- This thesis focus is only on the finding the crack on a Sample of different Sample . I found the crack on the Sample.
- How cracks effect on the quality of Sample s: Some of the crack have larger in size on the crank shaft is effect the quality of Sample. They can create problem in their quality. So finding crack with their size is necessary. If there are less no. of cracks on the Sample are found improve quality.
- Earlier procedures to finding the cracks: A-Scan and B-Scan are also recently used to find cracks in industries but there are accuracy is not much as per our need. If you need the highest quality of Sample for a specific purpose.
- How it can be automated by machine We are using C-Scan technique to automatized the detection technique. This involves two types of method one of them is sound and other is energy.
- Technique implemented to get best result: C-Scan technique gives the best result with the use of energy for finding cracks and better than sound scanning.
- Is this technique is feasible for industry: Yes this technique is more feasible for industries. We can show by our simulation that is feasible to find the cracks with better accuracy.

Overall response: Our technique is best ever technique that is proposed by me as compare to the industry uses. This means the C-Scan technique on the basis of energy is best technique to finding the cracks.

IV. RESULTS AND DISCUSSION

We represented a scanning Sample that will show the quality of crank shaft through the C-Scan technique with energy ratio. In this we have scanned the Sample of Sample and get the results.

4.1 Sample Results

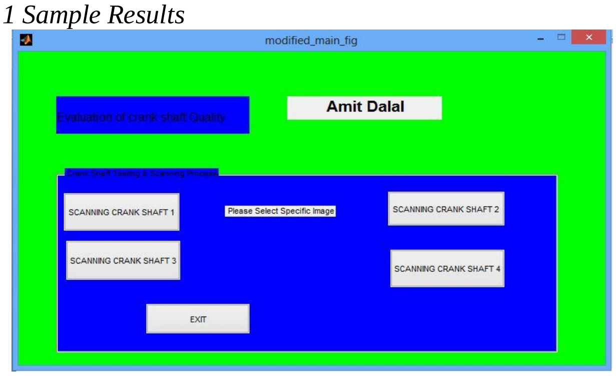

Fig 4.1: Display selection of crank shaft

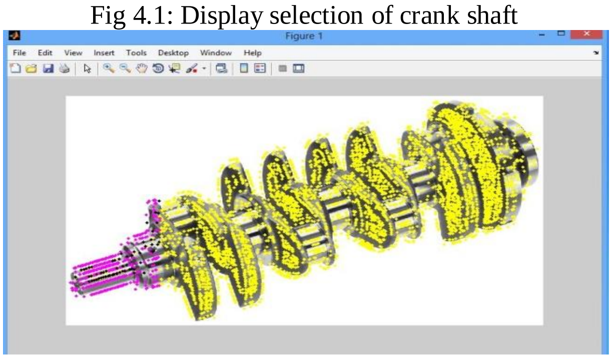

Fig 4.2: Display different crank Sample

We created the GUI interface to select the different crank shaft for further scanning process. This interface gives us our options of different crank shaft. From there we can choose any option. After choosing the option the we selected the crank shaft for scanning.
Descriptions: In this above figure we have seen the GUI interface. From here we can select the Sample for scanning. If we have not select any Sample it will not move on next step.

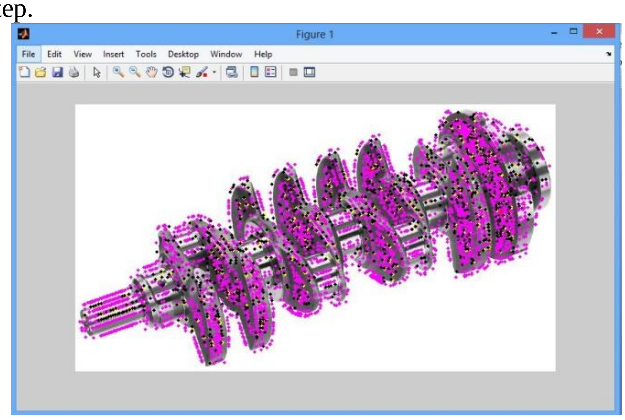

Fig 4.3: After Scanning

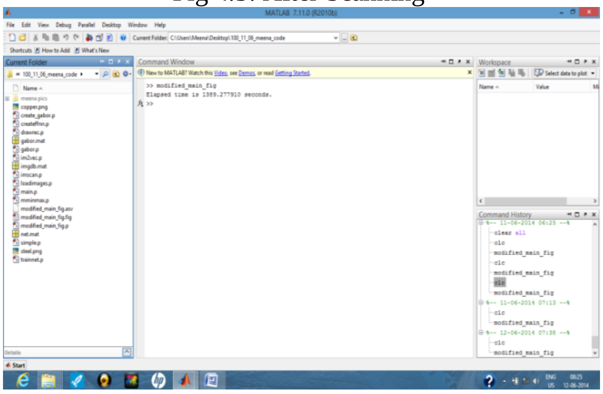

Fig 4.4: Show the time taken in scanning

This is the scanned Sample pixel by pixel. There are so many blank spaces which are the type of cracks. These cracks are shown in the

4.2 Performance Measures
After scanning through C-Scan technique we get the graph of that crank shaft. This graph is of crank Sample . In this we saw there is less cracks so it gave the quality of the Sample with Sample.

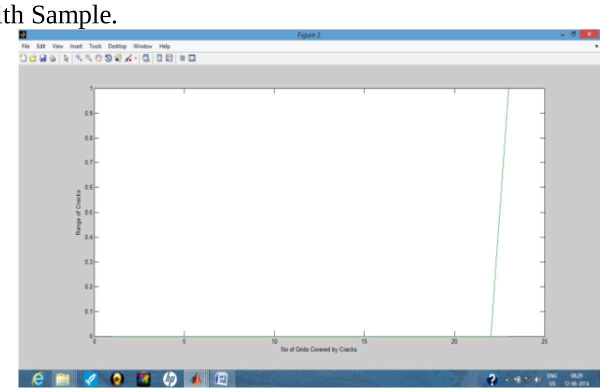

Fig 4.5 -Graph of crank Sample

These graphs show the condition and cracks on a Sample. It shows there is less number of cracks in crank and more in Sample as compare to crank so the quality of crank is very good and crankshaft quality is showed average. Same thing is shown in next output screen. So after scanning the generated graph decides the quality of the Sample is good, average or poor.

V. CONCLUSION AND FUTURE WORK

5.1 Conclusion
On this C-scan process there is easily predict the surface condition and how and where crack is located on crank shaft. This process gives us better and efficient method for crack detection in Sample with high level of accuracy. In the scanning implementation we have taking any crank shaft and through scanning we find the quality of that Sample whether it is good, average or poor. This scanning technique gives us better and efficient method for crack detection in Sample with high level of accuracy. In this we have use tools and technology of MATLAB 2010B. This work can be used in:

- Support Vector Machine: C-Scan technique uses for fine scanning .
- Light energy used instead of sound to get better scanning results.

5.2 Future work
Our future endeavors will include further development of the system, such that it could be used in real time through the Internet, as an online Web-based structural health monitoring system. In we can helpful in repairing the damage in Sample. This technique is helpful to get more accurate results through C-Scan process.

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