Advances in Digital Radiography for Aerospace, Rail and Oil & Gas Industries

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Abstract. This presentation will describe the work that has been carried out to date on the EU Framework 6 Integrated Project, FilmFree. Within the scope of this project, a number of new and innovative technological advances in industrial digital radiographic non-destructive testing will be researched and developed mainly for the aerospace, rail and oil & gas industries, but also for power generation and shipbuilding industries. The project will effectively promote the replacement of radiographic film with various radiographic digital media that will enable safe, fast and accurate on-site and production-line non-destructive inspections with automated defect recognition.

Introduction

The objectives of the EU Framework 6 Integrated Project, FilmFree, are to make a number of new and innovative technological advances that will take the industrial digital radiography sector into a new era to effectively replace film as the detecting media with digital technology. The project will be the industrial equivalent of the replacement of film based camera photography with digital cameras. This will reduce the cost, waste and man-hours associated with traditional film radiography, and increase the accessibility and accuracy of radiographic non-destructive testing.

FilmFree is a four-year project, and in September 2006, it will have completed its first year. The development and trials to date of the innovative digital radiographic techniques, compared to traditional film radiography, will be presented.

Provision of Defect Samples

The first phase of the project involves the design and production of numerous industry representative test specimens to be later used for digital radiographic technique development. The samples are made from various materials and contain a variety of defects, both real and artificial, mainly from the aerospace, rail, and petrochemical, oil & gas industries, but also including the power generation and shipbuilding industries. Traditional film radiographs of the samples will be compared to various digital radiographs taken through different methods to ensure that the images are at least the same quality in terms of defect detectability, contrast and sensitivity.

Over two hundred samples have been provided for the project representing a wide range of materials and defect types, including: corroded and eroded pipes, welded pipes, plates and components both manual and automatic, and rail section samples. There is also a wide range of castings including light alloy castings in aluminium, titanium and magnesium, turbine blades, and complex steel castings.

Development of Prototype Digital X-Ray Hardware

The second phase of the project involves the research, development and production of various new radiographic hardware systems. Several x-ray generation systems are currently being produced for the project which include: a 450kV microfocus x-ray generator, a 250kV Panoramic millifocus x-ray generator, and an x-ray backscatter radiography system. The various types of digital media include: direct detector arrays, phosphor-imaging plates, computed radiography systems and x-ray backscatter detectors; this digital media will also be adapted for use with x-ray gamma sources. Highly accurate manipulators are also being produced to hold and position the samples between the x-ray source and detector.

The individual radiographic components described above will be integrated together to form complete x-ray systems that are flexible, highly accurate and reliable. These systems will then be tested, optimised and validated through comparison to other radiographic systems.

Development of Theoretical Models for New Radiographic Techniques

The third phase of the project involves the research and development of individual theoretical models for current and new x-ray sources, samples and defects, and the various detection media, as well as combined models for complete radiographic techniques. Such models will be used to establish the optimum radiation exposure conditions and detector variables that will provide the highest level of resolution and defect detection sensitivity for each industry sector. They will also be used to simulate radiographic images of the various samples, enabling for efficient radiographic technique trials and optimisation. The theoretical models will initially be optimised through testing, trials and validation of the radiographic hardware described previously.

Development of New Radiographic Techniques

The fourth phase of the project involves the development and production of new and novel digital radiographic techniques, such as x-ray backscatter, double wall pipe radiography and the use of digital detectors, which will promote the replacement of radiographic film by radiographic digital media. For example, on-site pressure pipe weld examination could be carried out using computed radiography and x-ray gamma isotopes as opposed to traditional film. These techniques will potentially reduce exposure times, have increased penetration of materials, and will automatically identify areas of defects within the material. These techniques will improve on current methods and will be established and validated using the samples provided for the project. These techniques will also be directly compared to film radiography through trials and modelling.

Future Work

Further phases of the FilmFree project that will not have started by September 2006, and the future direction of work, will be briefly summarised. This will include the research and development of automated defect recognition algorithms, improvements into the probability of detection of defects, digital image qualification criteria, validation of the various radiographic hardware and software, and laboratory and field trials of the completed systems.

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