METHODS AND SYSTEMS FOR INSPECTING AIRCRAFT FUSELAGE FRAMES

BACKGROUND OF THE INVENTION

This invention relates generally to aircraft fuselage frames, and more particularly to methods and systems for non-destructive inspection of aircraft fuselage frames.

In order to facilitate performing high-speed digital radiography for defect detection on passenger aircraft fuselage frames in both a timely and cost efficient manner, speed of data collection is primary. Speed can be addressed by rapid image acquisition, which can be accomplished through the synchronous motion of the energy source and the detector. In order to achieve adequate image quality, the detector must be located close to and along the outside of the aircraft fuselage to reduce the effects of magnification.

The proximity of the inspection system to the aircraft fuselage increases the potential for collision and damage to both the aircraft and the inspection system. To facilitate preventing collision and damage, at least some method of avoidance and protection is required.

BRIEF DESCRIPTION OF THE INVENTION

In one aspect, a method for inspecting an aircraft fuselage using an inspection system that includes a moveable detector is provided. The method includes coupling a collision avoidance system to the inspection system detector, monitoring the collision avoidance system during operation of the inspection system, and controlling operation of the inspection system with the collision avoidance system.

In another aspect, an apparatus for inspecting an aircraft fuselage is provided. The apparatus includes a moveable detector, and a collision avoidance system in electrical communication with the moveable detector to control the moveable detector for inspecting the aircraft fuselage.

In another aspect, an inspection system for inspecting an aircraft fuselage is provided. The system includes a moveable detector, at least one proximity sensor electrically coupled to the moveable detector, and a collision avoidance system in electrical communication with the moveable detector and the at least one proximity sensor for controlling the moveable detector during the inspection of the aircraft fuselage.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration of an aircraft fuselage; and

Figure 2 is a block diagram of a collision avoidance system coupled to an inspection system for use with an aircraft fuselage.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is an illustration of an aircraft fuselage 10 of a passenger jet. Figure 2 is block diagram of an inspection system 12 for use with an aircraft fuselage, such as, aircraft fuselage 10 in Figure 1. Inspection system 12 can detect defects in the aircraft fuselage, such as cracks, corrosion, delaminations, disbonds, etc. Inspection system 12 may also be used with other types of aircraft fuselages, structural components, and materials that include these types of defects. More specifically, inspection system 12 includes a moveable detector 14 coupled in synchronous motion with an energy source (not shown). In one embodiment, inspection system 12 is a high-speed digital radiography system, such as the DXR-500 available from General Electric Inspection Technology, Cincinnati, Ohio. However, as will be appreciated by those in the art, other systems can be used within the scope of the present invention.

In operation, inspection system 12 rapidly passes close to and along fuselage 10. A collision avoidance system (CAS) 20 is coupled to inspection system 12 in order to prevent contact between inspection system 12 and fuselage 10 during the inspection process. CAS 20 includes at least one proximity sensor 22, at least one protection device 24, and a collision monitor 26. Proximity sensor 22 is electrically coupled to detector 14. In one embodiment, proximity sensor 22 is remotely coupled to detector 14. In one embodiment, proximity sensor 22 is a single sensor that includes at least an

infrared sensor, an air-filled bladder sensor, or an accelerometer. In another embodiment, proximity sensor 22 is a group of sensors that includes a combination of at least an infrared sensor, an air-filled bladder sensor, or an accelerometer. An infrared sensor allows for measuring distance between detector 14 and fuselage 10. An air-filled bladder allows for monitoring changes in pressure and provides damage prevention. An accelerometer allows for measuring detector speed

In operation, proximity sensor 22 generates signals during the operation of detector 14 and transmits those signals to collision monitor 26. If during the inspection process proximity sensor 22 detects an imminent collision, then a signal is transmitted to collision monitor 26. Monitor 26 is configured to send an imminent collision signal to an inspection system stopping mechanism 28. Stopping mechanism 28 is configured to immediately halt the motion of detector 14 and facilitate preventing a collision between detector 14 and fuselage 10. In one embodiment, stopping mechanism 28 is a manipulator that moves detector 14 away from fuselage 10.

A protection device 24 is coupled to inspection system 12. In one embodiment, protection device 24 includes, but is not limited to, one or a combination of at least an air-filled bladder, a balloon, or an airbag system. In another embodiment, protection device 24 includes other devices capable of protecting detector 14 as described herein.

Protection device 24 is in electrical communication with stopping mechanism 28 such that during operation, when stopping mechanism 28 receives an imminent collision signal from monitor 26, protection device 24 is deployed. Accordingly, detector 14 does not contact fuselage 10. In an alternative embodiment, protection device 24 is in electrical communication with proximity sensor 22 such that when proximity sensor 22 detects an imminent collision, protection device 24 is deployed and prevents contact between detector 14 and fuselage 10.

The above-described collision avoidance system 22 for an aircraft fuselage inspection system 12 is both cost-effective and highly reliable. The inspection system receives input from at least one proximity sensor coupled to the collision avoidance system to facilitate the prevention of contact between the movable detector and the aircraft

fuselage. Furthermore, the collision avoidance system allows non-destructive inspections of aircraft fuselage frames. As a result, the inspection system can perform high-speed digital radiography on aircraft fuselages in close proximity without concern of damage to the detector or the fuselage or loss of image quality.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

WHAT IS CLAIMED IS:

1. A method for inspecting an aircraft fuselage (10) using an inspection system (12) including a moveable detector (14), said method comprising:

coupling a collision avoidance system (20) to the inspection system detector;

monitoring the collision avoidance system during operation of the inspection system; and

controlling operation of the inspection system with the collision avoidance system.

2. A method in accordance with Claim 1 wherein coupling a collision avoidance system (20) comprises coupling at least one proximity sensor (22) to the inspection system detector (14).

3. A method in accordance with Claim 2 wherein coupling a collision avoidance system (20) comprises coupling the at least one proximity sensor (22) to the inspection system detector (14) such that the collision avoidance system receives signals from the proximity sensor during operation of the inspection system.

4. A method in accordance with Claim 2 wherein coupling at least one proximity sensor (22) to the inspection system (12) further comprises coupling at least one proximity sensor to the inspection system that is configured to generate an imminent collision signal.

5. A method in accordance with Claim 2 wherein controlling operation of the inspection system (12) comprises controlling operation of the inspection system based on input received by the at least one proximity sensor (22) during operation of the inspection system.

6. A method in accordance with Claim 1 wherein coupling a collision avoidance system (20) comprises coupling at least one protection device (24) to the inspection system (12) to facilitate preventing contact between the inspection system and the aircraft fuselage (10).

7. A method in accordance with Claim 1 wherein coupling a collision avoidance system (20) comprises coupling at least one of an air-filled bladder sensor and an accelerometer to the inspection system detector (14).

8. An apparatus for inspecting an aircraft fuselage (10) comprising:

a moveable detector (14); and

a collision avoidance system (20) in electrical communication with said moveable detector to control said moveable detector for inspecting the aircraft fuselage.

9. An apparatus in accordance with Claim 8 wherein said apparatus further comprises at least one proximity sensor (22) electrically coupled to said moveable detector (14).

10. An apparatus in accordance with Claim 9 wherein said at least one proximity sensor (22) is electrically coupled to said collision avoidance system (20) such that said collision avoidance system receives a signal from said at least one proximity sensor (22) during operation of said moveable detector (14).

11. An apparatus in accordance with Claim 9 wherein said at least one proximity sensor (22) comprises at least one of an infrared sensor, an air-filled bladder sensor, and an accelerometer.

12. An apparatus in accordance with Claim 9 wherein said at least one proximity sensor (22) generates an imminent collision signal and transmits said signal to said collision avoidance system (20).

13. An apparatus in accordance with Claim 9 wherein said moveable detector (14) is controlled based on input received by said at least one proximity sensor (22) during the inspection of the airplane fuselage (10).

14. An apparatus in accordance with Claim 9 further comprising a stopping mechanism (28) coupled to said moveable detector (14) and configured to receive an imminent collision signals from said at least one proximity sensor (22) to facilitate

preventing contact between said moveable detector and the aircraft fuselage (10) frame.

15. An apparatus in accordance with Claim 8 further comprising at least one protection device (24) electrically coupled to said moveable detector (14) to facilitate preventing contact between said moveable detector and the aircraft fuselage (10).

16. An apparatus in accordance with Claim 15 wherein said protection device (24) comprises at least one of air-filled bladder, a balloon, and an airbag system.