Blisk Inspection System

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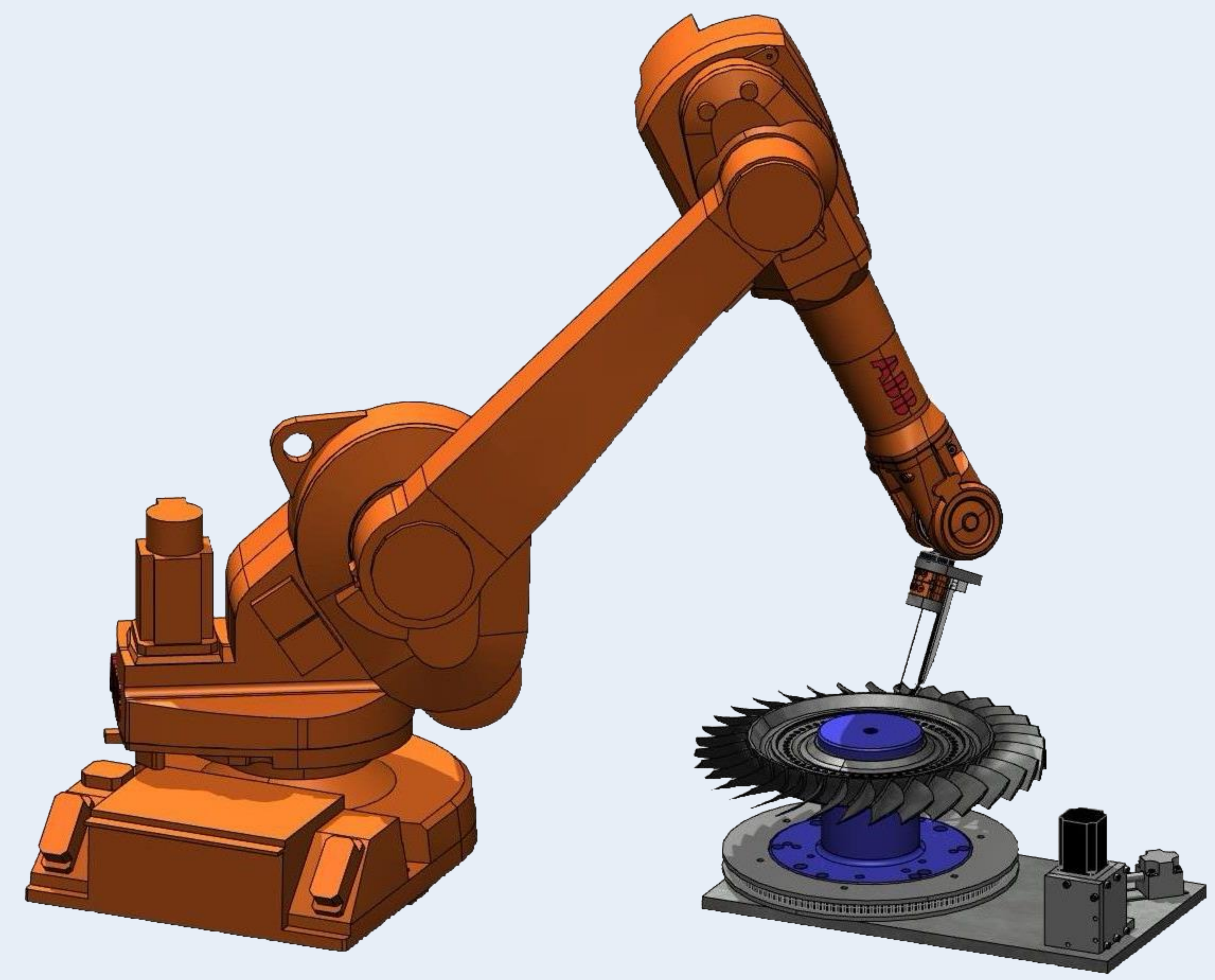
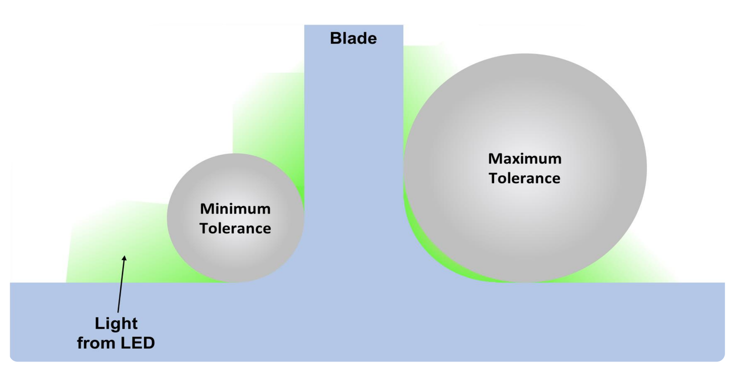
Abstract

The Blisk Inspection System utilizes an ABB robotic arm equipped with a custom end effector, actively communicating with a programmable logic controller and custom turntable. This system is primarily controlled through a Windows application, serving as a user interface while also managing computer vision and logging inspection results. Quality analysis of bladed disk (blisk) root fillets is currently being performed by hand, requiring excessive labor and consumable costs. This system will serve as a suggested solution to reduce overall cost of production and increase factory output.



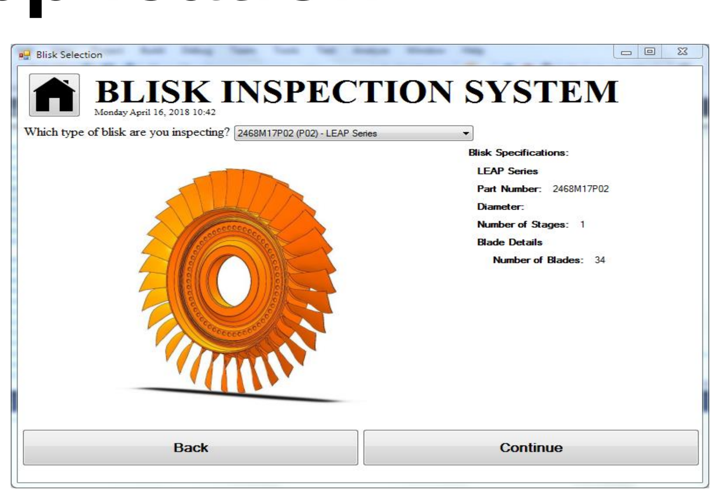
Background

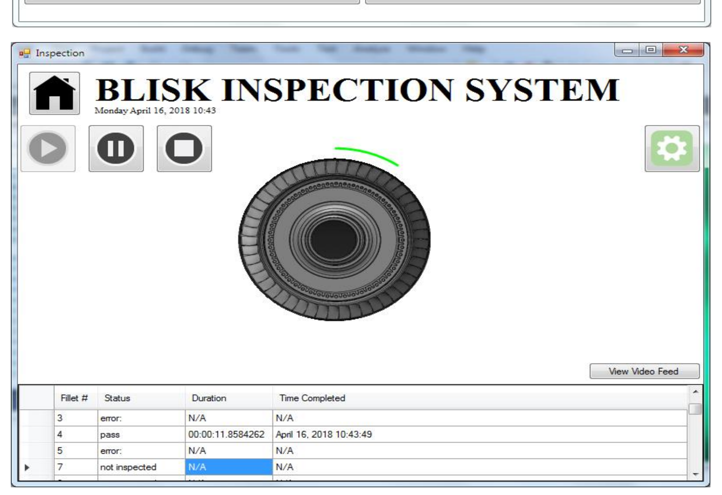
- Blisks are part of the compression stage in a turbine engine.
- LEAP series blisks are precision made from a single piece of titanium.
- Current inspection process is performed by hand.
- Fillets must be within a given tolerance.



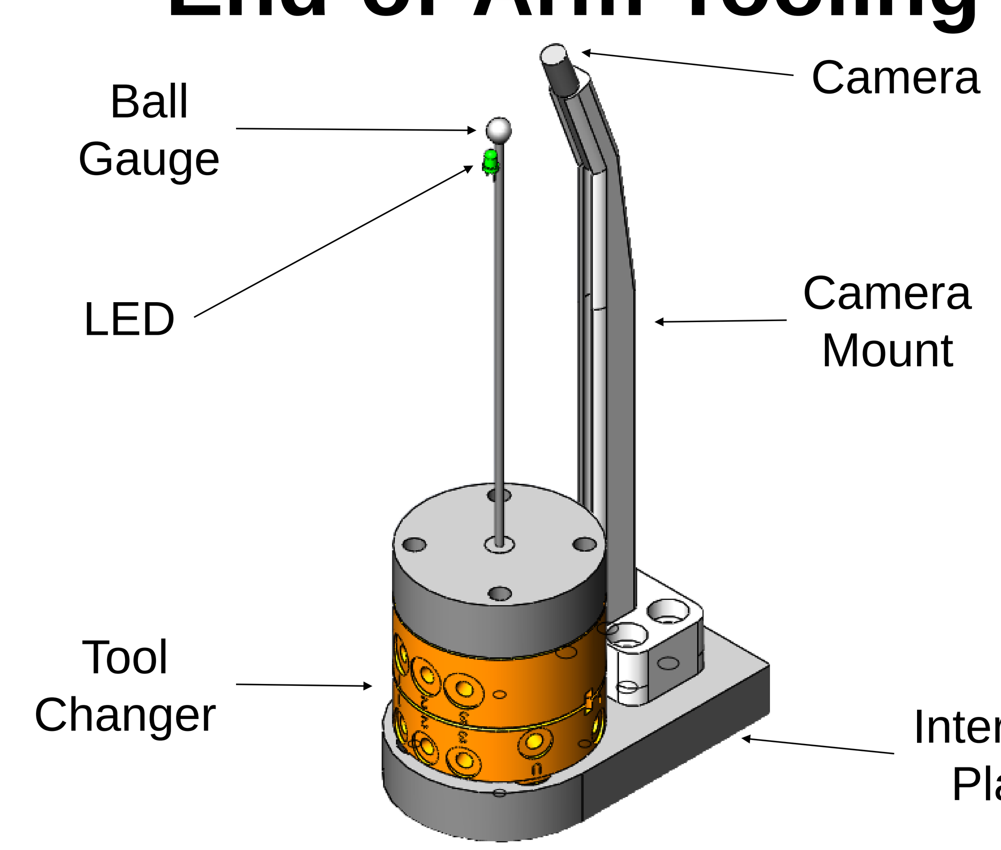
Software Application

- Provides the inspector with an easy-to-use interface for operating the blisk inspection system.
- Handles the interaction between the camera and the computer vision.
- Frames from the video feed are passed into our computer vision algorithm.
- Exports frames that failed inspection along with a summary for the entire inspection.





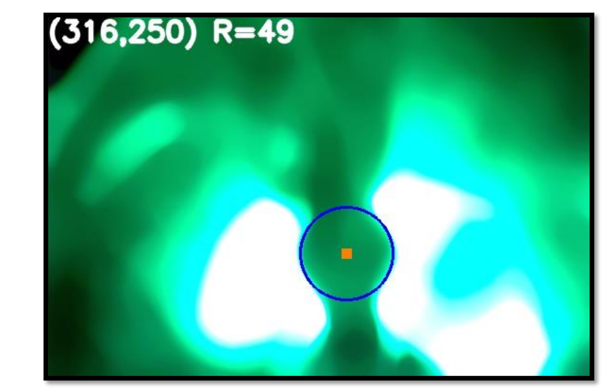
End-of-Arm Tooling



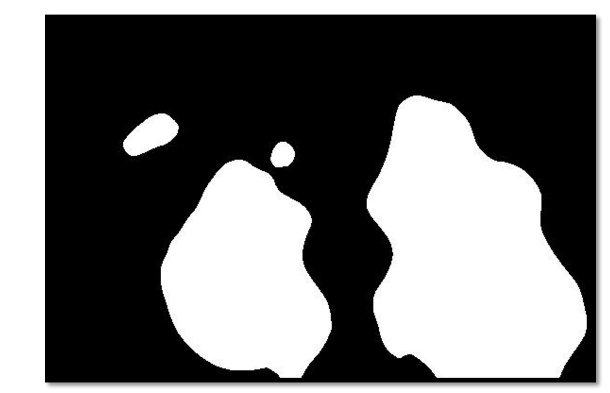
- Endoscopic camera
- Camera mount
- Precision ball gauge
- ATI tool changer
- Custom interface plate
- Green LED

Computer Vision

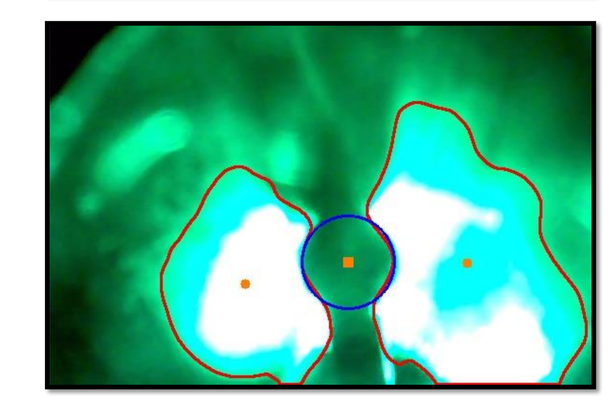
Goal: Locate the ball gauge, detect the points of contact between the ball gauge and the blisk, and analyze the light pattern.



- Reduce the noise and sharpen the edges in the frame using a median filter.
- Find the ball gauge by using the edges to detect a circle of a desired radius.



- Mask the original frame for a range of HSV values to isolate the regions of green light.



- Use the mask to outline regions of light bordering the ball gauge. Due to the shaft,

  \# of contact points = # of regions -1

- We use the number of contact points to determine whether or not the fillet passes inspection. The number of contact points also informs the system if the ball gauge is no longer in the fillet.

Results

- Computer vision algorithm successfully identifies whether or not a fillet is within tolerances.
- End effector switches between different ball gauge sizes.
- End effector positions LED, ball gauge, and camera in proper orientation between LEAP series blisk blades.
- Interface plate connects ATI tool changer, camera mount, and ABB 1600.
- Micro stepping turntable driver increases steps per revolution from 3,200 to 20,000.
- PLC communicates with the turntable to step the proper distance to move from blade to blade.

Acknowledgements

Thank you to our sponsor, General Electric Aviation!