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Vision System Non Contact Measurement of Pintail Type Fasteners

Ryan Haldimann
Electroimpact

ABSTRACT

Accurately measuring the length of a pintail type fastener is limited by the process of forming the fastener. When the pintail is formed its overall length is not dimensionally controlled. To accurately measure the grip of the bolt a vision system is utilized that finds the notch between the tail and bolt shank. The grip, diameter and angle of the bolt prior to insertion are then measured. This method proves to be more accurate than measuring the bolt mechanically and provides a number of other advantages including; decreased measurement speed, accuracy, FOD detection and angle of the bolt in the fingers prior to insertion.

INTRODUCTION

Building aircraft demands accurate measurement of fasteners using in the construction process. Of all the fastener types used, pintail type fasteners are very difficult to measure because of the way they are manufactured. The pintail is formed on the fastener in a swaging operation. Because it is swaged the length of the pintail is not well controlled, thus overall bolt length is not an accurate measure of grip length. Using a vision system integrated into the head of the machine allows for measurement of critical parameters of the fastener prior to insertion into the panel. The vision system utilizes industry standard software to measure the location of the pintail/fastener interface. It is then able to calculate the bolt grip, angle and diameter, ensuring the correct bolt is installed as called for in the CNC program. This method of measurement takes less time than traditional methods allowing for decreased cycle times when closely integrated into the machine structure.

MAIN

PROBLEM STATEMENT

Accurately measure the grip of a pintail type fastener without adding cycle time and mechanically integrate it into current machine design (Figure 1).

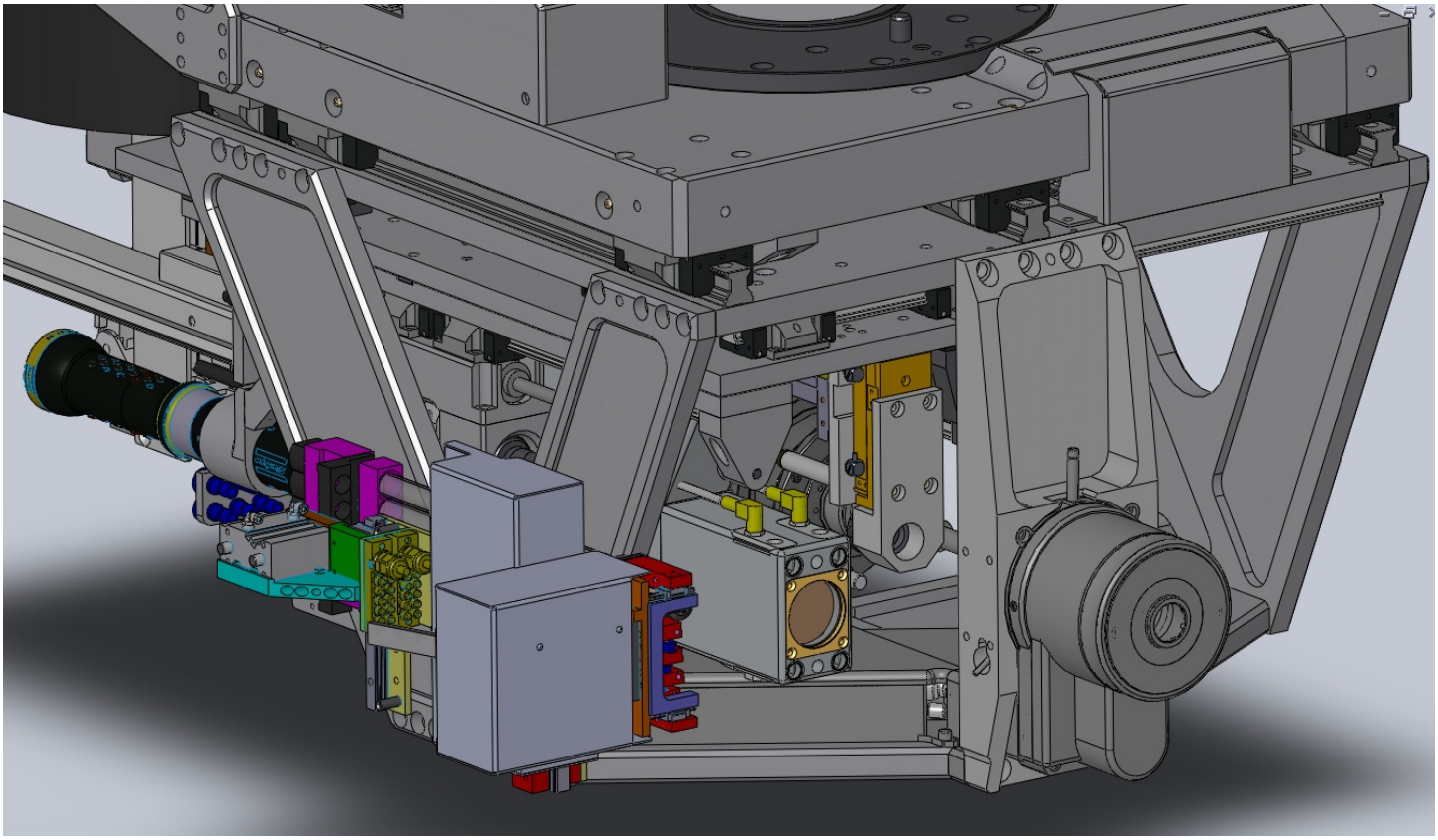

Figure 1: Aircraft Fastening/Drilling Machine End Effector

SYSTEM DESCRIPTION

The system consists of a digital camera and illumination system constructed such that it fits in the machine structure. To do this a digital camera, on axis lighting, and mirrors to alter the optical path are integrated into a single assembly (Figure 1), installed such that the bolt is visible just after it is inserted into the bolt inserter fingers. The mature end effector design required the use of mirrors to bend the optical path to optimize camera location and view of the fastener. To effectively illuminate the fastener an on axis light source was used which provided collimated light along the imaging axis. To allow as much light to travel to and from the fastener as possible, components were selected that avoided loss due to reflection and were as large as feasible. For this type of measurement, rear illumination is the best option, however due to space constraints and existing design this was impossible. A reflective film was used behind the fastener to achieve a similar effect to rear illumination. After capturing the image, it is processed on a conventional industrial computer using industry standard pattern matching software. Measurements are then transferred to the CNC for validation prior to installing the bolt. The system is able to measure fasteners from 3/16" to 1/2" diameter and grips from 1/4" to 1-1/16".

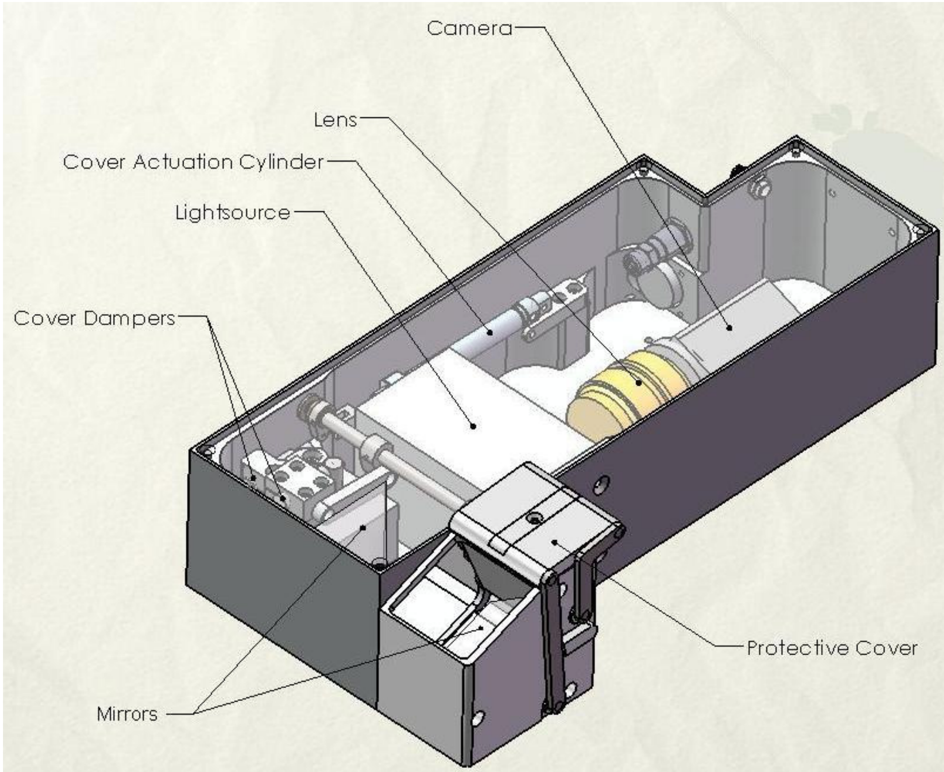

Figure 1: Bolt Camera Assembly

OPERATION

The fastener is fed to the bolt inserter from operator feed tubes or automated hoppers. It is then measured while in the bolt inserter fingers. The fastener is checked for diameter, grip and angle in the bolt inserter fingers. The information collected is then displayed to the operator. (Figure 2). The presence of FOD shows up during measurement as a failure to measure any of these critical dimensions. If the fastener fails these tests it is rejected and another fastener is fed to the bolt inserter and subsequently checked.

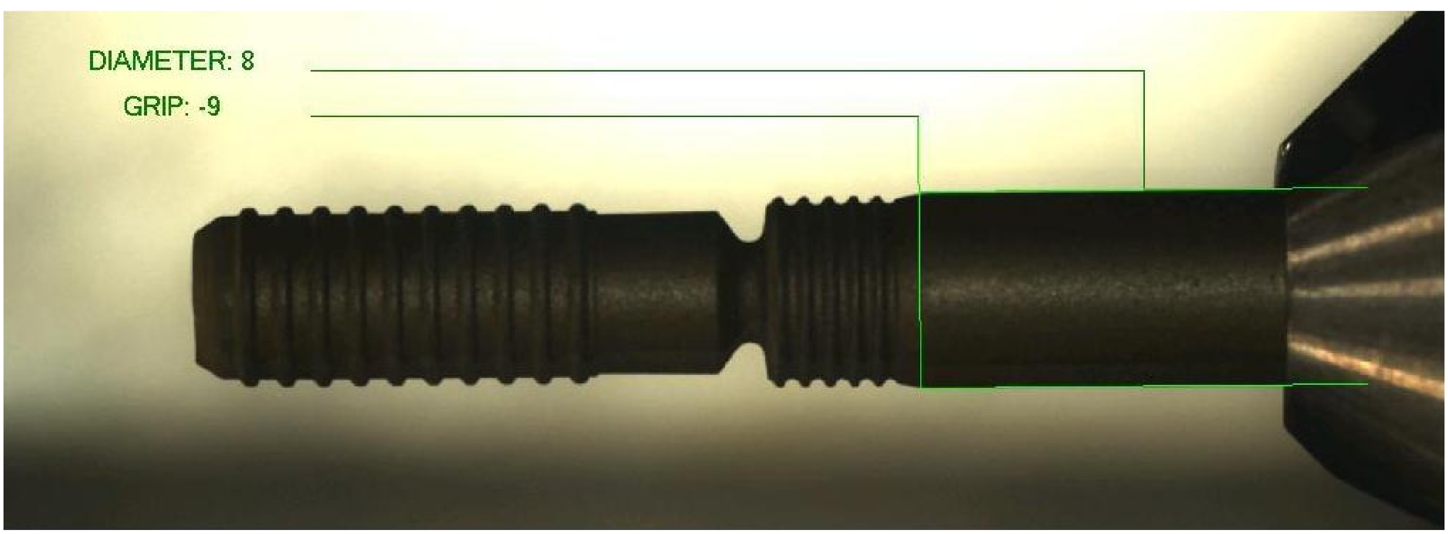

Figure 2: Operator Display of Measured Bolt Dimensions

The bolt grip is measured by locating the separation notch and calculating the end of the grip based on the manufacturing drawing. To measure the overall length the bolt head must be located. Although the head is obscured by the bolt inserter fingers (Figure 2), the location of the driver face is located when tooling is changed. This location is stored thus making it possible to measure the grip from the face of the inserter to the end of the grip located using the separating notch and data from the manufacturing drawing for the fastener. Figure 3 shows the inspection software finding the notch and measuring the diameter and angle of the bolt.

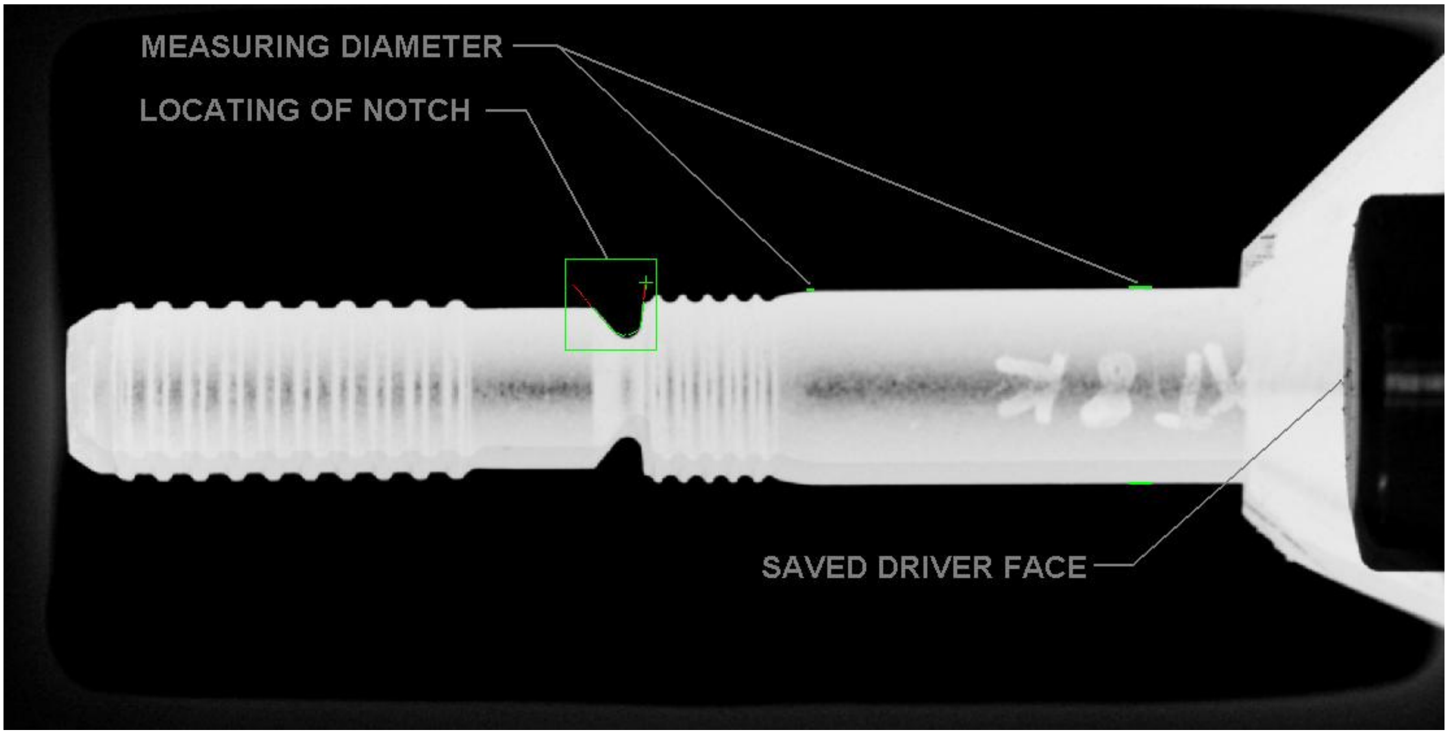

Figure 3: Measurement of Bolt

PERFORMANCE

The checking of the fastener must be as quick as possible so as not to effect cycle time of the machine. The inspection process takes around 400 ms, this includes image capture and communication to the CNC. The high speed and accuracy at which this system operates minimizes machine cycle time.

The system is able to measure the diameter and grip to within .001", providing very repeatable and accurate results.

OTHER BENEFITS

The system also has the benefit of being able to display an image to the operator after sealant has been applied to the bolt. This allows the operator to monitor sealant coverage prior to insertion and adjust as required.

SUMMARY/CONCLUSIONS

Using a vision system to inspect physically difficult to measure fasteners turns out to be faster than traditional measurement and provide more information about the fastener prior to insertion. Of critical importance is the ability to keep the optics clean and process the image efficiently, low light levels require long exposures possibly impacting cycle time. The bolt inspection system has been in production since August 2009, inspecting thousands of pintail type fasteners.

REFERENCES

CONTACT INFORMATION

Ryan Haldimann
Controls, Vision, Mechanical Engineer
Electroimpact, Inc.
ryanh@electroimpact.com
(425) 609-4921

ACKNOWLEDGMENTS

DEFINITIONS/ABBREVIATIONS

CNC: Computed Numerical Control

FOD: Foreign Object Debris

BOLT INSERTER: Process tool that drives interference fasteners into the aircraft structure.

BOLT INSERTER FINGERS: Tooling that holds the bolt on the end of the bolt inserter.

APPENDIX