Automated Torquing Cell

for Jeep Cherokee Trans Bridle Assembly

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Abstract— **Autonomous assembly is the driving force for humanities fourth industrial revolution. Android Industries assembles engine for Jeep in Belvidere, Illinois. Android Industries strives to increase efficiency without sacrificing the health and safety of its employees. Automation on assembly lines is the means of meeting the ever-increasing consumer demands. Employees working on assembly lines often experience ergonomic issues in their joints caused by repetitive motion and forces transferring through their body. Android Industries requires an autonomous torqueing cell to accomplish the repetitive tasks, increases the quality and repeatability of the work, while also mitigating the harm to the workers. The Torquing cell was designed and prototyped in SolidWorks before being manufactured and implemented into Android's existing systems. The cell is pneumatically driven, controlled by a programmable logic controller. The design features three subassemblies: the motion mechanism, the control system, and the support structure.**

I. Introduction

Android Industries requires the torqueing cell to perform the final torque attaching a bridle to the engine mounting bracket. The automated torque cell is designed to torque a specified bolt without the interaction of a human operator. The auto torque cell containing a DC Nut-runner positions itself in the correct orientation and drives a fastener to final torque value. The auto torque can torque bolts for three different engine models on multiple planes and angles. This auto torque cell design includes three major sub-assemblies: the motion mechanism, the control system, and the support structure. The divisions of the torque cell coincide with the manufacturing process. The motion mechanism is fabricated and assembled, followed by the control systems for testing and optimization, while the support structure is assembled at the location for implementation.

II. Design Features

A. Motion Mechanism

The motion mechanism of the automated torqueing cell is the DC nut-runner assembly. This DC nut-runner assembly is made up of off the shelf components with custom made brackets attaching them together. The use of off-the-shelf components allows Android to easily replace broken or worn-out parts rapidly. The brackets that were designed to use readily available materials sizes to reduce the amount of machine time, this reduces downtime of the mechanism and complexity. The main component of the DC nut-runner assembly is the linear bearing slides these linear bearing slides allow the nut runner assembly to have smooth movements resulting in a long service life. The movements of the assembly are accomplished using pneumatic cylinders. By using pneumatic cylinders, the assembly can have rapid movements and part commonality with Androids' other machines. Shock absorbers are used to slow the assembly down, when it reaches a position. This reduces stress on the components of the assembly and leads to longer service life.

Figure 1: SolidWorks Model of Auto-Torque Cell

B. Control System

The system is controlled by a programmable logic controller (PLC) using RLS Logix 5000 version 19. Androids System communicates directly to the controller housed in the control box. The control box contains the PLC, the power supply, an air manifold with a series of two-way air solenoid switches, relays, and circuit breakers. The PLC receives signals from Android indicating which engine model is currently in the station and determining which of the three programs to run. The PLC sends a signal to the Nut-runner to begin spinning and moves to align the Nut-runner with the bolt on the engine model. Induction sensors

attached to the air cylinders indicate the location and authorize the movement of the Nut-runner towards the engine. The Nut-runner sends the value of the torquing and indicates whether the bolt is torqued to the proper amount or not. The completed torque signals for a systematic retraction

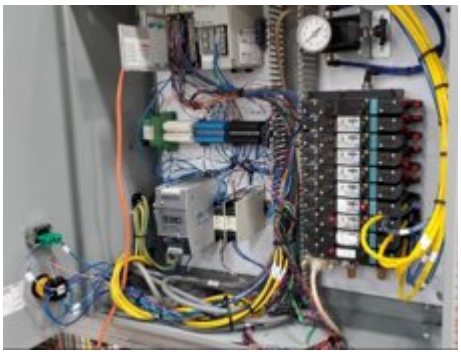

Figure 2: Control Box Layout

of all the pistons, and the PLC indicates to the status to Androids Industries system and workers in the area via a stack light.

C. Support Structure

The support structure is made of 80-20 Aluminum and is designed to seamlessly integrate into androids existing support structures. The structure was designed to ensure maximized adjustment to the range of the hard stop. The support structure holds the motion assembly above the engines as they pass through the station. The Support structure also holds the control panel for easy access to the wiring adjustments to the programming and wiring. All wires and tubes run safely along the support structure in cages and are secured with zip ties.

III. Implementation

During the design phase, adjustments were made to utilize materials that were available at Android Industries as well as to match the fabrication methods already in place. The original PLC was replaced by an older version that was compatible with the version of the RLS Logix was licensed to Android Industries. Many of the switches, wire busses, and relays were pulled from Android Industries extra supply stock.

The Torquing Cell was delivered, and the support structure was assembled at Android Industries. The support structure required significant adjustments to ensure that it did not interfere with existing sensors while still maintaining all clearance requirements and maximum adjustability.

The largest challenge with this project came with the shelter in place order issued due to the COVID-19 pandemic. Android Industries shut down due to the virus and did not allow for visitors. Engineers at Android Industries [1] were able to finalize all wiring and adjust the program to integrate with their systems properly.

The Automated Torqueing Cell is fully functional for all three engine models and has been tested during the extended plant shutdown. However, the cell will not be optimized until the production restarts, and live testing opportunities become available.

IV. Conclusion

The new Automated Torqueing Cell ensures that the bolts are tightened to the specific regulations improving the quality and repeatability of the station it replaces. The new cell allows for Android Industries to reduce the ergonomic issues experienced by workers performing repetitive tasks by allocating the replaced manual labor to perform more complex tasks.

The new Automated Torqueing Cell increases the efficiency of the Android's assembly line, improving their on-time delivery and production efficiency.

Figure 3: Auto-Torque Cell at Android Industries

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References

1. Allen Bradley https://www.rockwellautomation.com/en_NA/support/download-center/overview.page