Water Pump Bearing Durability Test Stand

By

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Products Used
NI PCI-6229
NI PCI-4472
LabVIEW 8.0
NI Sound & Vibration Toolkit
Newport ICN77R333-PV Temp. Controller
APC 320C15 accelerometers
Marsh Bellofram Type T3511 Electronic Pressure Regulator
AC Tech Motor Controller Model M14150

Challenge
Developing an application to automate the long duration life testing of pump bearings used extensively throughout the automotive industry. The testing required comparison of current values to limits of vibration increase over initial levels, speed, torque, load and temperature. The system was required to concurrently test eight bearings for up to 200 hours.

Solution
Creating a solution that independently monitored and controlled two test tables, each with four bearings. Each test table rotated the bearings using a single motor with a belt drive to the bearings. The vibration of each bearing was monitored using accelerometers wired to an NI-PCI-4472. All other signal I/O was routed through the NI PCI-6229 multifunction board.

Abstract
The manufacturers of pumps must pay special attention to validating their models of bearing life with experimental data. There are several indicators of bearing degradation. The increase of bearing vibration is a better indicator than the absolute level of vibration. Temperature, torque and the ability to control load and speed are secondary indicators. A flexible system was developed to permit the concurrent testing of eight bearings while independently comparing their current condition to allowable failure limits.

Details
Data Science Automation was selected to develop automated software to test up to eight bearings at once. Each table would contain four bearings, if one of the bearings went out of compliance of the noise limits, all four bearings were considered failed. The two tables are independently controlled so if one set of bearings fail the other set could continue to run and log results. The application would monitor 22 analog inputs and 19 digital inputs. The analog inputs monitored are; four thermocouples per table, four accelerometers per table, one motor current per table, one motor speed per table, and one pressure feedback per table. The digital inputs are eight pressure cylinder limit switches per table, one safety guard per table, and one emergency stop input. It would also control 4 analog outputs and 28 digital outputs. The analog outputs are a motor speed control and an air pressure control per each table. The digital outputs are four temperature alarms, four speed alarms, a speed alarm, an air load, and an air unload per each table. The noise analog input is measured by an accelerometers output, there is one accelerometer for each bearing under test. The need for the automated test stand to monitor several other parameters of the testing was very important to determining the true acceptance of the bearings. The motor speed needed to be between 5000 and 5100 RPM through out the length of the test. The pressure form the air cylinders needed to be kept at a specific pressure to apply a set force in pounds on the tensioning belt. The motor current had to be converted to torque and monitored so it did not exceed a set limit. For each test table four pneumatic cylinders with proximity switches at inter and outer limits of motion are also monitored. And the two safety guard inputs and the emergency stop input needed to be

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monitored. The functionality of the test is set up so the operator can select from a manual or automatic mode of operation. To select the mode of operation the operator could simply click on the tab for the table desired as seen in Figure 1.

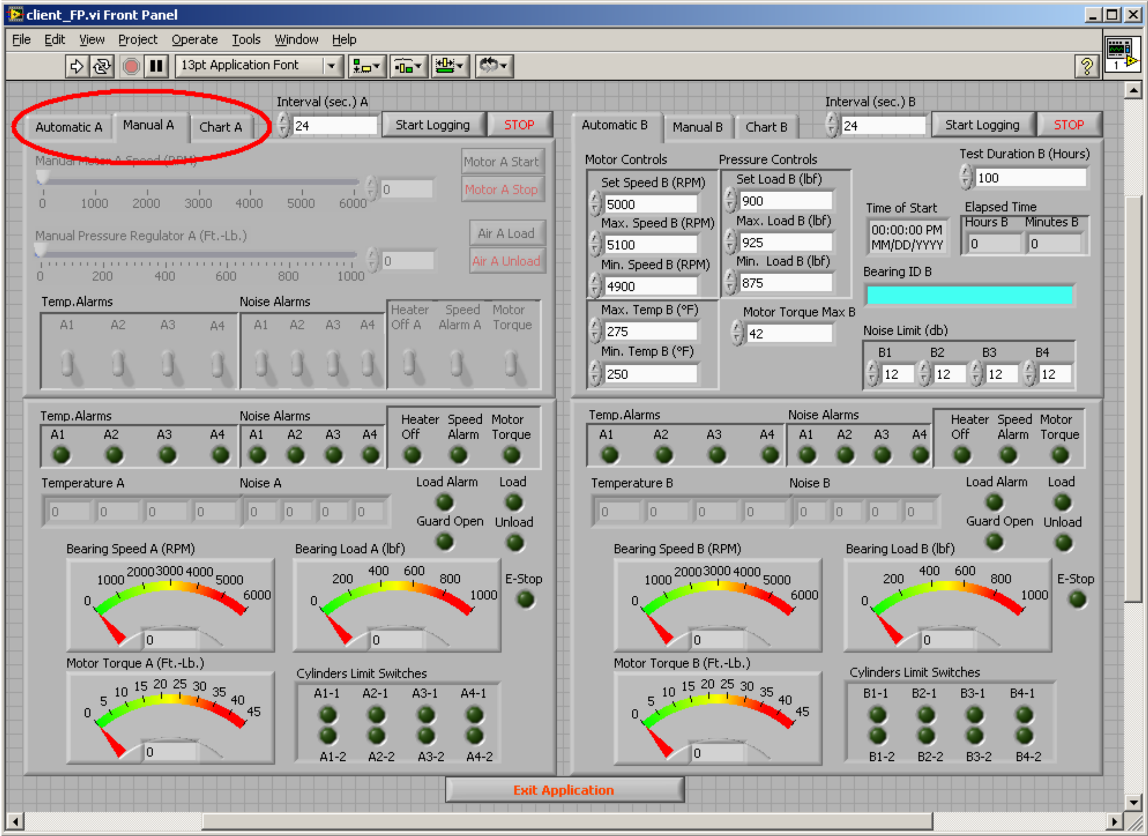

Figure 1. Manual Mode (on left for Table A) and Automatic Mode (on right for Table B).

When in the manual mode of operation all the outputs can be manually controlled. The outputs will let the operator start and stop the motor, change the speed of the motor, load and unload the pressure cylinders, and trip the output alarms. The only inputs that effect the operation of the application while in manual mode are the “Safety Guard” and the “Emergency Stop” inputs. Due to the manual mode of operation being without operational checks like the automatic mode a login to allow operator access is required as shown in Figure 2.

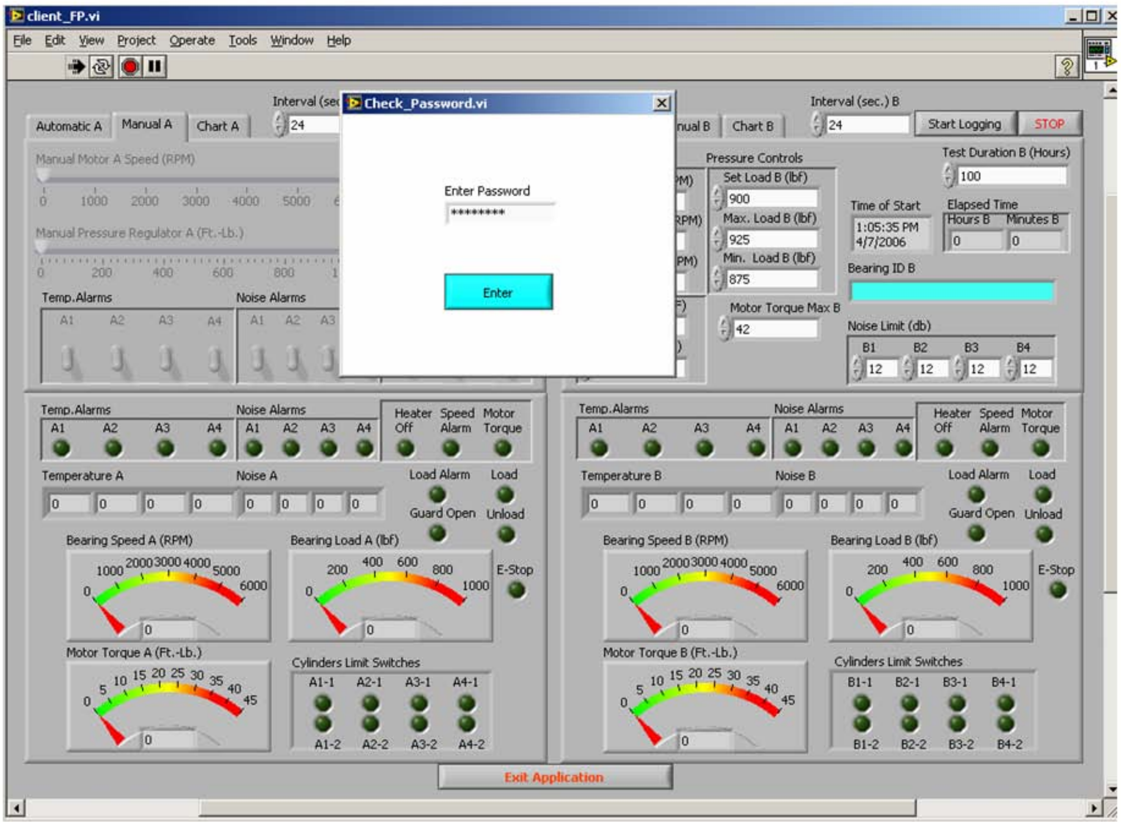

Figure 2. Password required to enable manual mode.

In the automatic mode the test will allow the operator to set up the limits that the test must operate within then wait for the operator to click on the “Start Logging” button. Once the test is under way the limit controls will gray and disable and the start time will hold the initial time for the test. In the automatic mode the test will go through a start up sequence by applying the air pressure then ramping up the motor over time of five seconds. After the motor speed has come up to its set point comparisons of the incoming readings from the DAQ boards will occur and the data will be recorded to the file for the table under test. If the incoming analog values go out of the set parameters the test will go through a shut down procedure for only the table that has failed.

National Instrument’s Sound & Vibration Toolkit simplified software development greatly simplified this project. With the Sound & Vibration Toolkit the incoming accelerometer measurements were easily converted into a decibel reading to be compared to the preset limits. The overall architecture for this application was a state machine due to its flexibility and ease of modification for other future complements to the application.

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Summary

Labview's capability to control multiple instruments and conduct data acquisition made the application developed by Data Science Automation a success. The Sound & Vibration toolkit also reduced development time be providing the needed functions. This was a great help due to the strict time table of this project.

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