Statistical analysis of parallel sensors measurements to control process accuracy

B.Sc. (Honours) in Applied Physics and Instrumentation

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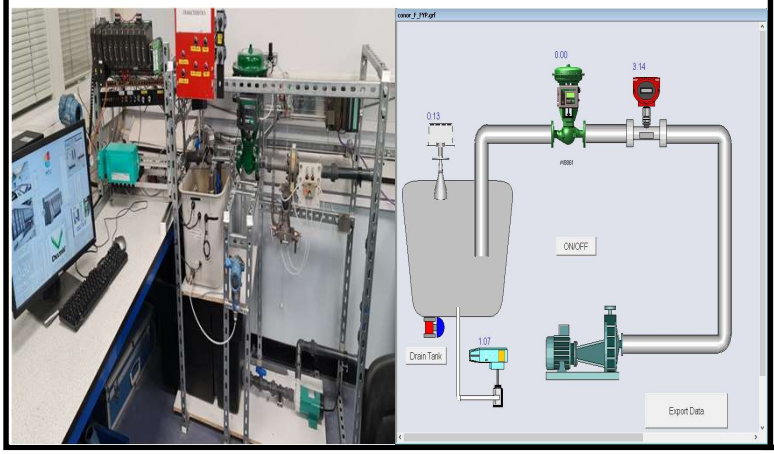
Introduction

Introduction:

Two Sensors of differing measurement concepts, a Differential Pressure sensor and an Ultrasonic sensor, are use as part of a PAT (Process Analytical Technologies) Initiative to show that parallel sensor measurement can maintain data integrity through the use of redundancy and statistical analysis. These instruments will give real-time data that can aid the overall process and any drift or inaccuracies in measurement can be detected in real-time. The process will be monitored by the DeltaV Statistical Process Monitoring tool software, which will aid the engineer in charge of the process. This will mean that because of the parallel sensors, one can be changed out or recalibrated while the other will continue to monitor the process. The result is reduced calibration cost, increased data integrity and off-spec uncertainty. This approach to process analysis and management has a higher initial cost but through out the length of the process lifespan will yield far greater savings in cost because of less downtime.

Rig and Setup:

On the left below is the rig with the DeltaV workstation next to it. On the right is the picture that was created to simulate the process using DeltaV explorer.



Problems and Solutions

Problems:

1. The first problem encountered was a licensing issue, DeltaV Statistical Process Monitoring tool requires a license that is not viable for a one off project like this because it is quiet costly.
2. The instruments that were provided initially were not the correct instruments for this project. The DP sensor had an operating range between 0 and 1 bar, the resolution of this sensor was not adequate for the project. The first radar sensor had an operating range of between 0 and 35 metres and the second radar sensor had an operating range of between 0 and 40 metres. Both of these radar sensors proved to be not suitable for this project, this was due to the fact that the tank in this rig was only 0.35 m in height. Ideally an instrument should be operating in and around its mid point of its range.
3. The final problem encountered was the data extraction from DeltaV. The data is collected using the collection historian but to extract this data is very difficult. There is again a licensing issue and it is not possible to extract data without purchasing the license from Emerson. There was a way of extracting the data through excel but that was through an older version of excel that was available on windows 96.

Solutions:

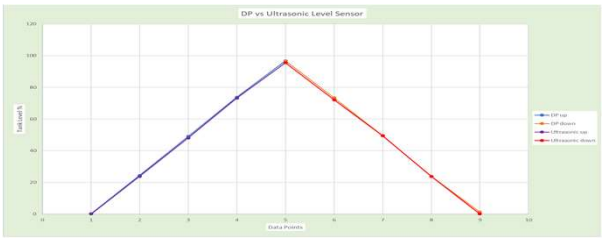
1. The licensing issues could not be resolved because they would have been too costly for this one off project. Instead it was agreed that the data would be collected and analysed through excel.
2. The DP level sensor was changed for a more accurate DP sensor with an operation range between 0 and 0.1 bar. The radar sensors was changed out for an ultrasonic sensor, this was because the radar sensors were operating in meters and were made for much larger tanks and did not detect accurately the small increments of level change in the tank, where as the ultrasonic sensor had an operation range of between 0 and 1.25 m and had an accuracy of 3mm. This proved to be a success and useable data was able to be collected.

If this project was to actually be implemented into an industrial process it would be a great addition and would save time and money because there would be no need for periodic inspections and calibrations.

Results and Conclusions

Data Collection

The data that was eventually collected had to be manually entered into excel. This was not great practice, but was necessary for this project because of the licensing issues. The data displayed below shows data points collected from the DP and Ultrasonic sensors at 0, 25, 50, 75 and 100% marks on the tank when filling and emptying. These data point where very close together which was to be expected. As time goes on these data points could drift apart. The DeltaV software will detect this drift or irregularities and alarms will be triggered to alert the engineer.



Data Analysis

For a typical process, the tank would fill to 50, 75 and 90% and level measurements would be taken. After each measurement, more solutions would be added and an agitator would start and stop after the solutions have been mixed. After the final mixing is complete the tank would empty. All these data point for the level measurement would be collected and relayed to the DeltaV software in real-time and any drift or irregularities would set off alarms and the engineer in charge would be alerted, so that changes to the process could be adjusted so that the solution being produced is not lost. If real-time data collecting is not possible then data is collected in the DeltaV historian and then extracted through excel. In excel macros can be written to analyse the data. This can be either achieved directly through excel or via a visual basic application.

Project Conclusion

This project was a difficult project to be involved in because of the software licensing issues. I did expect the project to be challenging and for there to be obstacles along the way but the fact that I could not stick to the scope was frustrating. For anyone thinking about doing a similar project in the future, I would highly recommend against it. This is because the software licenses are designed for industries in which money may be no object as long as the processes are uninterrupted. This project was beneficial for learning how to build a rig, fault finding and showing the importance of choosing the right instrument for each individual process. Every instrument should ideally operate in or around the midpoint of its range and should not operate at the min or max range, like the first instruments that were being used.

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