Statistically based cascade calibration

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*Abstract*— This paper aims to demonstrate how statistical methods can be used in order to identify whether calibration routines should take place. Currently calibration is triggered by a filtered diameter signal and has the problem of false triggering. Furthermore, it seems that diameter offsets are very stable and that calibration does not need to be done every time a spool is removed from the material spindle. The method proposed is a way that false positives can be prevented via a cascade algorithm at the cost of increased probability of false negatives.

# Introduction

During meetings regarding the diameter sensor it has been hypothesized that false triggers on calibrations are causing the reported diameters to be incorrect by large margins. The basic principle of the algorithm proposed is that by having multiple statistically based sanity checks on the diameter knowing that errors generally occur at the lower range of diameters, false triggers can be removed. Furthermore, recalibration of the linear offset can only happen the sensor is measuring the material spindle, thus the algorithm aims to ensure this state before recalibration.

In order for recalibration to take place, three main checks take place all of which must be true:

1. The standard deviation of a sample of 30 is deemed to be within the 99% confidence interval
2. The sampled mean diameter must be less than 3.5 inches by statistically significant margins
3. The sample mean diameter deviates from 1.25 inches by statistically significant margins yielding a recalibration

# Standard deviation check

It is assumed that an identified working sensor can be tested beforehand in order to identify a sample standard deviation. The confidence interval of the population deviation can then be estimated (right-tailed test). It is important to note that a spinning spool will increase the deviation , because of mechanical artefacts which should be taken into account. Using the confidence interval can be calculated.

Therefore, if the standard deviation exceeds the value then we assume that sensor has malfunctioned.

For example let , . From the table .

# Null Hypothesis Check

This is to ensure that we are actually looking at the material spindle which should return 1.25in. The explicit assumption is that if the diameter is less than 3.5in, there cannot be a spool on the spindle, therefore the sensor measures the spindle of 1.25in nominal.

The first hypothesis of can be tested as below:

Let

Suppose that in and .

Calculate the sample mean deviation

Since then we reject for and continue to the next test.

Note that to demonstrate the algorithm working a value close to 1.25in was selected.

Let

Since we fail to reject and thus do not recalibrate. In the event that in the second check, we recalibrate.

# Conclusion

The algorithm intent is summarized below:

1. Ensure that the signal from the sensor is of reasonable quality by checking the standard deviation
2. Sample diameter and ensure that it is less than the smallest spool which indicates that the sensor is measuring the spindle
3. Check the that the sample mean significantly deviates from the accepted mean of 1.25in and recalibrate if necessary.