Belt Volume by Vision

Optical Measurement of Belt Conveyor Throughput

Fig. 1: Vision technology provides a method for analysis of belt flow.

Picture: Wikimedia Commons

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Belt scale accuracy is important to the efficiency and quality of processes dependent on mass flow. This article describes how non-contact, Ethernet camera technology can be used to produce an integrated volume measurement of product on a conveyor which can minimise maintenance and optimise accuracy and reliability of the mass flow measurement.

Measuring the volume of material being transported by a conveying system is a difficult task for traditional weight scales. Problems associated with installation, vibration and maintenance can all affect the accuracy of a belt scale system. In addition, calibration must be checked frequently and the re-calibration process is not an insignificant undertaking usually requiring the belt to be off line.

Scales are important elements in many processing applications. Manufacturers use scales to monitor such things as the total weight for custody transfer of product or the weight of product feeding a continuous process, or even the weight of multiple product streams feeding a blending process. Whatever the use, the accuracy of the scale is important to the efficiency of the overall process as well as the quality of the end product. Inaccuracy due to calibration drift, and the associated down time for maintenance and repair, negatively impacts cost and quality.

Vision Technology

Vision technology provides a method for analysis of belt flow that avoids these costly problems of traditional belt scales. The concept employed is based on a mathematical integration of the flow profile as it falls off a pulley or belt terminus, see Fig. 2.

Referencing back to the calculus text books at school one will remember the integral is defined as a summation of thin chunks of area under the function curve (Fig. 3). As the thickness of these chunks tends toward 0 the true value of the function is determined.

If we think of point 'a' as the belt pulley, where the profile of the product is measured, and the boxes to the right of point 'a' as sections of product on the belt moving up to the pulley it becomes apparent that totalling a series of profiles taken in rapid succession fits the definition of the integral well.

The advantage the vision system has is that it is a non contact instrument, and so it does not suffer the same physical limitations that impact the belt scale. Vision systems remain in calibration indefinitely as long as they are not moved or re-focused. A constant relative position of the camera and belt means that the scale that each camera pixel represents never changes, and so the calibration remains the same versus time.

Contact Free

Another benefit of the vision system for this application is the avoidance of impact and vibration due to direct contact of the scale with the conveyor and its contained product. Not only from a maintenance perspective is this beneficial, but from an accuracy perspective as well. Vibrations due to product falling on the conveyor can lead to errors in instrument readings.

Pictures: J.M. Canty

Fig. 2: Rocks leaving a conveyor.

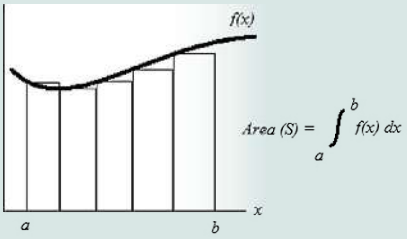

Fig. 3: Integral representation of product on the belt.

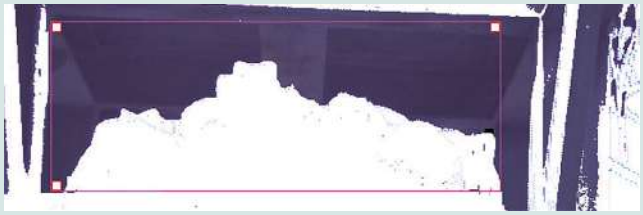

Fig. 4: Digitised image capture of product on the belt.

The greatest hindrance to belt scale performance may be the trouble shooting required to determine sources of error. Conveyors can generate forces on the scale other than the weight of the product. Changes in belt tension, idler alignment and debris within the scale can become sources of error. Calibrations are required to be frequent and maintenance is a daily function. All these issues translate to significant operational cost.

Vision systems are essentially maintenance free. Choice of proper lenses allows the camera to be mounted away from the conveyor and its immediate area which can be quite dusty and dirty. The live ethernet camera feed is taken into a PC where software calculates the volume flow. The data output can be sent to a control system continually in order to keep the process running at optimum level.

The data, and video feed, may also be sent across a corporate intranet or the internet for remote monitoring. Fig. 4 shows a digitised image of rocks moving over a conveyor pulley. The software is able to detect the stone profile in wide ranging lighting and moisture conditions allowing for continuous operation. Obviously the case of no product on the belt is also detectable.

Multiple Analyses

An added benefit of a vision system is the capability to do multiple and different analyses. The general guideline for vision applicability is if the eye can see the measurement wanted to be made, the vision system can do it.

Referring to Fig. 2, a second application for this camera set up would be possible and that is monitoring the alignment of the belt on the pulleys. Belts do drift and adjustment is needed quite often. The vision system can perform this measurement and control as well as the belt volume measurement and control.

Conclusion

In conclusion, vision technology, while not an obvious choice, may be the most accurate and reliable system available for many different conveyor weight applications. While there are limitations to vision, such as variable density product flows, the many applications that vision is suitable for might lead to a more efficient operation. ■

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