COTTON FLOW MONITORING SYSTEM FOR GINS

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Abstract

This paper describes the design and implementation of a cotton flow sensor for use in cotton gin. The sensor is utilizing electro-optic technology. The sensor combines emitters and detectors mounted on the lint conveyers. As the cotton passes through the conveyer it is illuminated by infra red light of the emitters. The detectors which are positioned across the conveyer detect light pulses. The pulse count is proportional to the volume and density of the cotton. The pulse count can then be used to estimate the mass and the rate of the cotton passing through. The rate information can be processed in real time to produce a sensing and controlling signal s(or data and command strings) for the gin machinery. This technique enables operators of the gin improve on the efficiency and throughput of the facility.

Definition of Terms

Sensor. emitter or detector unit containing the light emitting and detecting devices.
Detector. electrical circuit which performs the detection and signal conditioning (and discrimination from noise) of the Emitters light.
Emitter. circuits which illuminates cotton inside the conveyer for the purpose of detection and analysis.
Conveyer. A chute, pipe or similar tube like apparatus used to transfer cotton (or any other material) from one place to another. In this document all conveyers utilize blowers to transport the cotton with the fast moving airflow.

Introduction

The ability to monitor cotton flow on gin machinery is a necessary component in the control process of a gin. The sensing system enables one to closely monitor the performance of the gin and to adjust its parameters for optimum operating conditions. The recent introduction of cotton flow sensors in cotton yield monitors for cotton pickers have demonstrated their performance and accuracies. The transfer of such technology to cotton gin is discussed in this paper.

System Description and Operation

The Agriplan Gin Monitoring System, figure 1, consists of the following components: the Main Processing Computer (CPU) with an integrated display. An array of flow sensors (emitters and detectors) mounted across the cotton conveyer. During operation the flow of cotton, passing between the emitter and the detector, generates pulses. The monitor uses the pulse count to calculates the flow. The digital processor in the monitor also generates a numerical output, proportional to the flow, which can be fed into gin machinery for speed and power control.

Sensor Design and Operation

The sensor is composed of Infra Red (IR) emitters, detectors, signal conditioning and processing units; figure 2. The emitters are built of IR lamps which are driven by pulsing driver circuits. The sensors components are mounted on the surface of the conveyers. Openings are drilled on the conveyers for passage of the sensor IR light. Electrical cables connect the sensors assemblies to the CPU.

The emitters illuminate the conveyer. As cotton passes through it blocks the IR light from reaching across to the detectors. The light blockage provides information about the size (volume) of the cotton passing through. The signals from all the detectors is being filtered, amplified and converted into digital format for further processing by the sensor's on board processor. The resulting measure of the cotton mass is transmitted on the system bus to the monitor.

Flow Calculation

The system calculates the flow of cotton multiple times per second (cycles). Each cycle the results are fed into a mathematical model. The digital output is then converted into an analog signal which can be fed into other gin machinery.

For each cycle, the number of detected pulses ***N*** are calculated using the following formula (1):

$$N=\sum_{s}\left(\int g_B v_B dt\right) \quad (1)$$

where:

N - pulse count
s - signal detectors
v_B - detected signals from blocked light sources.
g_B - gain coefficient for blocked signals

This figure ***N*** can be used to calculate the weight W_i

of the cotton passing through the conveyer during the cycle ***i*** :

$$W_i=c(a_n N^n + a_{n-1}N^{n-1} ... + a_0) \quad (2)$$

W_i - is the cotton weight passing through during interval i,

a - is polynomial coefficient.
c - is the weight coefficient
N - pulse count calculated by the equation (1).

The analog output is generated by applying the pulse count ***N*** to a digital process. The evaluation of such process is outside the scope of this paper.

Tests, Results and Discussion

The objective of the test conducted at Continental Eagle Corporation, Prattville AL, to compare the system estimated weight of seed cotton conveyed through their engineering gin to the actual weight of the cotton as measured with the use of a scale. The measurement were performed on "small" amounts of cotton, about 50 lb. which does not actually compares flow but the integrated of flow. The result of the set of measurements taken on November 14th, 2000 are presented in table 1. The indicated Agriplan weight is the calculated weight of the cotton. One can notice that with the exception of couple of out lyres the estimated (Agriplan) weight fell within few percentage points of the actual weight. In the coming year Agriplan is planning to install additional sensors in several other locations, along the cotton flow, in the gin. Furthermore the analog output generated by the system will be used to improve the gin efficiency.

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Summary

The design and implementation of electro-optic cotton flow monitor was presented. The sensor was installed and operated on a conveyer of a small gin. Accuracies in the range of 5% were reached in laboratory operation where sac size amounts of cotton (approx. 50 lb.) were measured and compared to standard scale reading. The tests performed have demonstrated that the sensor was useable in gin environment, and its performance and accuracy was in line with that obtained in cotton picking equipment, i.e. 3-5 % error.

References

Mike Gvili et. al. 2001; Stripper Cotton Yield Sensor Produces Yield Map. Proceedings Beltwide Cotton Conference 2001.

Mike Gvili, 1998 Yield monitor for cotton pickers; Beltwide Cotton Conference 1998.

J.A Thomasson et. al. 1997.Mass Flow Measurement Of Pneumatically Conveyed Cotton. Proceedings Beltwide Cotton Conference 1997.

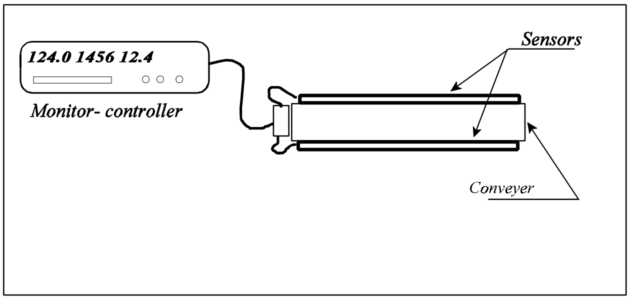

Figure 1. System Configuration.

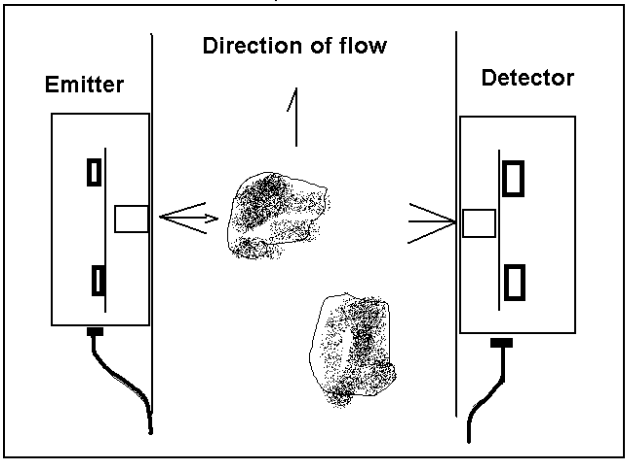

Figure 2

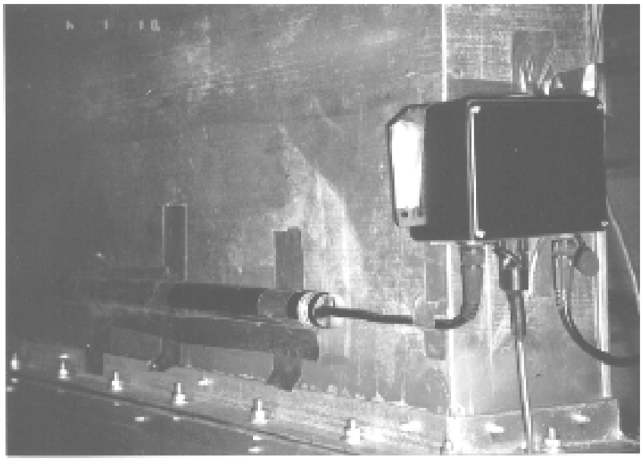

Figure 3. Flow sensor installed behind the gin stand.

Table 1. Weight measurements, test results.

	Act. Wt.	Agriplan	Agri Error
calibration load	100	127.9	
pre cleaned cotton	100	119.5	0.46%
pre cleaned cotton	100	122.2	-1.79%
pre cleaned cotton	100	118.4	1.37%
module seed cotton	50	51	1.06%
module seed cotton	50	52.5	-1.85%