ACOUSTIC SENSING OF SEED-COTTON TRASH LEVELS

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Abstract

Modern cotton gins have a limited capability for handling varying levels of trash in the seed cotton. They can however slow down to provide another level of control. Due to the economics of running the gin plant, this is however a last resort that should only be done for the highest levels of trash where there is a high probability that the gin would not be able to clean up the cotton in order to produce acceptable lint grades and avoid bark or grass calls that would incur discounts onto the final bale valuations. In the interest of providing a means to assess seed-cotton trash-levels, for use as a control signal controlling the plant, this research explores the potential use of acoustic sensing for assessing seed-cotton trash levels.

Introduction

Modern cotton gins have a limited capability for handling varying levels of trash in the seed cotton. They can however slow down to provide another level of control. Due to the economics of running the gin plant, this is however a last resort that should only be done for the highest levels of trash where there is a high probability that the gin would not be able to clean up the cotton in order to produce acceptable lint grades and avoid bark or grass calls that would incur discounts onto the final bale valuations. In the interest of providing a means to assess seed-cotton trash-levels, for use as a control signal controlling the plant, this research explores the potential use of acoustic sensing for assessing seed-cotton trash levels.

The objective of this research effort was to develop methods for analyzing constituent properties of seed-cotton for use in optimal control of cotton-gins and harvest operations. The sub-objective addressed by this study was to examine the potential use of acoustics to characterize various properties of seed-cotton, lint turn-out, trash-content and lint-quality.

Materials and Methods

This study reports on an acoustic test method's performance for use in predicting the lint-turnout and trash content of seed-cotton samples where the test method was the use of the single microphone variant of the Simplified-Three-Microphone Acoustic Test Method which is detailed in Pelletier et al., 2017. Utilizing this test method, the acoustic properties of seed-cotton and seed-cotton constituents (lint, burs, sticks, seeds) were evaluated over the frequency range of 500-4000Hz. Seed-cotton samples were constructed at two trash levels [0, 21%] and at eight mass levels. Each seed-cotton sample and each constituent was acoustically measured as independent test specimens. During the testing procedure it was determined that lint was the driving acoustic absorber so a follow up test was constructed that utilized only the lint at eight mass levels and three moisture contents that were created by conditioning the lint samples in ambient dry air (<35% RH) and to obtain wet lint samples; conditioning over two salt solutions were utilized [75% RH (NaCl); 85% RH (KCl)].

Results and Discussion

This study reports on an acoustic test method's performance for use in predicting the lint-turnout and trash content of seed-cotton samples where the test method was the use of the single microphone variant of the Simplified-Three-Microphone Acoustic Test Method which is detailed in Pelletier et al., 2017. The results of the study indicate that the seed-cotton constituents (burs, sticks, seeds) only provide minimal acoustic attenuation. Lint weight however was found to be highly correlated as was moisture-content of the lint. Multi-variable regression analysis found that a single acoustic frequency combined with measured, or a-priori known, moisture-content is sufficient to provide strong predictive capabilities for the prediction of lint-mass, $r^2adj = 0.872$. The use of additional frequencies over the range of 400-4000Hz, were not found to add an appreciable improvement in the prediction as such they were not entered into the regression. Details of the performance of the regression are shown in Figure 1.

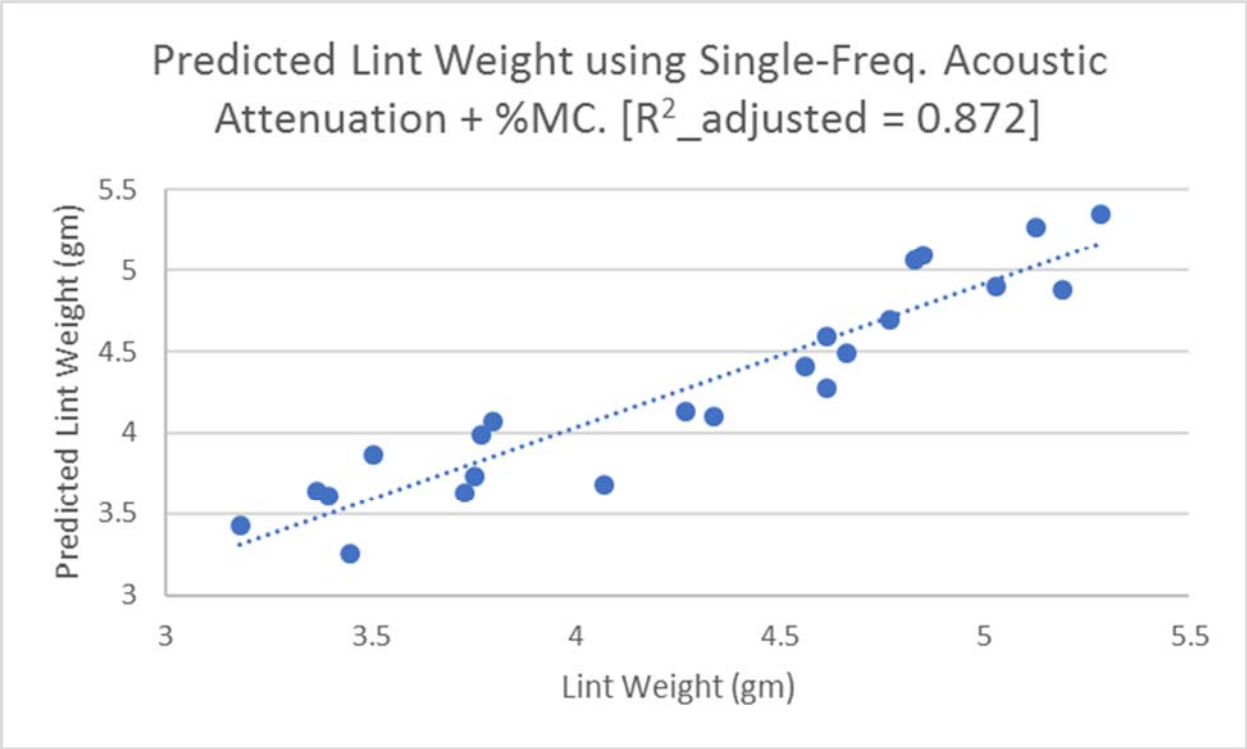

Figure 1. Performance of acoustic sensing of lint turn-out of seed-cotton when moisture content is used as a factor.

Summary

In summary, this study indicates that there is potential for use of acoustics in the determination of lint turn-out in seed-cotton. It should however be noted that accurate results will require the use of an additional measurement of moisture content, (Pelletier et al., 2012; Pelletier et al. 2016). It is suggested that the use of microwave sensing is the most promising of the known methods.

References

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