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Performance Evaluation of an End-Effector Designed Based on Harvesting Multiple Cotton Boll at a Time

S. Thapa[1, *], G. Rains[2], W. Porter[3]

[1]College of Engineering, University of Georgia, Tifton, GA, USA
[2]Department of Entomology, University of Georgia, Tifton, GA, USA
[3]Department of Crop and Soil Sciences, University of Georgia, Tifton, GA, USA
*Corresponding author: shekhar.thapa@uga.edu

Abstract

Cotton bolls at the bottom third to half of the plant have the best value and yield. These bolls are also the earliest to open and are subjected to prolonged weathering before harvesting, resulting in quality decline and production loss. Harvesting cotton bolls as soon as they open can maintain the fiber quality and reduce yield loss. To achieve this, a harvester must go out to a field several times (multiple passes) during harvesting season. In current practice, cotton harvesting is done in only one pass by a huge, heavy, and expensive mechanical cotton harvester, which has several drawbacks that harm the sustainable production of cotton: soil compaction, breakdown wait time, and inaccessibility to small growers. Robotic cotton harvesting is one of the most promising solutions to address the above-mentioned issues. A few research on robotic cotton harvesters has been conducted, with emphasis on navigation, cotton detection & tracking, and end-effector design. The robotic cotton harvesters used in those studies have slow harvesting time per boll since they are designed to detect individual cotton bolls and harvest one at a time. In this study, an end-effector with a roller and several tines was designed based on harvesting multiple cotton bolls by gathering bolls together at the end-effector while moving down the row to achieve a faster picking rate and higher picking efficiency than the previously studied systems. The harvesting performance was assessed in terms of picking ratio and harvesting time per boll using a prototype of the designed end-effector that was attached to an existing robotic platform called “small red rover”. In the lab and field testing, the average picking ratios of 63.47% with a standard deviation of 7.68% and 40.75% with a standard deviation of 4.20% were found, respectively. Similarly, for the lab and field experiments, the system was able to pick cotton at the rate of 1.93 seconds/boll and 5.52 seconds/boll, respectively. Compared with other robotic cotton harvesting systems, there is a big room to improve the picking ratio of this end-effector design, but it has a significantly faster harvesting time per boll than the other systems. Making larger and wider end-effectors believe to improve the picking ratio; this will be investigated in upcoming studies.

Keywords: robotic cotton harvesting, rover, roller tines, picking ratio