# AN INITIAL LOOK AT ROBOTICS IN COTTON HARVESTING

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## Abstract

Two small robots were procured and field tested in terms of mobility and data collection in a cotton field. One robot is the Jackal by ClearPath Technologies. The other is the TerraSentia by Earthsense, Inc. Additionally, consideration was given to the possibility of ginning cotton on a field-based robotic platform. The report will cover description of the two robots as well as preliminary testing and collected data. It will also cover the thought processes involved in implementing field-based ginning as well as some planning for small-scale-gin data collection to enable design for field-based ginning on an autonomous platform.

## Introduction

Modern agricultural machines tend to be very large in order to maximize the efficiency of the humans driving them. These machines are fast in terms of area covered per unit time, but because of their size they tend to compact the soil, reducing its productivity. At the same time, agricultural laborers are less available, and worldwide demand for food is increasing rapidly for the foreseeable future. In light of these trends, robots will likely play a major role in agriculture in the future. Since robots do not need a human driver, there is no need to maximize the efficiency of the driver, so the machines can be smaller and lighter, thus producing less soil compaction. Multiple small robots could do the work of one large manned machine. Robots can also work day and night, among other advantages they offer.

Cotton harvesting may well be a part of this move towards robotic agriculture. Current cotton harvesters are used in a once-over operation and require waiting until most of the cotton bolls are mature. If multiple small robots were used, they could potentially harvest bolls on multiple occasions as they mature. In this way the fiber quality could be maximized by (1) reducing weathering, (2) reducing the likelihood of harvesting immature fiber, and (3) potentially reducing the amount of foreign matter entrained with the seed cotton at harvest.

## Methodology

Research has been undertaken to evaluate small robots for cotton harvesting and potentially fiber-seed separation. Two different robots (fig. 1) were acquired and evaluated in the field: Jackal (ClearPath Robotics, Kitchener, Ontario, Canada) and TerraSentia (Earthsense, Champaign, Illinois, USA).

Fig. 1: TerraSentia (left) and Jackal (right)

Both robots have cameras so they can capture images of cotton plants. They were tested in the field to evaluate how a robot can be controlled between plant rows and to compare the robots in terms of field performance. In order to control the Jackal an internet network is required. Both robot and laptop were connected to the internet, and then the robot was controlled with ROS-based software on the laptop. The control of TerraSentia does not require an internet connection. It can be controlled by the application on the tablet. The tablet must connect to the robot's Wi-Fi. Fig. 2 shows two images captured by the robots. The captured images by Jackal are transferred to the laptop by internet connection but TerraSentia saves the images in the computer inside the robot.

Fig. 2: Captured image by the robots in the cotton field: left image by Jackal and right image by TerraSentia

Table 1 represents a quick comparison between Jackal and TerraSentia. The compared features are based on the lab and field test.

Table 1: A quick comparison between Jackal and TerraSentia

| **Specification** | **Jackal** | **TerraSentia** |
|---|---|---|
| **Robustness** | Very Robust in terms of manufacturing | Doesn't Robust for long time use (for example its legs must be more stronger) |
| **Control ( just remote control applied during test)** | Via Internet; Sometimes Halting occurs because of slow internet connection | Directly by a tablet; Smooth control on the robot |
| **Ground clearance** | 60mm | 85mm |
| **Suspension Systems** | Doesn't have | Coil springs |
| **Date transfer** | Via internet connection to the laptop | Transfers to computer inside the robot |
| **Camera adjustment** | Manual | Via the app. on the tablet |

The size of the robots is appropriate so they can maneuver between the rows. The ground clearance of the Jackal could be problematic in uneven areas. If this robot goes over a stone or clod, the robot may be lifted up and stuck, turned off course, or upended. These robots are not appropriate platforms for cotton harvesting and fiber-seed separation. For cotton harvesting the robot must remove seed cotton from bottom to top of the plant. The cotton harvester robot must be capable of sensing the three-dimensional position of the cotton bolls. A stereo camera can perform this duty, but further sensors like infrared or ultrasonic may be needed. Automatic navigation must be done by GPS and object detection sensors like infrared or Lidar sensors.

Cotton ginning is currently done in factory-like ginning facilities. Cotton in the field is harvested at one time, so defoliation is required before harvesting to reduce the amount of trash in the seed cotton. If a robot harvester were developed, then it is conceivable that it could separate the fiber from the seed in the field. A small robot capable of fiber-seed separation would require some type of small ginning unit. In order to understand potential requirements a small scale ginning machine was purchased and tested in the lab (fig. 3). An early evaluation suggested that it takes about 10 min. to gin 100 g of seed cotton.


Fig. 3: Small Scale ginning machine

A ginning unit would be a heavy addition to a small field robot, so it may not be sensible to attach it to a harvesting unit. If the field is relatively small, then a semi-stationary gin unit could be placed at the edge of the field, and the harvester robot could transfer the seed cotton to the ginning unit at the edge of the field (fig. 4).

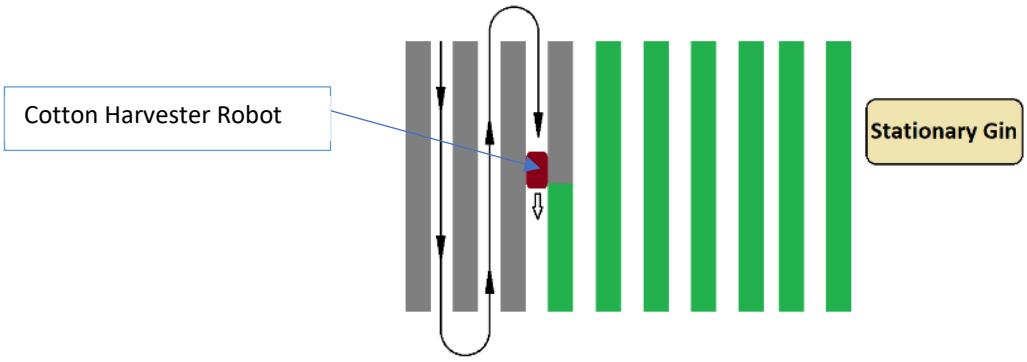


Fig. 4: Stationary gin and cotton harvester robot

If the field is larger, a more mobile ginning machine could move at one end of the field to accommodate the position of the harvester as it moves through the field (fig. 5).

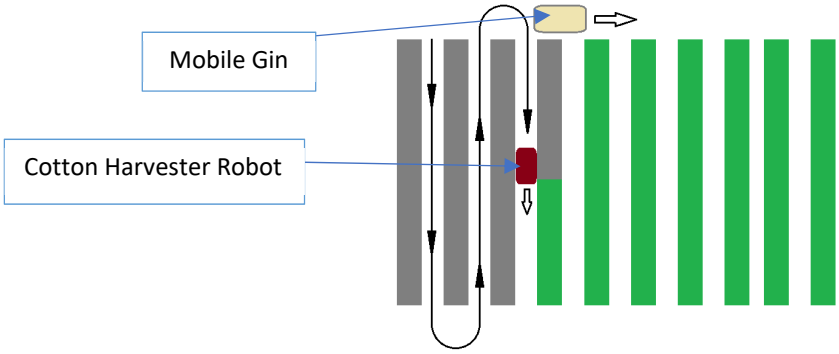


Fig. 5: Ginning and cotton harvester robots

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