Project Title: Precision Peanut Re-planting with a Small Multi-Purpose Autonomous Rover
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Project: Objectives - Accomplishments:

Skip	Northing	Easting	Altitude (ft)	Longitude (ft)
1 Start	31.4724619	-83.5310598	248.92	15
1 End	31.4724982	-83.5310349	249.63	
2 Start	31.4725725	-83.5310295	250.4	10
2 End	31.4725962	-83.5310138	250.82	
3 Start	31.4725359	-83.5309241	251.8	5
3 End	31.4725483	-83.5309159	252.07	
4 Start	31.4726717	-83.5310118	251.35	15
4 End	31.4727083	-83.5309866	252.14	
5 Start	31.4726551	-83.5309346	252.55	5
5 End	31.4726677	-83.5309259	252.87	
6 Start	31.4729475	-83.5308302	255.45	10
6 End	31.4729719	-83.5308139	255.76	
7 Start	31.4732178	-83.5306538	254.64	10
7 End	31.4732427	-83.5306371	254.34	
8 Start	31.4732993	-83.5305544	254.08	5
8 End	31.4733112	-83.5305464	253.9	
9 Start	31.4733938	-83.5305378	252.29	15
9 End	31.473429	-83.5305145	251.84	
10 Start	31.4733685	-83.5304636	253.74	10
10 End	31.4733932	-83.5304477	253.44	
11 Start	31.4734539	-83.5304081	252.87	15
11 End	31.4734895	-83.5303849	252.47	
12 Start	31.4735119	-83.5302361	253.68	5
12 End	31.4735245	-83.5302279	253.49	

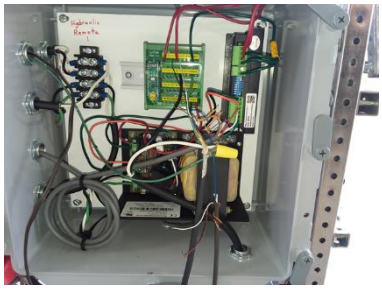

Figure 1 GPS points located at peanut skip locations, table of skip points extracted from aerial image and planter controller hardware.

Objective 1: Take UAV image and make prescription map

A 3DR Solo UAV with Hero4 Camera was used to take aerial image of peanut crop at 90 feet altitude one month after emergence and 12 artificial skips added randomly across a 1/4 acre peanut field. There were 4 skips each of 5, 10 and 15 feet. Ground control points (GCP) were placed on the ground at 6 locations around the field and used to more precisely geo-reference the points identified in the aerial image. Agisoft GIS software was used to stitch aerial images and adjust the georefenrce points so that GPS points of the skips picked off the image are precise. Two GPS points per skip (start and end of skip) were extracted manually and placed in an excel table (Figure 1).

Objective 2: Add Autonomous controller to raise and lower the planter

An embedded computer on the rover was loaded with the table values. A program in the embedded computer compared the rover location to GPS points from the table within a 3ft radius. When a point was found, the controller sent a signal to microcontroller. A program on the microcontroller raised and lowered the planted using a hydraulic arm and relays. A limit switch was used to turn on a stepper motor to meter the seed through a vacuum plate (Monosem System) when the planter was lowered. When planter was raised, the stepper motor was stopped.

Objective 3: Conduct Field Tests

Field Tests of the planting system were conducted 2 weeks after the initial aerial flight to identify the skip points. This delay was due to finalizing the programming for the autonomous planting. Preliminary testing was required to obtain proper timing between when a skip point was detected, speed of the rover and speed of the hydraulic arm that raised and lowered the planter. Parameters were set for a rover speed of approximately 2 mph. Seed were planted at 7-8 seed per foot. Seed emergence was over 50%. In several treatments, the planter was lowered 2-3 feet early or late to the beginning of the skip. This was consistently one or the other based on if the rover was moving up or downhill. It was surmised this was caused by the GPS antenna leaning forward or back, depending on the rover attitude.

Figure 2 Planter with opening disks, closing mechanism and press wheel

Conclusions:

- ❖ UAV can provide skip location accurately using GCP's and GPS on drone OR high accuracy GNSS on drone
- ❖ Flight height and camera resolution will determine how small a skip you can detect. At 90 feet altitude, we easily detected 5-foot skips using the HERO4 camera
- ❖ Planter can be raised and lowered to plant using GPS coordinates retrieved from aerial image
- ❖ Planting was successful, will need to add adjustment for antenna angle if planter is on an angle
- ❖ Will work on proposal to USDA to develop a 2-row system that can be attached to tractor or other utility vehicle.