Multi-Robot Farming on Marginal, Highly Sloped Lands

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K-STATE Research and Extension

National Science Foundation WHERE DISCOVERIES BEGIN

USDA NIFA

2050RL

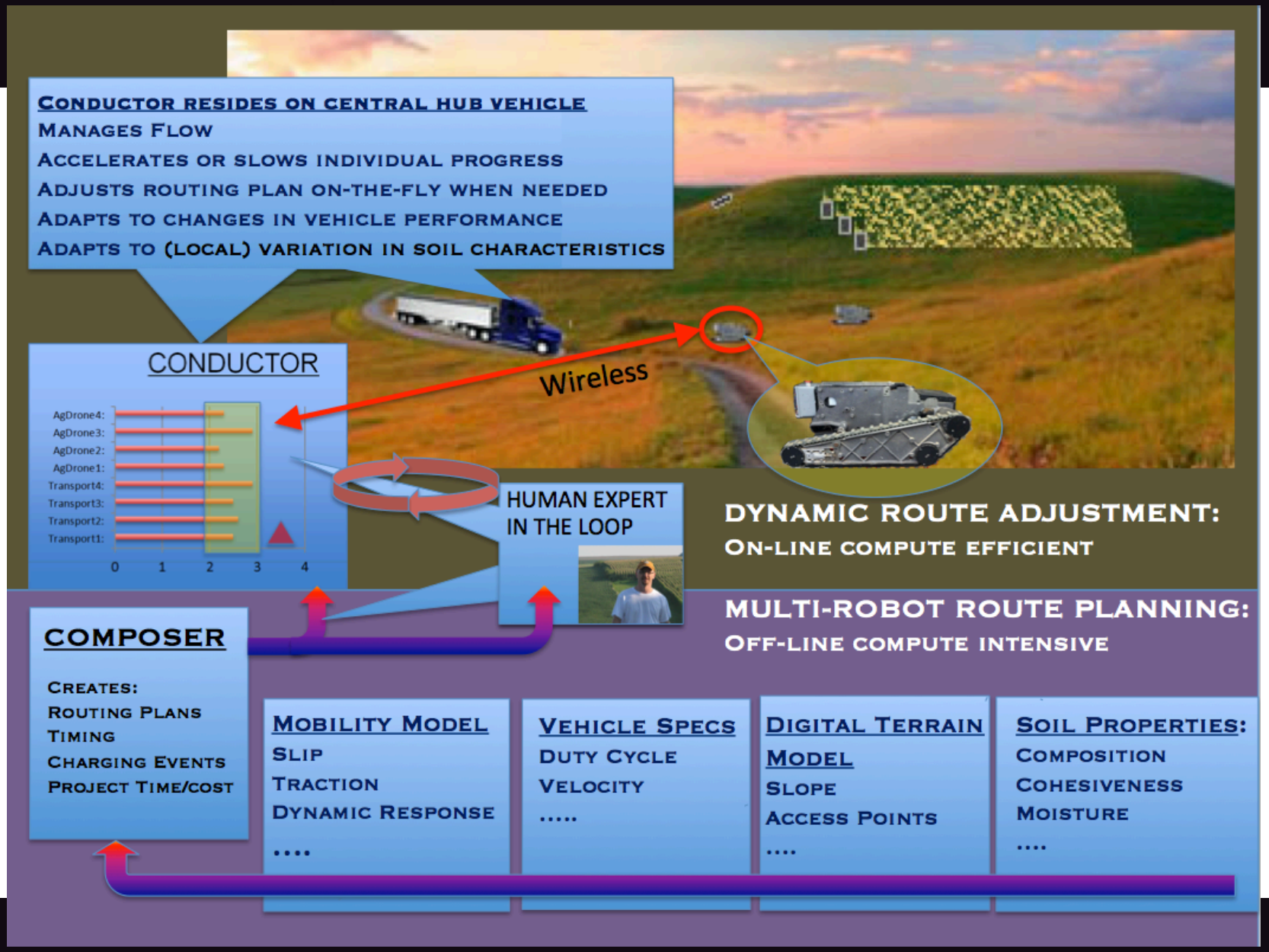
2050 Food Crisis

- How to feed over nine billion people by 2050?
- Currently annual percentage crop yield increases are only half those required to meet projected food needs.
- Increase in yield in spite of:
  - Climate change
  - Declining water resources
  - Competing crop use demands (Bioenergy)
  - EPA regulations
  - Less arable land

- We are working to expand arable land through autonomous mechanization on highly sloped hills that are unsafe for conventional equipment

NRI: Goals

- Multi vehicle autonomous system to complete crop work in a scenario where conventional equipment will not work
  - Multistage procedure: Composer-Conductor with farmer expert in the loop
  - Explore new ways to do crop tasks, get seed in ground, harvest yield from plant.
  - Pave the way for further Autonomous Crop Systems


Conductor resides on central hub vehicle
Manages Flow
Accelerates or slows individual progress
Adjusts routing plan on-the-fly when needed
Adapts to changes in vehicle performance
Adapts to (local) variation in soil characteristics
CONDUCTOR
AgDrone4:
AgDrone3:
AgDrone2:
AgDrone1:
Transport4:
Transport3:
Transport2:
Transport1:
0
1
2
3
4
Wireless
HUMAN EXPERT IN THE LOOP
DYNAMIC ROUTE ADJUSTMENT:
On-line compute efficient
MULTI-ROBOT ROUTE PLANNING:
Off-line compute intensive
COMPOSER
Creates:
Routing Plans
Timing
Charging Events
Project Time/cost
Mobility Model
Slip
Traction
Dynamic Response
....
Vehicle Specs
Duty Cycle
Velocity
.....
Digital Terrain Model
Slope
Access Points
....
Soil Properties:
Composition
Cohesiveness
Moisture
....

AgDrone

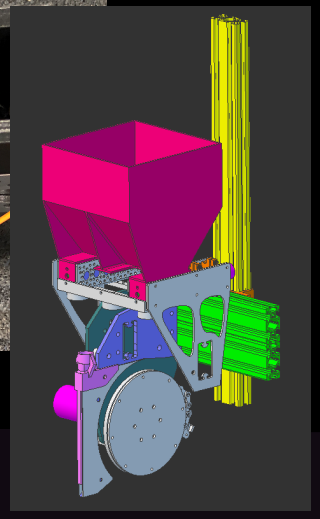
Wheat Drilling

Conventional Wheat Drills can require over 500lbs of downforce to plant.

AgDrone vehicle weighs 200lbs

Powered active tilling is required

Auger type seed singulation



Quick Release Batteries

More about the battery

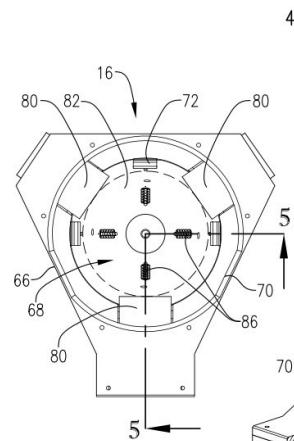


FIG. 4

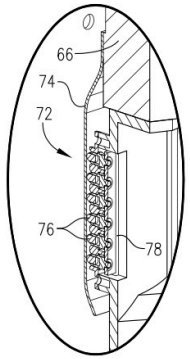


FIG. 6

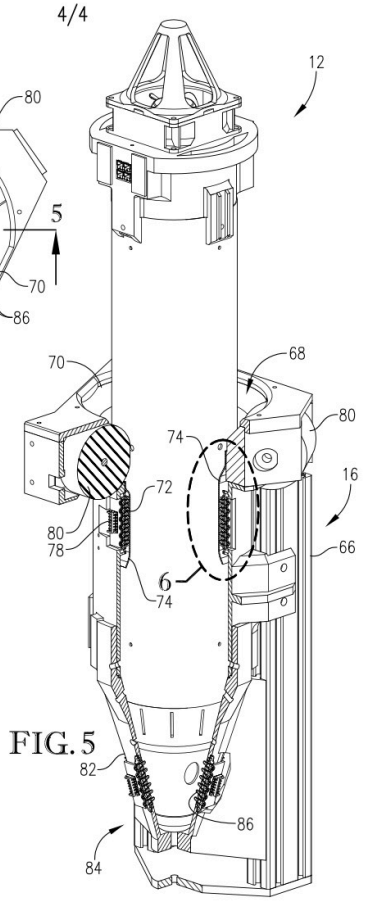
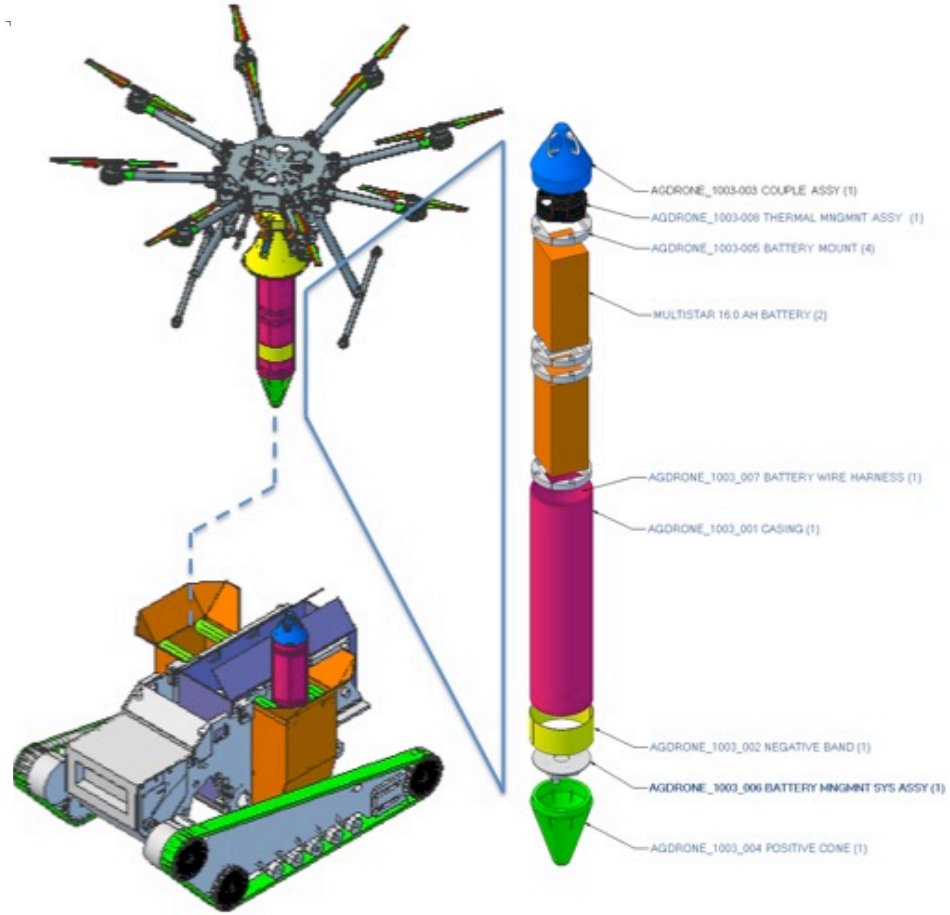


FIG. 5

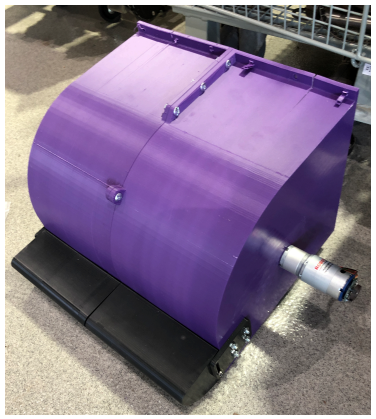


BSFC Charts at each slope and soil type

By pulling a variable load across multiple slopes and soil types we are able to create energy consumption charts to find efficiency at varying loads and speeds. Traction behavior in these situations was also measured.
All this data will be used for routing optimization.

UE4 Ground Simulation

STRIPPER HEADER



Stripper Head Harvesting
Only harvest seed, not stalks

Thank you