AUTONOMOUS AG!

Presented By: Mel Torrie
• Founded 17 years ago, +100 Engineers
• Located in Logan, Utah, USA
Diversified Focus

- Field robotic ground vehicle solutions leveraging our platform building blocks
- $100M Bootstrapped through Manufacturers and large end users
ASI FACILITY
• 100 Acres
• 24 Hour Product Verification, Validation, and Functional Safety Testing
• Fiber Optic connection to Customer Sites
Video
Building Blocks
System Organization
The solution

• GROUND VEHICLE AUTOMATION PLATFORM

• 01 VAK
• OEM Agnostic Vehicle Automation Kit

• 02 Vantage

• 03 Mobius
01 VAK

• Vehicle Automation Kit

• Installs easily into any vehicle platform

• By-wire, mechanical, and hydraulic modules accommodate different vehicle

Automate Any Vehicle Type In Your Existing Fleet
02 VANTAGE
Obstacle Detection & Avoidance

- Sensor Fusion: Layering multiple sensor inputs
- GPS – denied navigation
- Ongoing automotive sensor studies
- Sensor independent / agnostic

Sensor Fusion  See-and-Stop  See-And-Avoid  3D Terrain Mapping
AI and Machine Learning

• General Scope
  • Obstacle classification, LIDAR-Camera sensor fusion, and vehicle auto tuning
  • Improve mobility and behavior of autonomous vehicles in challenging environments
03 Mobius

- Multi-Vehicle Command & Control

- Command and monitor multiple autonomous vehicles
- Map Builder supports USGS, shape file, and military formats
- Optimized mission planning:
  - Waypoints, area coverage, Path Builder
  - Path trainer, cost-based road utilization
  - Known obstacle avoidance
  - Dynamic event-based re-planning
03 Mobius

- Multi-Vehicle Command & Control

- Mixed Fleet
04 Telematics

• Cloud Based Real Time Data Aggregation
Next Steps: Dynamic Profit Tuning

• Create the productivity and Maintenance Costs Transfer function

• Mining Example: 5 mph on corners -> 10% maintenance = 9,000 tons/hour

• Machine Learning and AI for automatic tuning
What does the Future of Agriculture look like?
How will we feed 9 Billion people in 2050

• Drivers
• Key Enablers
• Lessons Learned
Drivers for Automation

1. Step change in Labor Costs
   - Minimum wage hikes

2. Availability of labor and the right skill levels
   - Children not staying on the farm as often
   - Immigration reform, pending wall, etc.

3. Maintenance savings
   - Mining example -> 3X tire life in an autonomous mine

4. Productivity – deterministically optimize how crop is covered, the size of the equipment, and the number of units for choice of priorities (time, compaction, fuel, cost, etc.)
More Drivers for Automation

1. Timing
   • How close to the ideal time can the farmer plant, fertilize, and water?

2. Precision
   • How precise can we vary seed, fertilize, and water? $m^2$? single plant?

3. Conservation - Must minimize waste
   • Energy, Inputs (Seed, Water, and fertilizer)

4. Compaction – Big impact on yield?

5. Minimize variability costs
   • Weather, Soil Type, Insects, Operation/Equipment Costs
Key Technology Enablers in Automation

- Positioning
- Perception
- Communications
- Artificial Intelligence and Deep Learning
Communication

Challenges

• Non-line of site communications (Buildings, Foliage, Terrain)
  • Low frequency options don’t have sufficient bandwidth for video and many require licensing

• There are still large gaps in Cell Phone coverage
  • Good IT skills currently needed to setup and maintain
  • OSHA requires “constant” link to driverless vehicle
Positioning

Challenges

• Some applications still can’t afford high precision
• GPS availability gaps
• GPS dropouts next to trees and buildings
• Indoors infrastructure setup costs up to 45% of robot system costs

Path Forward

• Companies like ours are developing relevant GPS-denied SLAM solutions thanks to increased sensor accuracy and decreasing costs
Artificial Intelligence and Deep Learning

Challenges
• AI can’t be functionally safe anytime soon
• Capability is growing quickly through use of cloud platforms
• Processing but new GPUs are helping
Machine Perception

"Sensing" surroundings

• We need to replace the operator’s senses (Hear bad bearing, smell burning belt, see plugged implement, feel flat tire,...)

• Agriculture needs foliage penetration capabilities
  • Radar has the greatest potential but resolution and cost are prohibitive
  • Military is spending in this area for aerial reconnaissance but a long ways off

• Agriculture and Construction need dust and weather penetration capabilities
  • Radar has the greatest potential but it doesn’t have the resolution to be effective
Lessons Learned
It can never be too simple!
- Setup, Operate, Fix
- Give them choices
Service and Support

Vital for scalability

Ultimately: Robots will resupply and service equipment, ...While it is moving
Automotive Innovation is Helping all of us

• Google has +2 Million unmanned miles – Regression test suite
• Tesla gets 1M per day – Shadow driving
  • OTA updates is the great enabler
• Uber & Lift 10M per day
• AI?
  • “While it is "relatively easy" to create a machine learning system that is 99 percent correct, it is "vastly more difficult" to reach 99.9999 percent accuracy.” Tesla
Data Sharing is Hard

- Lack of agreed upon protocols and data formats
  - While ag has done arguably well with ISOBUS VT for interoperability (other than Class 3 hiccup), standardized data formats remain a challenge
- Who owns the data?
- Groups like Agricultural Data Coalition (ADC) are making a go of it
OEMs will sell smaller machines, less service, and fewer total units.

Smaller vehicle companies looking to disrupt.
IT IS FAR BEYOND LABOR BUT MUST BE QUANTIFIED

• Fewer Vehicles, Less Downtime...
• Less Maintenance: eg. 3X the tire life
• 10 houses!
People blindly trust driverless vehicles far more than human driven vehicles.

Slippery Slope!
1. Ignore them
2. Stop monitoring them
3. Taunt them!
SABOTAGE CAN KILL PROGRAMS AND PEOPLE

Must proactively avoid

• Put protections in place and educate workers that they are there

• Black box Synchronized playback of data and video feeds
OVERRIDING SAFETY ALERTS QUICKLY BECOMES AUTOMATIC
MUST CREATIVELY FIND WAYS TO ASSURE INSTALLATION, MAINTENANCE DONE CORRECTLY

FORGOT TO CALIBRATE THE BRAKE!
Liability is a bigger hurdle than technical challenges

People disable safety systems and win lawsuits in every industry
- Design tamper proof systems
- Get good insurance
- Support best practice standards establishment
Functional Safety

- An accident sets us all back
- Find the relevant safety standards and get educated and if possible contribute
- ASI is ANSI registered as experts for driverless standards
  - ISO 25119 Agriculture Machine Safety
  - ISO 18497 Highly Automated Agriculture Machines (HAAM)
Thank You
Any Questions?

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