Servo Solutions For Mobile Automation Challenges

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ELECTROMATE
Robotic and Mechatronic Solutions
Problem Statement

With automation expanding out of the factory, machine builders are faced with a varying set of new challenges. Mobile platforms are expected to operate in extended environments and carry their own power source; all while being light weight and compact. To meet the current and future needs of the market, enabling technologies need to be applied and discovered.

At the forefront of the enabling technologies are servo drive controls. Servo control not only make a robot or mobile platform move, they can also be solutions to the other design requirements. As a an integral component to any mobile solution, servos can help with power efficiency, communication, agility and dexterity.
Agenda

Mobile Automation
- Mobile vs Factory Automation
- Mobile Challenges

Mobile Systems
- Components

Bots and Solutions
- Cobots
- Unmanned Systems
- Autonomous Vehicles

Summary
- Applications
- Servo Axes
- Technologies
<table>
<thead>
<tr>
<th>Mobile vs Factory</th>
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<tr>
<td><strong>Environment</strong></td>
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<tr>
<td>• Transportable/Increased Shock and Vibration</td>
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<tr>
<td>• Temperature Extremes</td>
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<tr>
<td>• Wide Range of Extremes</td>
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<tr>
<td><strong>Factory</strong></td>
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<tr>
<td>• Stationary/Minimal Shock and Vibration</td>
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<td>• Modest Temperature Range</td>
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<td>• Controlled and Known</td>
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<td><strong>Power</strong></td>
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<tr>
<td>• Finite</td>
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<td>• Onboard</td>
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<tr>
<td>• DC/Lower Voltages</td>
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<td><strong>Factory</strong></td>
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<tr>
<td>• Infinite</td>
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<tr>
<td>• Peripheral</td>
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<td>• AC or DC/Low to High Voltages</td>
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<tr>
<td><strong>Machine Interface</strong></td>
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<td>• Tethered</td>
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<tr>
<td><strong>Factory</strong></td>
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<tr>
<td>• Hardwired</td>
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<td>• Limited Range</td>
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<td><strong>Maintenance</strong></td>
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<td>• Unscheduled/Exposure Based</td>
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<td><strong>Factory</strong></td>
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<tr>
<td>• Schedules/Usage Based</td>
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<td>• On-site Personnel</td>
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Mobile System

Controller (Host)
- Supervisory Control
- Safety/Sensors Algorithms

Sensors
- Provide Data About Environment

Communication
- Link to Operator

Interfaces
- Components Communication

Servo Drive
- Controls the Motor(s)

Feedback
- Provides Positional Information of Motor/Load

Servo Motor
- Moves Mechanics of Robots
- Manipulators/Traction Axes
Servo Control

The Servo Drive and/or Controller is able to efficiently control the...

- Torque
- Velocity
- Position

...of the servo motor (each axes of control).
Motor Types

- AC Induction
  - Large Loads
  - Traction/Propulsion
- Permanent Magnet
  - Stepper
    - Manipulator Positioning
  - Servo
    - Brushed for Grippers
    - Brushless for Traction/Propulsion and Manipulators
    - Low Inductance
    - High Pole Counts
    - Dual Winding
A mobile robot either carries it’s power source or is tethered to an external source. Both of these solutions have drawbacks.

**Tethered**
- Travel Limited by length of tether
- Added weight and size to system
- Considerable Voltage drop in DC cabling

**On Board Power**
- Power is Finite
- Batteries are Heavy
- Batteries take up space on robot
- Batteries add to the expense
Where Are Mobile Robots Used?

- Homes
- Offices
- Factories
- Hospitals
- Farms
- Mines
- Warehouses
- Parking
- Transportation
- Hotels

...expanding uses everywhere.
Mobile Automation Challenges

Communication
- Between Sub-systems
- Between Robot and Controller/Host
- Between Robots

Modularity
- Platforms that can easily accept different assemblies

Reliability
- Critical Operations

Cost
- Use COTS technology

Maintenance
- Modular/Scalable Designs

Autonomy
- Localization
- Globalization
Mobile Automation Challenges

Power –
Finite/Heavy
  – Efficiency of Sub-Systems
  – Total system must be viewed as a single unit

Traction –
Speed/Acceleration/Climbing
  – Voltage/Current Burst/CURRENT Extended Time
  – How to get it all? (Motor and Drive Technologies)

Environment –
Temp/Shock/Vibration/Altitude/Depth
  – Wide Operating Range

Size/Weight
  – Need to be Compact and Lightweight
  – Integration of Sub-systems
  – Thermal Considerations
  – Cabling Complexity
Types of Mobile Robots

Cobots
- Security
- Information Kiosk
- Greeter
- Material Handling
- Inspection
- Caregiver/Healthcare
Types of Mobile Robots

Unmanned Vehicles
- UAV/UAS
- UGV
- UUV
- USV
- AGV
- AGC
- ROV
Types of Mobile Robots

Autonomous Vehicles

– Tractors
– Cars
– Trucks
– Buses
– Retrofits
Servo Solutions

- Traction
- Steering
- Turret
- Joint Movement
  - Shoulder
  - Elbow
  - Wrist
- Manipulators
  - Grippers
  - Hands
  - Probes

Needs:

- Shock and Vibration
- Compact Assemblies
- Multiple Axes
Merging Assemblies

Include other Sub-Assemblies

- Servos, Controller, Power Management....One Assembly

Solution:
Custom Assemblies
Multiple Axis Assemblies

Multiple Axes in One

- One Enclosure/Multiple Axes

- One Carrier Card/Multiple Axes

Solution:
Embedded Drives
Custom Carrier Board
UUV, USV and ROV

Servo Solutions
- Propulsion
- Control Surfaces
- Camera Control
  - Pan and Tilt
- Manipulating Arms
- Grippers

Needs:
- Conformal Coating
- High Pressure Environments
- Compact Designs
To save space and weight, Servo Drives can be integrated:

- Into Bot Chassis
  - Reduce Overall Volume
  - Reduce Weight

- Into Motor/Actuator
  - Reduce Wiring
  - Reduce Weight
  - Reduce Cost
  - More Robust

Solution:
- Embedded Drives
- Custom Assemblies
Servo Solutions
- Control Surfaces
- Propulsion
- Camera Control
  - Pan and Tilt

Needs:
- Small/Lightweight
- Integrated Heatsink
- High Altitude/Low Pressure
Extended Environments

Humidity/Condensation
– Conformal Coating

Shock/Vibration
– Low Profile Components
– Mechanical Adhesives

Pressures
– Submersed in Non-Compressible Fluid
– Thermal Dissipation
Extended Environments

Extended Temps
– Automotive Grade Components
– High Efficiency Designs for Power Devices

Ingress Protection/Water Proof
– Plastic Cases
– Gaskets
– Connectors
AGV and AGC

Servo Solutions
- Traction
- Steering
- Lift

Needs
- Power/Large Currents
- Compact
- Permanent Magnet or AC Induction Motors
Integrated Intelligence

Motion

– Jogs, Homes and Indexes
– Motion Programs
– Offload the Controller for Distributed Control
– Reduce Parts/Saves Volume
Application Summary

Applications

- Military
- Agriculture
- Research
- Surveillance
- Recon
- Medical
- First Responders
Summary of Servo Axes

Cameras
Propulsion
Traction
Manipulators
  Grippers
  Hands
  Fingers
Joints
  Shoulders
  Elbows
  Wrists
Enabling Technology

**Power Devices**
- Size
- Efficiency
  - Thermal
  - Power

**Processors**
- Size
- Faster
- Efficiency
  - Thermal
  - Power
  - Lower Power Modes

**Battery Technology**
- Power Density
- Cost

**Materials**
- Alloys
- Plastics
- Carbon Fiber

**Intelligence**
- Localization
- Autonomy
- Algorithms

**Data Collection**
- Sensors
Gating Technologies

- Power Density of Batteries
- Data/Analysis vs Computational Power
- Mechanics
- Actuators
- Pattern Recognition
- Remote Operation
- Sensor Integration
- Mapping/Exploration
- Autonomy
Why Servos Are Robot Critical

Size and Weight
- robot can be smaller overall
- servos can be placed closer to load
- enclosures no longer dedicated to contain servos
- servo motors have the highest power density
- less energy needed to move robot
- robot can operate longer on finite power

Power and Efficiency
- servo systems are the most efficient devices for robotic platform movement

Environment
- Temp
- Shock/Vibration
- Humidity
- Condensation
- Pressure
Why Servo Drives from AMC

- Custom Solutions
- Size
- Weight
- Power Density
- Power Efficiency
- Intelligence
- Configurability

Custom Solutions
Questions?

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Thank you!