ROBOTICS IN MOTION

Making Smart Machines Smarter

Tomer Goldenberg
Elmo Motion Control
We live in an interesting world...
We want our workers to perform like robots:

Yet...
We want our robots to be more human:
We want our robots to be more human:

Intelligent
Independent
Sensible
Mindful
Eco Friendly
Powerful
Flexible
Responsible

While also ensuring manufacturing them is:
Simple & Affordable
The role of servo and motion technology within Robotics is now more important than ever.

During this talk we will cover:

- Intelligent Motion
- Independent
- Sensible
- Mindful
- Eco Friendly & Green Automation
- Powerful
- Flexible
- Responsible & Safe Collaboration

While also ensuring manufacturing them is:

Simple & Affordable Implementation
Motion Challenges in Robotics
Can be resolved with intelligent motion & smart servo control
Motion Challenges in Robotics
Can be resolved with intelligent motion & smart servo control

- High Bandwidth
- High sensitively, good resolution
- Cogging Compensation
- Current & Velocity Gain Scheduling
- Advanced Kinematic Support
Intelligent Motion

Simple Implementation

Green Automation

Safe Collaboration

*Best results with Any Servo Load **Wide bandwidth >4.5 KHz ***Fast & accurate PI Vector Control *Safety Feedback, Advance commutation (>3KHz) *Smart Phase advancing *High current dynamics 2000:1 *60us current loop *Current Loop Gain Scheduling *60us Velocity loop *Velocity Loop Gain Scheduling *60us Position loop *Position Loop Gain Scheduling *Selectable 1:1 or 1:2:2 Servo control *60us Velocity loop *60us Position loop *High order filters on different control loop segments *Low pass filters *High Pass filters *Notch and Anti-Notch filters *Lead-lag filters on references

*Functional Safety (IEC 61800-5-2, SIL-3): STO, SOS, SLS, SS1, SS2, SLT, SBC, SLA, SAR... *FIR *Gitch *LPF *High order general bi quad filters *Scheduled filters *Unlimited Control Numerical values *Automatic calibration Procedures *Commutation alignment *Phase sequencing *Current loop *Offset adjustment *Current loop gain tuning *Current gain scheduling *Velocity loop *offset adjustment *Velocity gain tuning *Velocity gain scheduling *Position gain tuning *and much servo capabilities *Any Feedback on the market support *Absolute serial *Incremental Quadrature *Incremental Quadrature + Halls

*Digital Halls only *Analog Halls (single turn sin-cos) *Serial Single and Multi Turn *Resolver with wide frequencies support *Analog Sin-Cos Encoder *8192 Internal multiplier *reaching 300,000,000 counts/ revolution *SAFE I/O *Encoder Emulation outputs *PWM (Pulse Width Modulation)


*Wide Homing methods *Two advanced independent motion profilers *2 Analog inputs supports current, velocity, position loop *By the Rock* standardised IEC61158 EtherCAT

Gold Twitter | Highest Intelligence-Density Drive
Advanced Tuning Tools
Enable robot manufacturers to achieve optimum performance at any position, with any load

- Plant design
- Filter design
- Gain Scheduling
Automatic Multi Dimensional Tuning

Intelligently performs automatic 3D tuning and gain scheduling, to achieve optimal control algorithms for multi axis robots, with a click of a button.
Intelligent motion is about extending the barriers of the mechanics, taking robots beyond their limits.
Everyone’s Game | Robotics no longer just for big name companies
Small to medium size companies are creating innovative Robotics in all sectors

Minimal Time-to-Market with absolute Implementation Simplicity is crucial
Dedicated Robotic Motion Tools
Contribute to design, simulation, and commissioning Simplicity

Manufactures today decrease their time-to-market with:

advanced motion simulation tools

Let’s examine some of these tools

Kinematic package presets, saving lots of time

The flexibility to program in any stands language, not needing to handling with code conversions

Automatic network identifications tools

Intuitive visualization creation tools
Software in the Loop (SIL)
A huge milestone for robotic manufacturers.

Complex models, profiles, kinematics and more are commonly programmed in a MATLAB/SIMULINK environment.

Special infrastructure within Elmo controllers allow for integration of MATLAB code within the real time code of the robot.

Why does it matter?
(for example) customers can program their own unique kinematics, not needing drive manufacturer to pre-embed into the firmware, which may be raveling to their IP

Automatic code conversions | huge time saving | keep your motion IP
**Built in Kinematics**

For those with “standard” robot kinematics, the road to implementation is even shorter.

**Built-in to firmware | standard feature | no time wasted on complex equations**

**Allows manufacturers to focus on their application**
**Simplifying Motion**

The Motion Interface that does it all

- **Simple** multi axis motion implementations
- **Advanced tools** for machine building, testing and performance enhancements
- **Visual 2D/3D tools** for simulations and recording of profiles
- Tools to **increase** machine **accuracy** and **throughput**
- **Saves time** in setting up a system, and simulating, and commissioning a robot/machine
Enhanced Visualization Tools

Allow manufactures to create fully functioning remote/target HMI screens simply and intuitively.

Operators want to monitor robot and component operation in a simple and graphic way.

Development of high level HMI Screens directly in the IEC 61131-3 IDE, with direct access to all application and motion variables.

Target device (HMI) or Remote Visualization (web browser HTML5).

Operation is straightforward and easy to use.
Profile Simulator
Comprehensive Motion Prediction

Manufacturers can plan and simulate motion from a .NET library interface

Profile simulation for single/multi axis

Understand in advance where robot mechanics will experience jerks, oscillations, and other mechanical behaviors

Save time | predict behavior | immediate results
Simple Implementation of robotics is helping manufactures improve their time-to-market, while increasing overall competitiveness.
Battery Operating MobileRobotics

Efficiency of the Servo drive is mandatory and critical to all types of battery-operated AGVs.

Higher efficiency means longer AGV operation between charges.

Better efficiency also means taking better care of the battery and prolonging its lifetime.
Inefficiencies in Motion Control Systems

- Power Supply
- Servo Drives
- Motor
- Gear

Inefficiency

Green Automation

Simple Implementation

Intelligent Motion

Safe Collaboration
Inefficiencies in Motion Control Systems

Many sources of inefficiencies in power conversion process, resulting in various non-green environmental pollutions.
Inefficiencies in Motion Control Systems

The inefficiencies in the servo world result in non-green environmental pollutions:

- Power Conversion Inefficiency
- Excessive Heat
- EMI
- Torque Generation Inefficiency
- Torque Ripple & Non-linearities
- Moving the Load Inefficiency
- Mechanical Resonance

Trying to resolve these “pollutions” in traditional ways, will lead to more wasted energy and further inefficiency.
Introducing Green Motion Control
Green Automation

Green Motion Control
With ultra Efficient Power Conversion

Elmo servo drives are **99% efficient** in power conversion | **Minimal heat generated** | **Minimal EMI** |

Elmo’s proprietary FASST PWM switching technology
Fast and Soft Switching Technology (FASST)

99% efficient in power conversion | **Minimal heat** generated | **Minimal EMI** |
What Ultra Efficient Servo Drives look like!

Double Gold Twitter
160A/80V
10,000W

Gold Twitter
80A/80V
5000W
What Robots with Ultra Efficient Servo Drives look like!
Green Automation

High Efficiency Means High Currents in Small Packages
Ideal for high power robotic applications, with confined space, and battery operation

650A/80V

100A/900V

150A/100V

75A/100V

40A/100V

50A/100V

160A/80V
Green Automation driven by efficient servo drives contributes to minimized robotic design, with high power, low EMI, and energy savings.
Safe Collaboration

Traditional Machine/Robot Safety

A machine/robot that cannot injure humans

Safety guards
Safety cages and fences around industrial robot

Safe mechanical construction
No sharp edges, accessible hazards, etc.
No manual loading/unloading

The traditional way:
No access no risk
But production today is more complex, there is a higher degree of human-machine interaction.
The New Wave of Robotics

Human-Machine Collaboration
Human-Machine “Intimate” Interaction
Unmanned / Uncaged / Autonomous Workspace
Adaptable/Flexible Workspace

Safety, more than ever is an integral part of today’s smart factory, with Servo Drives in its heart.
‘Functional Safety’ shift the safety responsibility, now relying on the servo drive for critical safety functions.

This shift creates a huge advantage for manufacturing:

- **Less Hardware**
  - Added Machine Functionality
  - Through innovative safety features

- **Less Price**
  - Simplified Machine
  - Replace Safety Hardware for motion Software

- **Less Time to Market**
  - Replace Power Components for Logic Level
Doing all of that, with this.... And much more

That, is SMART SAFETY.
Fast & Simple Safety Implementation

The world's most advanced motion implementations software is now where you can easily customize your robot’s Functional Safety.

SOS (Safe Operating Stop) Implementation

SLS (Safely Limited Speed) Implementation
Safe Collaboration is about truly reliable safety orchestrated by servo drives, leading manufacturers to save on hardware, cost, and development time.
The role of **servo and motion technology** within Robotics is now more important than ever
THANK YOU

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