



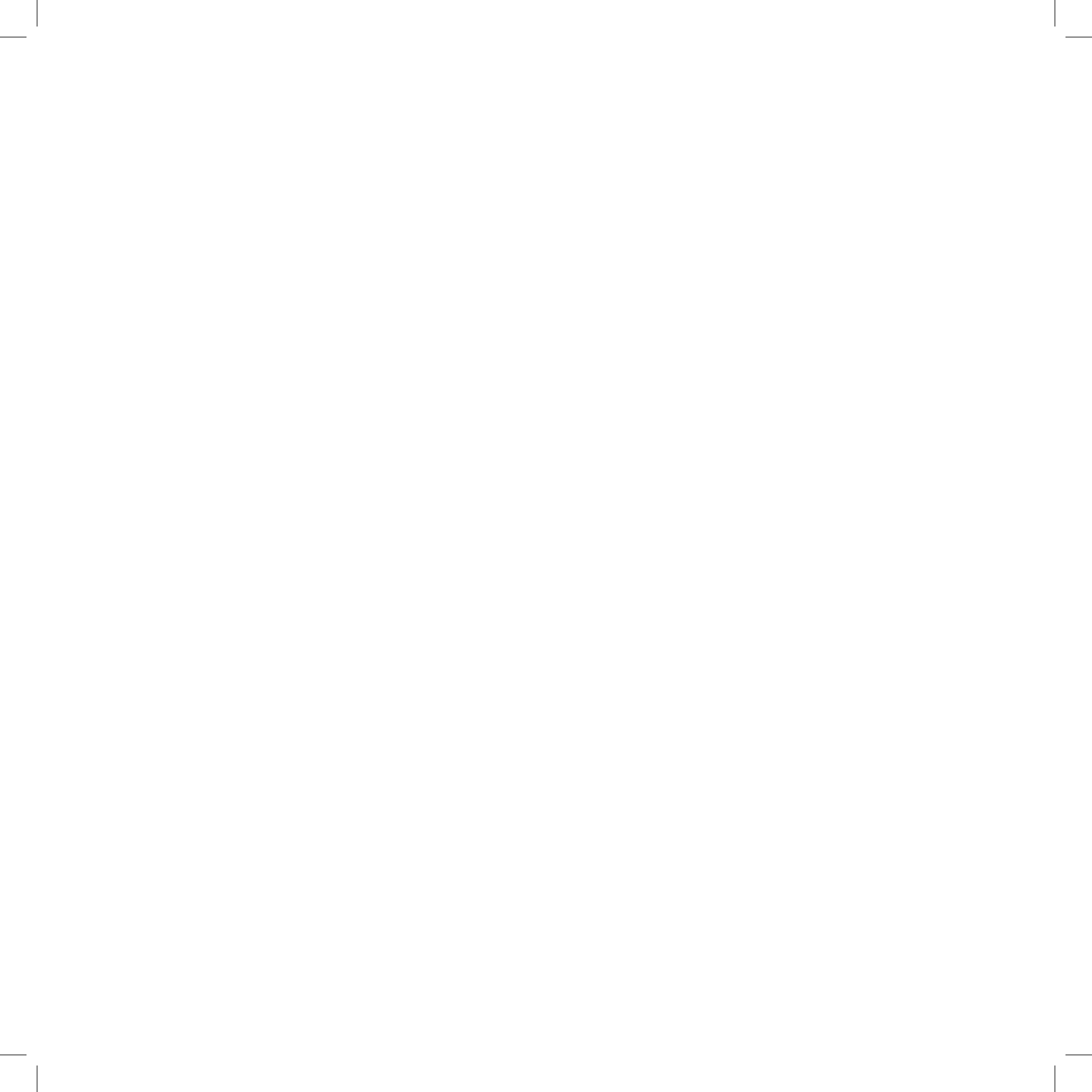
Confederation of Indian Industry

INTELLIGENT MACHINES

A Compendium of
Robotics, Drone &
Automation
Technologies

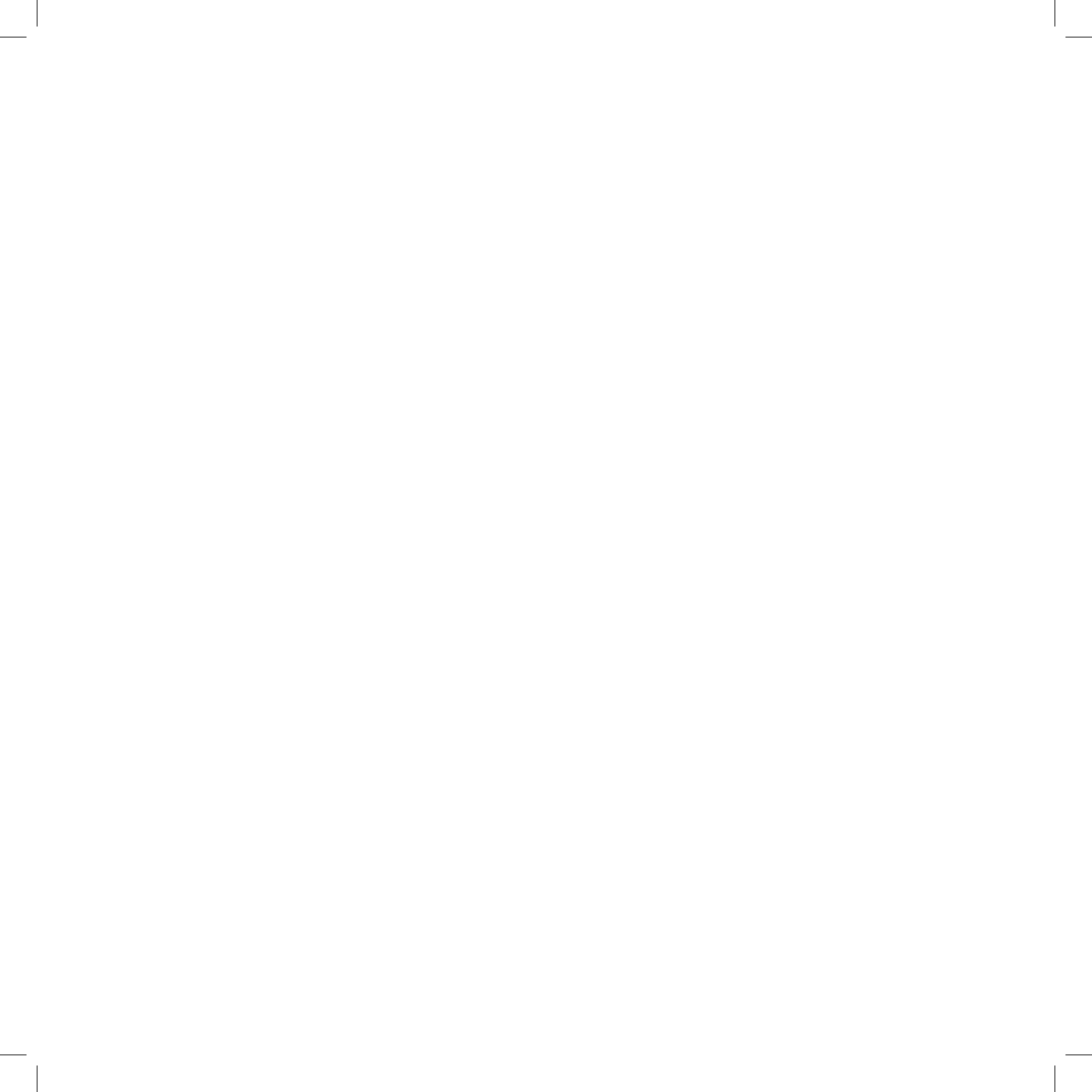


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Contents

Executive Summary	5
Case Study 1: Articul Surgical Pvt. Ltd	6
Case Study 2: Automed Systems Private Limited	10
Case Study 3: Botsync Pte Ltd	13
Case Study 4: Botsync Pte Ltd	16
Case Study 5: Botsync Pte Ltd	19
Case Study 6: Gravitaz Automation Pvt Ltd	22
Case Study 7: ViTachyon Robotics Pvt. Ltd.	25
Case Study 8: ViTachyon Robotics Pvt. Ltd.	28
Case Study 9: ViTachyon Robotics Pvt. Ltd.	31
Case Study 10: ideaForge Technology Ltd.	34
Case Study 11: INYX by Lithion Power Private Limited	37
Case Study 12: L&T Technology Services Limited_(LTTS)	39
Case Study 13: Vortex Engineering Works India Pvt. Ltd.	43
Case Study 14: Sirona Robotics	45
Case Study 15: CSIR-Central Mechanical Engineering Research Institute	48
Case Study 16: CSIR-Central Mechanical Engineering Research Institute	52
Case Study 17: Zetta WATT Private Limited	57
Case Study 18: CDSpace Robotics Pvt Ltd	60
Case Study 19: Merritt Innovative Solutions India Pvt. Ltd.	62
Case Study 20: SCANXT Scientific Technologies Pvt Ltd	65
Case Study 21: xTerra Robotics Pvt Ltd	69



Executive Summary

The Compendium of Technologies on Robotics, Drones, and Automation provides a concise overview of the technologies transforming industry and driving the shift toward intelligent, autonomous systems. Powered by advances in AI, sensors, and connectivity, these technologies are enhancing productivity, precision, and efficiency across sectors such as manufacturing, agriculture, logistics, healthcare, and defence.


The compendium maps key technology trends, highlights emerging innovations like cobots and autonomous systems, and showcases high-impact use cases. It also identifies critical challenges, including regulatory frameworks, standards, and skill gaps, while outlining pathways to accelerate adoption and innovation.

For India, robotics, drones, and automation are central to strengthening competitiveness, boosting advanced manufacturing, and enabling technology-led growth. This compendium serves as a strategic resource to support informed decision-making, collaboration, and the development of a future-ready technology ecosystem.

Case Study 1: Artculus Surgical Pvt. Ltd

ORGANIZATION DETAILS

Organization Name	Artculus Surgical Pvt. Ltd.
Website	www.articulussurgical.com
Headquarters	Bengaluru, Karnataka, India
Sector / Industry	Healthcare • Medical Devices • Surgical Robotics Training



PROJECT TITLE

Nebula by Artculus Surgical: India's First Multi-Platform Robotic Surgery Simulator Bridging the Skill Gap for the Next Generation of Surgeons

PROJECT DETAILS

Problem Addressed:

No surgical simulator exists that replicates all major robotic surgery platforms, leaving medical students and trainees without standardised, accessible, hands-on preparation for the future of robotic-assisted surgery.

Solution Deployed:

Nebula, a high-fidelity robotic surgery simulator with multiple structured training modules (Beginner to Clinical scenarios), platform-agnostic design, VR immersion, biomechanically optimised console, and performance analytics.

Where Implemented:

Medical colleges, post-graduate surgical training programmes, and hospital simulation and training centres across India.

Key Outcome:

Measurable improvement in trainee bimanual dexterity, motion smoothness, precision, and procedural readiness, before any exposure to a live robotic operating theatre.

Current Status:

✓ Commercial Scale | Export-Ready

Technology Category

- Medical Robotics
- Surgical Simulation & Training Technology
- Virtual Reality (VR) Systems
- Medical Device / MedTech

Awards & Recognition

- Forbes India – Top 100 Startups
- Royal Academy of Engineering, UK
- NASSCOM Deep Tech Emerge 50 – 2025
- YourStory Tech30 – 2025
- CNBC MoneyControl – Top 100 Startups to Watch 2023

BACKGROUND & CHALLENGE

The global adoption of robotic-assisted surgery is accelerating rapidly, yet the pathway for surgeons to acquire robotic operating skills remains fragmented and inadequate. Existing training options are largely limited to cadaveric workshops, OR observation, and a small number of proprietary simulators tied exclusively to a single robot brand, making cross-platform competency virtually impossible to develop.

For residents, and early-career surgeons, there is no structured, affordable, and accessible simulation

environment to build foundational robotic skills before entering the operating theatre. This creates a skill gap: trainees are often exposed to live robotic systems with minimal prior simulation experience, increasing cognitive load, extending learning curves, and raising patient safety concerns.

Articulus Surgical identified this critical void and set out to build India's first platform-agnostic robotic surgery simulator, a system capable of preparing surgeons for any leading robotic platform, not just one.

SOLUTION OVERVIEW

Nebula is a purpose-built robotic surgical simulator developed by Articulus Surgical to address the global deficit in structured pre-operative robotic training. Unlike proprietary simulators tied to specific platforms, Nebula is engineered to mirror the ergonomics, hand controls, motion scaling, depth perception, and tissue-interaction behaviour common to all leading robotic surgery systems, making it the only true multi-platform preparation tool available.

The system features a biomechanically optimised surgeon console with adjustable seating, natural wrist alignment, low-fatigue hand controllers, and an immersive VR display. Trainees progress through four structured skill modules: Beginner (core motor skills), Intermediate (robotic dexterity and suturing), Advanced (high-precision bimanual tasks), and Clinical Scenarios (guided stepwise surgical procedures on realistic anatomy models).

A dedicated Instructor Console enables real-time monitoring, session-by-session progress tracking, and guided corrections.

Nebula Pro, the advanced tier, adds simulated surgical procedures with multiple complexity levels, adverse

event scenarios, and deeper analytics, making it suitable for both emerging and established surgical training institutions.

OUTCOMES & IMPACT

Parameter	Before (Baseline)	After (With Nebula)	Impact
Skill Readiness	No structured robotic simulation; trainees enter OR with minimal preparation	Structured progression across multiple skill levels before OR exposure	Significantly reduced first-OR cognitive load and error rate
Training Access	Limited to brand-specific simulators or cadaveric workshops	Platform-agnostic simulation replicating all major robotic systems	Wider accessibility for institutions regardless of robot make
Performance Feedback	Subjective faculty observation only	Motion analytics, error maps, trend reports	Objective, data-driven individual and cohort skill tracking
Trainer Efficiency	Instructor required to be present throughout each session	Real-time remote monitoring via Instructor Console	Faculty time optimised; scaled training cohorts enabled
Ergonomic Fatigue	Standard lab setups not designed for extended simulation	Biomechanically aligned console; adjustable geometry; low-fatigue controllers	Extended training sessions without physical strain or skill dropout

UNIQUE CHARACTERISTICS

- **Platform-Agnostic Multi-Robot Simulation:** Nebula is the only simulator designed to replicate the ergonomics and controls of all leading robotic surgery systems, not tied to a single brand, enabling surgeons to build transferable skills for any future OR environment.
- **Four-Level Structured Curriculum:** Purpose-built progression from Beginner through Clinical Application ensures systematic, measurable skill acquisition, appropriate for master's students, residents, and experienced surgeons upgrading to robotic platforms.
- **Objective Analytics:** Real-time session scoring, motion path analytics, error maps, and longitudinal trend reports replace subjective faculty assessment with quantifiable, reproducible performance data at the individual and cohort level.
- **Surgeon-Centric Ergonomic Design:** Biomechanically validated console geometry, adjustable seat height, natural wrist alignment, low-fatigue hand controllers, and stable arm support and enables extended training sessions without physical strain, maximising repetition and skill consolidation.
- **Made in India, Built for Global Standards:** Developed under the Make in India initiative and recognised by Forbes India, the Royal Academy of Engineering (UK), NASSCOM, and YourStory Tech30, Nebula demonstrates that world-class surgical training infrastructure can be designed, manufactured, and deployed from India.

Case Study 2: Automated Systems Private Limited

ORGANIZATION DETAILS

Organization Name: Automated Systems Private Limited

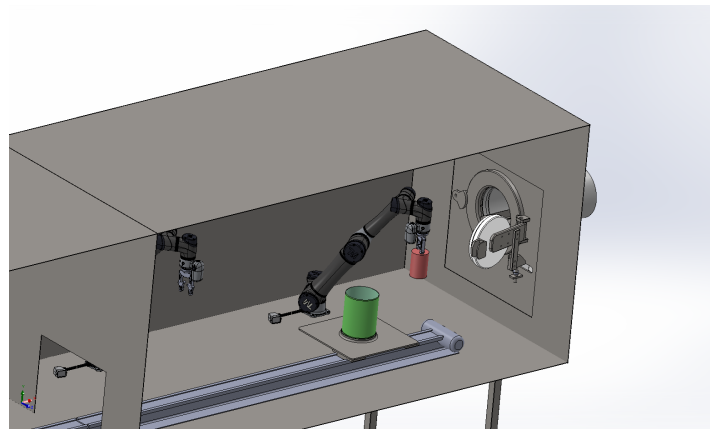
Website: www.automedsystems.com

Headquarters: Bangalore

Sector / Industry: Pharma, Food and Chemicals

PROJECT TITLE

Process Automation in a Pharmaceutical plant



Above Bin to bin transfer with flow control for High potent powder below, robotic handling of powder for radioactive compounds_

PROJECT DETAILS

Problem Addressed:

The core goal was to reduce manual material handling on the shop floor, improving process control and better utilities and building management.

Solution Deployed:

Build material movement automation, to lift, tilt, invert bins in closed environment IOT integration for interlocking mechanism for process safety and control. Designing a controlled cleanroom with precise HVAC and air filtration

Where Implemented:

Pharmaceutical plant in INDIA.

Key Outcome:

- 45% reduction in energy consumption
- Enhanced compliance and data integrity
- Improved process control and efficiency
- Less dependent on operators efficiency
- Better protection to operators from hazardous powders
- Scalable and future-ready facility

BACKGROUND & CHALLENGE

Background & Context

In OSD (oral solid dosages) manufacturing large amounts of API and Excipients go through a series of production processes that eventually becomes a product we use. This manufacturing process involves handling bulk powder in big bags, bins, charging process equipment and collecting the discharge powder / tablets and feeding them into filling lines and packing lines.

This involves operators moving drums, FBIC, and containers into clean rooms, dispensing and weighing batch quantities and feeding the right materials at the right quantity, at the right time, in a manner that meets regulatory compliance.

This makes the technical team that govern this process highly accountable. One wrong decision, one seemingly

minor oversight, and an entire batch of sometimes very expensive drugs and precursors is rendered unusable.

Process control, material handling automation, Utilities management, risk analysis and management, data management becomes critical

Objective

The core goal was to reduce manual material handling on the shop floor, improving process control and better utilities and building management.

The project involves integrating process, engineering, automation, and IT expertise to create a digitalized and automated production environment for oral solid dosage forms.

Challenge

- Achieving GMP-EU compliance with strict validation and audits
- Build material movement automation, to lift, tilt, invert bins in closed environment
- IOT integration for interlocking mechanism for process safety and control.
- Designing a controlled cleanroom with precise HVAC and air filtration
- Integrating IT and OT systems for seamless automation
- Optimizing energy efficiency while maintaining compliance

SOLUTION OVERVIEW

- Designing Automated closed loop powder handling systems for material handling
- Lifting and placing devices with integration with process equipment
- Building Management System (BMS), Environmental Monitoring System (EMS)
- ISA-95-compliant automation for seamless IT-OT integration
- HVAC automation to maintain cleanroom conditions
- Smart energy management for optimized resource use
- Technologies/ solutions implemented include:
 - o Optimize Productivity with Smarter, More Efficient Control Systems: with PLC (programmable logic controller) and PAC (programmable automation controller)
 - o Enhance energy efficiency and operational performance with Variable Frequency Drives (VFD): VFD for AHU (Air Handling Units)
 - o Plant-wide network connectivity systems enabling real-time control and information

Result

- 45% reduction in energy consumption
- Enhanced compliance and data integrity
- Improved process control and efficiency
- Less dependent on operators efficiency
- Better protection to operators from hazardous powders
- Scalable and future-ready facility

A scalable, modular solution that supports flexible production campaigns, real-time monitoring, and automated documentation.

The system integrates advanced intralogistics, tracking technology, and data acquisition into a sophisticated automation system, enabling seamless operations, unmatched efficiency, and best-of-class quality control – designed to meet the highest requirements of the industry and offering a scalable, resource-efficient solution.

UNIQUE CHARACTERISTICS

- Custom designed material handling automation from warehouse to packing
- IOT and ML for predictive maintenance
- QR code based real time service and documentation support

Case Study 3: Botsync Pte Ltd

ORGANIZATION DETAILS

Organization Name:	Botsync Pte Ltd
Website:	https://www.botsync.co
Headquarters:	Singapore
Sector / Industry:	F&B and FMCG, Automotive and Heavy Machinery, Distribution Centres

PROJECT TITLE

PT Tri Centrum Fortuna Scales Safe and Efficient Pallet Transport with MAG1000 AMRs



Botsync's MAG1000 Lifter AMR moves heavy parts across the PT Tri Centrum Fortuna factory floor

PROJECT DETAILS

PT Tri Centrum Fortuna, an automotive components manufacturer in Indonesia, faced challenges with manual pallet transportation of heavy parts across its large stamping facility. Botsync deployed MAG1000 Pallet Lifter AMRs to automate material movement between 17 pick-up and 7 drop-off points. Operators trigger missions via tablet, enabling seamless and controlled workflows. The solution enabled 24-hour operations with improved efficiency and reduced labor dependency, while

maintaining consistent production output of 15 engines per hour. With a return on investment achieved within 2.5 years, the deployment is now at commercial scale, delivering measurable gains in safety, cost efficiency, and operational performance.

Current Status:

✓ Commercial Scale

BACKGROUND & CHALLENGE

PT Tri Centrum Fortuna operates a high-volume automotive stamping facility spanning 20,000 square meters, with production running across three shifts. Prior to automation, pallet transportation of heavy automotive components weighing between 500 to 800 kilograms was handled manually using hand pallets.

This process required 12 operators and was physically demanding, increasing the risk of workplace injuries and

operational inefficiencies. The reliance on manual labor also limited scalability and introduced inconsistencies in material flow across the factory.

The company needed a solution that could reduce manpower dependency, improve safety, and ensure reliable transportation of heavy loads across multiple production points without disrupting existing workflows.

SOLUTION OVERVIEW

Botsync implemented the MAG1000 Pallet Lifter AMR solution to automate pallet transportation across the facility. The system was designed to move materials efficiently between 17 pick-up stations and 7 designated drop-off points, ensuring consistent flow of components across production stages.

Operators continue to load pallets manually at pick-up stations, after which they trigger AMR missions via a tablet interface. The MAG1000 AMRs then autonomously navigate the factory floor to deliver pallets to the correct destinations.

The AMRs are equipped with intelligent navigation systems and advanced safety features, including front-facing focus lights to alert nearby forklift operators and LED indicators that communicate operational states such as navigation, docking, and idle.

Additionally, the system includes workflow automation and auto-charging capabilities, ensuring continuous operations without manual intervention. This allows the facility to maintain round-the-clock production while reducing reliance on manual handling and improving overall operational consistency.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Cost Reduction	12 operators required	Reduced to 3 operators	75% improvement
Quality	Variability in handling	Consistent material flow	Improved
Downtime	Dependent on manual handling	Continuous 24-hour operations	Reduced
Safety	High physical strain and risk	Automated transport with safety systems	Strongly Enhanced

UNIQUE CHARACTERISTICS

- Autonomous pallet transport across multiple pick-up and drop-off points
- Intelligent safety features including visual alerts and state indicators
- Simple operator interface using tablet-based task triggering
- Auto-charging capability enabling uninterrupted 24-hour operations
- Significant reduction in manpower while maintaining production output

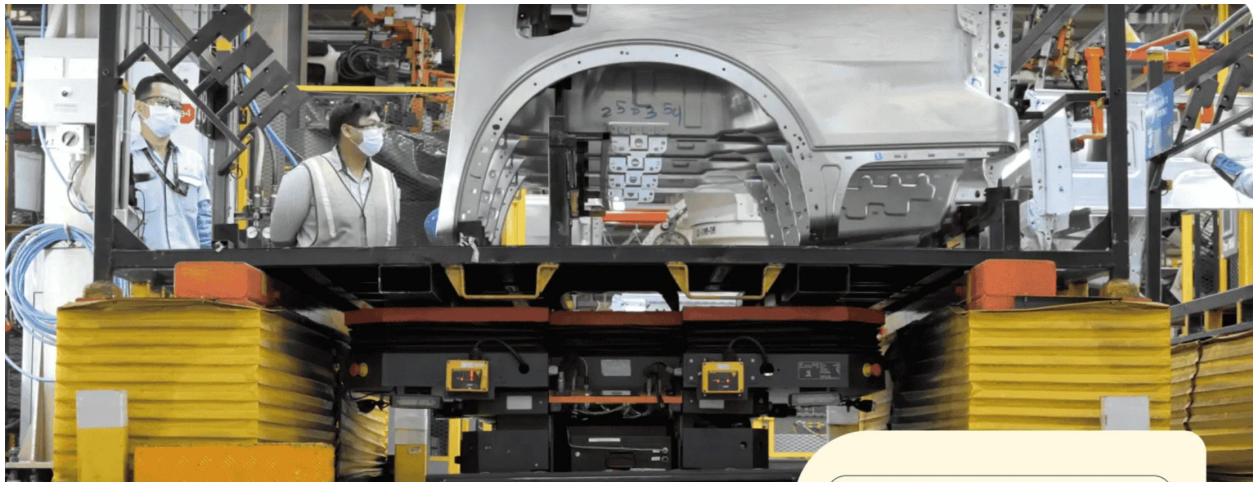
Case Study 4: Botsync Pte Ltd

ORGANIZATION DETAILS

Organization Name:	Botsync Pte Ltd
Website:	https://www.botsync.co
Headquarters:	Singapore
Sector / Industry:	F&B and FMCG, Automotive and Heavy Machinery, Distribution Centres

PROJECT TITLE

Global Automaker Achieves 12.5% Productivity Gain with AMR-Driven Body Shop Automation



MAG AMR Lifter enabling automated material transfer in automotive body shop

PROJECT DETAILS

A global automotive manufacturer faced labor shortages impacting critical body shop operations and overall productivity. To address this, Botsync deployed its MAG AMR Lifter integrated with SyncOS orchestration platform to automate material movement to assembly lines. The solution was implemented in the customer's body shop, where real-time coordination between AMRs, call panels, and production lines ensured seamless execution. As a

result, the plant achieved a 12.5% increase in production throughput while maintaining 99.4% uptime over two years. The deployment is currently at a commercial scale, with proven reliability in mission-critical processes.

Current Status:

✓ Commercial Scale

BACKGROUND & CHALLENGE

The automotive manufacturer was experiencing significant labor shortages, which directly impacted the efficiency of its body shop operations. Material movement between production stages relied heavily on manual handling and forklifts, creating bottlenecks and inconsistencies in supply to assembly lines. As production processes in the body shop are highly time-sensitive and mission-critical, even minor delays could disrupt the entire workflow and reduce throughput.

The company explored automation through AMRs but had concerns around reliability, system coordination, and whether such solutions could meet strict operational requirements. The challenge was not only to replace manual processes but to ensure seamless integration with existing production systems without compromising uptime, safety, or performance.

SOLUTION OVERVIEW

Botsync deployed its MAG AMR Lifter solution powered by SyncOS, a no-code orchestration platform designed for real-time intralogistics coordination. The system enabled intelligent task allocation by continuously monitoring the status of AMRs, call panels, and assembly lines. Based on live production requirements, SyncOS dynamically assigned missions to AMRs, ensuring timely delivery of materials to the lineside.

A key component of the solution was detailed cycle time mapping, where assembly line operations were closely aligned with AMR workflows to eliminate delays and

prevent production downtime. The solution also featured an intuitive user interface that simplified operator interaction, reducing task execution to just one or two clicks.

Additionally, the system was designed for high reliability, achieving consistent uptime through robust fleet management and system monitoring. By replacing manual forklifts and optimizing labor allocation, the solution created a more streamlined and predictable material flow, ensuring that production lines remained continuously supplied without interruptions.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	28 Jobs Per Hour (JPH)	32 Jobs Per Hour (JPH)	+12.5%
Cost Reduction	Manual labor + forklift dependency	1 Forklift removed, and 2 HC reallocated	Significant
Quality	Inconsistent supply timing	Stable, synchronized delivery	Improved
Downtime	Occasional delays	Near-zero disruptions	Reduced
Safety	Forklift-based movement	Automated AMR operations	Enhanced

UNIQUE CHARACTERISTICS

- Real-time orchestration using SyncOS for dynamic task allocation across systems
- Seamless integration with existing assembly line processes without disruption
- High system reliability with 99.4% uptime over 24 months
- Detailed cycle time mapping aligned with production workflows
- Simplified operator interface enabling quick adoption and minimal training

Case Study 5: Botsync Pte Ltd

ORGANIZATION DETAILS

Organization Name:	Botsync Pte Ltd
Website:	https://www.botsync.co
Headquarters:	Singapore
Sector / Industry:	F&B and FMCG, Automotive and Heavy Machinery, Distribution Centres

PROJECT TITLE

Global Beverage Leader Transforms Pallet Transfer with Integrated AMR and Software Automation



MAG AMR integrated with conveyor and strapping systems for automated pallet transfer

PROJECT DETAILS

A global beverage manufacturer faced operational challenges in transferring finished goods pallets within a constrained factory layout, relying heavily on forklifts and manual labor. Botsync deployed an integrated AMR solution using MAG1000 conveyor AMRs combined with SyncOS orchestration to automate pallet movement from production lines to warehouse storage. The solution was implemented across multiple production zones with integration into conveyor systems, strapping cells,

SCADA, and WMS. As a result, the facility achieved 44 pallets per hour throughput with 24/7 operations at 99% uptime, while reallocating forklift resources to higher-value tasks. The deployment is currently at commercial scale, delivering improved safety, efficiency, and operational continuity.

Current Status:

✓ Commercial Scale

BACKGROUND & CHALLENGE

The beverage manufacturer operated in a space-constrained facility where the transfer of heavy finished goods pallets depended heavily on forklifts. This created a high-density environment with multiple forklifts operating simultaneously, increasing safety risks and limiting operational efficiency.

Additionally, maintaining production throughput required a significant number of trained operators working across multiple shifts, making the process labor-intensive and

difficult to scale. The reliance on manual handling also introduced inconsistencies in product flow and increased the risk of damage to finished goods.

The client needed a solution that could ensure continuous pallet movement, reduce dependency on manpower, and improve safety, all while maintaining high production volumes and integrating seamlessly with existing systems.

SOLUTION OVERVIEW

Botsync deployed an integrated automation solution combining MAG1000 Conveyor AMRs with the SyncOS platform to enable seamless pallet transfer from production lines to warehouse storage. The system was designed to handle pallets from multiple production areas, including those requiring intermediate strapping before final storage.

Using SyncOS Integrator, the solution was tightly integrated with the facility's conveyor systems, strapping PLCs via Kepware, SCADA systems, and warehouse management system (WMS). This enabled

real-time coordination across all components, ensuring synchronized operations and uninterrupted material flow.

The SyncOS Fleet Manager provided intelligent orchestration, dynamically assigning tasks to AMRs based on production demand and system status. The system was highly configurable, allowing it to adapt to changing production requirements while maintaining consistent performance.

By automating pallet movement and reducing reliance on forklifts, the solution created a safer and more predictable workflow, ensuring continuous operations even in a constrained environment.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Manual pallet transfer	44 pallets/hour automated	Significant
Cost Reduction	High manpower and forklift use	3 forklift and 9 forklift operators reallocated	Significant
Quality	Risk of handling damage	Reduced human interaction	Improved
Downtime	Dependent on operator availability	24/7 operations at 99% uptime	Reduced
Safety	High forklift traffic	Minimal forklift dependency	Strongly Enhanced

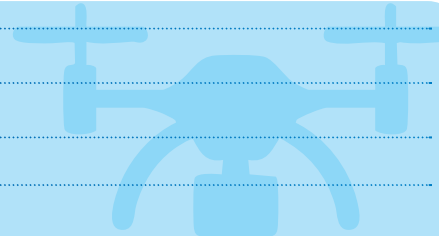
UNIQUE CHARACTERISTICS

- End-to-end integration across AMRs, conveyors, strapping systems, SCADA, and WMS
- Intelligent orchestration using SyncOS for real-time coordination of pallet flows
- Ability to operate reliably in narrow, space-constrained environments
- Highly configurable system adaptable to multiple production zones
- Significant reduction in forklift dependency, improving overall safety

Case Study 6: Gravitaz Automation Pvt Ltd

ORGANIZATION DETAILS

Organization Name:	Gravitaz Automation Pvt Ltd
Website:	www.gravitazautomation.com
Headquarters:	New Delhi, Delhi, India
Sector / Industry:	Automation



PROJECT TITLE

Robotic Spray Paint Coating System



Robotic spray paint coating system

PROJECT DETAILS

Problem Addressed:

As a soldier uses an arm such as a rifle/pistol in the field, it gradually loses its protective paint coating with time. In army workshops, such arms are usually cleaned and repainted using manual spray painting process. The control over layer thickness is skill-dependent. In addition such manual painting process suffer from problems such as a lack of uniform layer thickness on the arm and health hazards associated with inhalation of paint particles .

Solution Deployed:

Robotic Spray Paint Coating System which has predefined as well as custom painting programs for painting a variety of arms.

Where Implemented:

Indian Army

7001 EME Workshop, Mathura, Uttar Pradesh, India

Key Outcome:

Fully installed robotic spray painting cell. Integrated control system with automated paint delivery. Robot programming for multiple rifles/ arms. Safety systems including interlocks and emergency stop mechanisms. Operator Safety and prevention of occupational hazard.

Current Status:

✓ Commercial Scale

BACKGROUND & CHALLENGE

Manual Spray Painting Era

In this process, a worker operates a handheld spray gun to atomize paint and direct it onto the surface. The quality of the coating largely depends on the operator's skill, including their ability to maintain the correct distance, angle, and speed while spraying. Variations in these factors often lead to uneven coating thickness, surface defects like runs or orange peel, and inconsistent finishes across products.

Manual spray painting also raises serious health and environmental concerns. Workers are exposed to

hazardous fumes, solvents, and fine paint particles, which can cause respiratory issues and long-term health problems without proper protective equipment. Additionally, emissions from volatile organic compounds (VOCs) contribute to air pollution.

Problems:

- Inconsistent coating thickness
- High paint wastage
- Health hazards from toxic fume

SOLUTION OVERVIEW

In the robotic spray-painting setup, the gun / rifle is held in the fixture of a four-axis positioning robot that combines three orthogonal linear slides (X, Y and Z) and

a rotary axis (C). As coating begins, the PLC synchronizes the fixture motion profile with the robot's spray program: a servo on the Y-slide moves the gun radially toward

or away from the workpiece, while a second servo on the Z-slide raises or lowers it to follow the rifle's profile whereas the X axis allows the sprays gun additional degree of freedom for riffle handle profile painting. The gun / rifle is held in the fixture that spins at a constant, programmable speed, exposing every contour to a consistent atomized paint cloud. An encoder feeds real time position data to the controller, which controls the gun trigger and fluid flow to maintain an even value of

paint film thickness. Since the spray-painting gun can translate in all three directions and the rifle rotates simultaneously, the robot achieves full 360-degree coverage. This coordinated X-Y-Z scanning of the gun with continuous part rotation delivers uniform paint thickness and minimal overspray in a single automated pass. The HMI provides the cycle start stop controls, parametric settings for the travel lengths in XY and Z direction, linear travel speeds and rotational speed for rifle etc.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	20 ARMS/Hr.	40 ARMS/Hr.	100%
Quality	Skill dependent	Uniform Thickness	—
Downtime	Dependent on operator availability	No	—
Safety	Occupational hazards	No occupational hazard	Enhanced

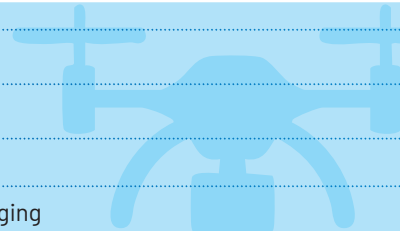
UNIQUE CHARACTERISTICS

- User friendly touch screen-based interface for parametric settings and operational control
- Only basic machine training required, final product quality not dependent on the operator's skill
- System halts during power loss and resumes operation once power is restored
- Use of absolute multiturn encoders for real time position detection of each axis
- Uniform thickness of paint deposited on the arm (Process repeatability)
- Can address multiple arms

Case Study 7: ViTachyon Robotics Pvt. Ltd.

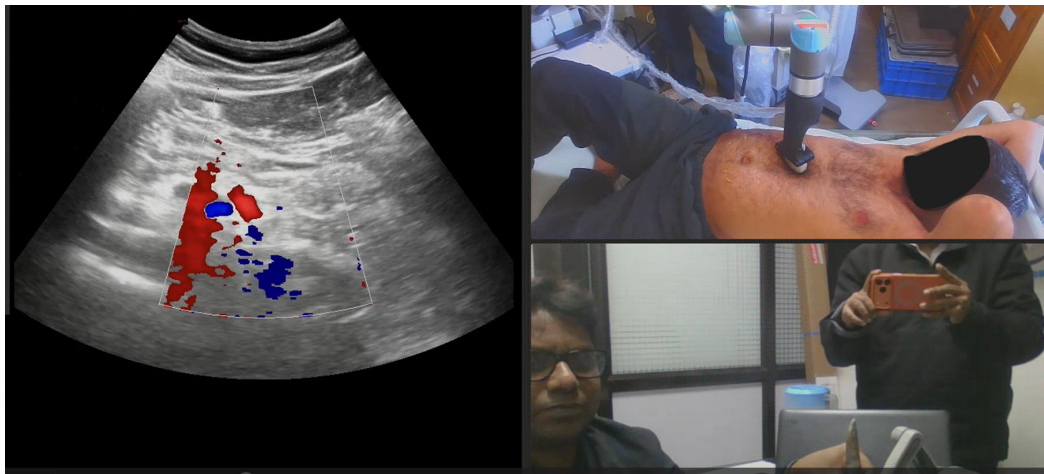
ORGANIZATION DETAILS

Organization Name:	ViTachyon Robotics Pvt. Ltd.
Website:	www.vitachyonrobotics.in
Headquarters:	New Delhi, India
Sector / Industry:	Healthcare, Medical Robotics, Diagnostic Imaging



PROJECT TITLE

Tele-Robotic Ultrasound for Remote Specialist-Guided Imaging



An Image showing live remote ultrasonography from a distance of 12000km

PROJECT DETAILS

Problem Addressed:

Limited access to expert ultrasound scanning in remote and underserved locations.

Solution Deployed:

A tele-robotic ultrasound system with robotic probe manipulation, haptic teleoperation, force-aware control, and real-time ultrasound/video streaming.

Where Implemented:

Long-distance validation and live demonstrations in hospital and field-linked settings.

Key Outcome:

Remote specialist-guided ultrasound maneuvering with live image feedback over internet-connected infrastructure.

Current Status:

Pilot

BACKGROUND & CHALLENGE

Mention baseline Ultrasound is a frontline diagnostic tool, yet access to high-quality scanning still depends heavily on the physical presence of a trained sonologist or radiologist. This creates a major gap for rural hospitals, remote regions, hard-to-reach geographies, and emergency situations where specialist imaging support is not immediately available. The baseline challenge was not

only acquiring images, but also extending expert probe maneuvering and scan supervision beyond the hospital. Conventional referrals increase delay, travel burden, and dependency on local availability. A tele-robotic approach was therefore developed to bring expert-guided ultrasound capability to distant points of care while retaining real-time clinical control.

SOLUTION OVERVIEW

The solution is a tele-robotic ultrasound platform that enables a remotely located expert to guide and control probe positioning in real time. It integrates a robotic manipulator for probe handling, a haptic input interface for intuitive command, force-aware control for compliant patient interaction, and a networking stack for control, video, and ultrasound data exchange. During operation,

the expert issues motion inputs through the haptic console, which are mapped to the robot side with safety and interaction constraints. Live ultrasound and scene video are streamed back for continuous adjustment of probe orientation, contact, and scan path. Its uniqueness lies in combining remote manipulation, interaction control, and imaging feedback in one scalable workflow for remote diagnostics and pilot deployment.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Specialist must be onsite	Remote specialist can guide scans	Context-dependent
Cost Reduction	Travel/referral overhead	Lower access-linked overhead potential	Case-dependent
Quality	Operator capability varies	Expert-guided scan consistency improved	Pilot-stage evidence
Downtime	Access delayed by availability	Faster expert reach through teleoperation	Operationally improved
Safety	Limited remote intervention	Force-aware supervised workflow	Workflow improved

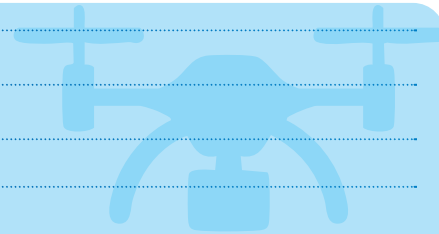
UNIQUE CHARACTERISTICS

- Combines robotic manipulation, haptic teleoperation, and live ultrasound feedback in one workflow.
- Extends specialist ultrasound capability to remote, underserved, and hard-to-access locations.
- Uses force-aware remote control to support safer and more compliant probe-patient interaction

Case Study 8: ViTachyon Robotics Pvt. Ltd.

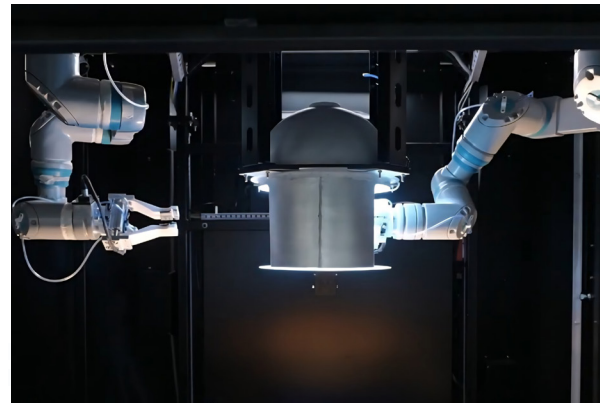
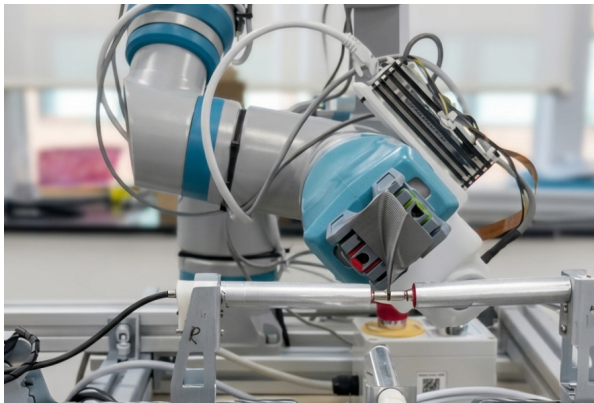
ORGANIZATION DETAILS

Organization Name:	Systemantics India Pvt. Ltd.
Website:	www.systemantics.com
Headquarters:	Bengaluru, Karnataka, India
Sector / Industry:	Robotics & Automation



PROJECT TITLE

Usage of Cobots coupled with Vision and Metrology for Aerospace domain
(or) Cobot-Driven Precision: Transforming Turbine Blade Inspection in Aerospace MRO



PROJECT DETAILS

A leading aerospace MRO facility handling commercial airline engine overhaul faced a critical challenge — turbine blade inspection relied entirely on manual QC processes prone to human error, inconsistency, and poor data traceability. Given that undetected surface defects or dimensional deviations in turbine blades can lead to catastrophic engine failure, the stakes for inspection accuracy could not be higher. A two-phase automated inspection platform was deployed, combining a programmable multi-wavelength dome vision system for surface defect detection with an LVDT-based metrology station for precision dimensional measurement —

purpose-built to accommodate all turbine blade stages without changeover. Where off-the-shelf alternatives proved cost-prohibitive and insufficiently specific, this custom-engineered solution delivered a cost advantage while eliminating manual bottlenecks. The result is a fully traceable, audit-ready inspection workflow with real-time digital logging and ± 0.025 mm measurement accuracy — IoT-enabled for AI-driven defect classification and built to scale with the facility's evolving compliance and operational demands.

BACKGROUND & CHALLENGE

In the Aerospace MRO sector, turbine blades are among the most safety-critical components in a commercial airline engine, subject to mandatory inspection cycles after fixed flight-hour thresholds. The facility in focus performs overhaul across all turbine blade stages — each with distinct geometry and dimensional tolerances — making inspection both technically demanding and operationally complex.

Previously, the facility relied entirely on expert QC engineers for two manual processes: visual surface examination to identify anomalies, and stage-specific gauge-based dimensional checks. Critically, dimensional results were recorded only as pass/fail, with no actual

values captured — creating a significant gap in data traceability for long-term maintenance records and regulatory compliance.

The process was highly susceptible to human error, inconsistent across inspectors, and required lengthy specialist training for new engineers. When inspection demand surged, the only recourse was costly headcount expansion. Meanwhile, off-the-shelf automation alternatives proved cost-prohibitive and lacked specificity to turbine blade geometry — leaving the facility with a manual bottleneck that threatened both throughput and auditability.

SOLUTION OVERVIEW

The deployed solution integrates two purpose-built subsystems – a dome-type vision system and an LVDT metrology station – designed to handle all stages of turbine blades within a single unified platform, eliminating the need for stage-specific tooling or manual changeovers.

Phase I – Surface Defect Detection: A custom dome-type inspection enclosure houses a programmable multi-wavelength illumination system (Red, Green, Blue, and White). By dynamically controlling light intensity and color, the system surfaces a wide range of anomalies that remain invisible under standard factory lighting. A single dome size accommodates all turbine blade variants, ensuring seamless inspection across the entire blade population without reconfiguration.

Phase II – Precision Dimensional Metrology: A dedicated LVDT-based metrology station performs automated measurement of four critical parameters: leading-edge thickness, trailing-edge thickness, chord length, and overall blade length – achieving an accuracy of ± 0.025 mm across all blade variants via a multi-stage fixture design.

Underpinning both subsystems is end-to-end digital traceability: a vision system mounted on the robotic arm automatically captures component serial numbers at the point of entry, while all inspection results and measurements are logged in real time. The IoT-enabled hardware further supports cloud connectivity for AI-driven defect classification and regulatory compliance report generation.

UNIQUE CHARACTERISTICS

- **Universal, Single-Platform Architecture:** Unlike conventional inspection setups that require stage-specific fixtures and manual changeovers, this solution handles all turbine blade stages within a single unified platform – integrating surface defect detection and dimensional metrology into one seamless, uninterrupted workflow
- **Tunable Illumination & Sub-Millimetre Metrology:** Programmable multi-wavelength illumination goes beyond fixed-light vision systems, allowing defect-type-specific tuning to reveal anomalies invisible under standard conditions. Paired with LVDT-based metrology achieving ± 0.025 mm accuracy, the system replaces subjective pass/fail judgements with precise, recorded dimensional values – a fundamental shift in inspection data quality
- **Error-Proof Traceability from Point of Entry:** A robotic arm-mounted vision system automates serial number capture at intake, eliminating manual ID entry as a source of error. All inspection results and measurements are logged in real time, creating an audit-ready digital trail that addresses regulatory compliance demands by design – not as an afterthought.
- **IoT-Enabled, AI-Ready Architecture:** The hardware's built-in cloud connectivity positions the system for AI-driven defect classification and automated compliance report generation without requiring future hardware replacement – future-proofing the investment as digital MRO mandates evolve

Case Study 9: ViTachyon Robotics Pvt. Ltd.

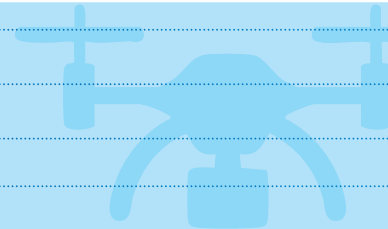
ORGANIZATION DETAILS

Organization Name: VigilRonyx AI Private Limited

Website: <https://vigilronyx.com/>

Headquarters: Bengaluru, Karnataka, India

Sector / Industry: Drones & Robotics



PROJECT TITLE

Enhancing Agricultural Drone Reliability in Complex Farm Environments through Adaptive Autonomy



Drone adapting to obstacles during spraying

PROJECT DETAILS

Problem Addressed:

Drone spraying fails in uneven terrain with obstacles.

Solution Deployed:

Real-time adaptive autonomy software.

Where Implemented:

Agricultural fields with natural obstacles.

Key Outcome:

Improved mission completion consistency and reduced safe mode interruptions in complex terrain.

Current Status:

✓ Pilot

BACKGROUND & CHALLENGE

Agricultural drones face challenges in uneven terrain with trees and creepers. Waypoint-based systems fail to adapt, causing incomplete missions and frequent safe

mode activation. These challenges were observed during real farm deployments, highlighting limitations of static waypoint-based systems.

SOLUTION OVERVIEW

VigilRonyx enables real-time obstacle detection, anomaly handling, and dynamic mission adjustment. The system adapts flight paths instead of strictly following waypoints, resulting in more reliable and continuous spraying

operations in real-world farm conditions.

Initial results are based on pilot deployments and operator feedback, with detailed quantitative validation currently in progress.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Frequent mission interruptions	More consistent mission completion	~20-30% improvement
Cost Reduction	Higher due to rework/manual intervention	Reduced due to improved automation	~10-20% reduction
Quality	Incomplete spraying coverage	Improved coverage consistency	~15-25% improvement
Downtime	Frequent safe mode activations	Reduced interruptions	~25-40% reduction
Safety	Over-conservative (frequent halts)	Balanced safety with continuity	~20-30% operational efficiency gain

UNIQUE CHARACTERISTICS

- Adaptive mission execution
- Real-time decision making
- Reduced manual intervention
- Works in rural low connectivity

Case Study 10: ideaForge Technology Ltd.

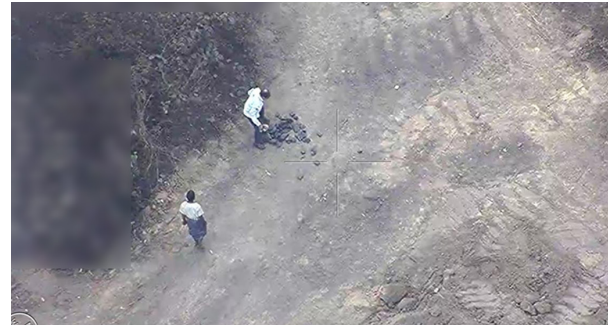
ORGANIZATION DETAILS

Organization Name:	ideaForge Technology Ltd.
Website:	www.ideaforgetech.com
Headquarters:	Navi Mumbai, Maharashtra, India
Sector / Industry:	Mining



PROJECT TITLE

ideaForge's FLYGHT Logs 120,000+ Flight Minutes to Transform Mining Security & Operations



Real-time aerial tracking enabled rapid theft detection and recovery across active mining sites.

PROJECT DETAILS

Mining operations across India have long struggled with theft, operational inefficiencies, and limited visibility across vast sites. Traditional monitoring methods failed to deliver real-time insights, leading to delays and losses. ideaForge's Drone-as-a-Service platform, FLYGHT, introduced continuous aerial surveillance and real-time intelligence. With over 2,000 flights and 120,000+ minutes of operations in 6 months, the solution enabled rapid response, improved monitoring, and reduced dependency on manual patrols. In one instance, 900 liters of fuel were recovered, and theft was resolved within 40 minutes, demonstrating a step-change in security and operational control.

Problem Addressed:

Theft, lack of real-time monitoring, operational inefficiencies, and safety gaps

Solution Deployed:

FLYGHT - 24/7 drone-based surveillance with real-time analytics

Where Implemented:

Mining sites in Odisha, West Bengal, and Rajasthan

Key Outcome:

Significant reduction in theft, improved operational efficiency, faster response times

BACKGROUND & CHALLENGE

Mining operations face persistent challenges due to their scale and complexity. Sites often span vast, remote areas, making continuous monitoring difficult. Traditional approaches such as human patrols and fixed surveillance systems lack real-time visibility and responsiveness, leading to frequent theft of high-value materials like coal, copper wires, scrap, and fuel.

Operational inefficiencies further compound the issue. Without live data, tracking vehicle movement,

managing logistics, and ensuring compliance becomes cumbersome. Safety risks also increase due to limited oversight during critical activities such as blasting or night operations. Delayed response times and high monitoring costs reduce overall productivity and profitability. These limitations highlighted the need for a smarter, scalable, and real-time monitoring solution capable of covering large mining areas efficiently.

SOLUTION OVERVIEW

ideaForge deployed its FLYGHT Drone-as-a-Service (DaaS) platform to address the security and operational challenges across mining sites. The solution leverages advanced UAVs equipped with high-resolution cameras and sensors to provide 24/7 aerial surveillance, including night-time operations.

Drones conducted multiple daily sorties (5-6 flights), capturing real-time data on site activities, vehicle movement, and perimeter conditions. The system integrated real-time alerts and analytics, enabling immediate detection of anomalies such as unauthorized access or theft attempts. This allows on-ground teams to respond quickly and effectively.

FLYGHT also enhanced operational efficiency by enabling continuous tracking of dumpers and logistics movement, ensuring smoother coordination and reduced delays. During critical operations such as controlled blasting, drones provide aerial oversight, improving safety compliance.

The DaaS model eliminates the need for heavy infrastructure investment and reduces dependency on manual patrols, making monitoring more cost-effective. Its ability to scale across large and complex terrains, combined with real-time intelligence, makes it a robust solution for modern mining operations.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Limited visibility, delayed operations	Streamlined operations with real-time tracking	—
Cost Reduction	High manpower & monitoring costs	Reduced dependency on physical patrols	—
Quality	Inefficient coordination	Improved planning and execution	—
Downtime	Frequent delays due to poor monitoring	Faster decision-making and reduced delays	Reduced turnaround time
Safety	Limited oversight, especially at night	24/7 surveillance with enhanced safety control	Significant improvement

UNIQUE CHARACTERISTICS

- **24/7 Drone-Based Monitoring:** Continuous surveillance including night operations across large mining areas
- **Rapid Incident Response:** Real-time alerts enabling action within minutes (e.g., theft resolved in 40 minutes)
- **DaaS Model:** No upfront infrastructure investment, scalable and cost-efficient deployment
- **Integrated Analytics:** Combines aerial intelligence with actionable insights for operations and security
- **Multi-Use Capability:** Supports security, logistics tracking, compliance monitoring, and safety oversight in a single platform

Case Study 11: INYX by Lithion Power Private Limited

ORGANIZATION DETAILS

Organization Name: INYX by Lithion Power Private Limited

Headquarters: Noida, India

Sector / Industry: Robotics & Drone Applications



PROJECT TITLE

India-Designed Energy & Motion Control Solutions for Robotics and Drones



BACKGROUND & CHALLENGE

India's robotics and drone industry has long depended on imported energy and motion control systems – battery packs, Battery Management Systems (BMS), and motor controllers sourced predominantly from China and Europe.

This creates supply chain vulnerabilities, long lead times, limited customisation, and high costs for Indian OEMs building next-generation autonomous platforms.

SOLUTION OVERVIEW

1. iNYX Battery Packs

IN MARKET

High-performance LFP and NMC battery packs with Smart BMS designed entirely in India. Cells from Grade-A global suppliers. Deployed across 6 OEM platforms with 20-30% uptime improvement.

2. iNYX FOC Motor Controller & Full Actuator

UNDER DEVELOPMENT

Lithion Power is developing a Field-Oriented Control (FOC) motor controller for robotic joints – governing torque, speed, and position. Hardware and firmware are entirely India-designed.

The full actuator programme (controller + motor + encoder + housing) is on the roadmap, targeting a complete India-designed actuation module for robot OEMs.

OUTCOMES & IMPACT

- 6 Indian drone & robotics OEM platforms powered by iNYX batteries
- 20-30% uptime improvement through intelligent BMS fault management
- Reduced import dependency on the highest IP-value battery component

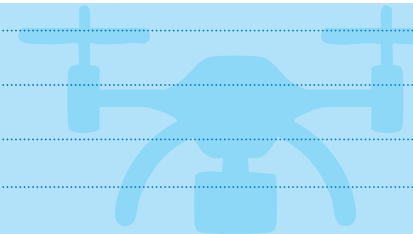
UNIQUE CHARACTERISTICS

- Robotics and drone platforms demand higher discharge rates, vibration tolerance, and compact form – fundamentally different from EV battery design.
- Developing the FOC controller in-house confirmed that motion intelligence is as critical as energy, and equally absent from India's robotics supply chain.
- Indigenising the highest IP-value components (BMS, FOC controller) while globally sourcing commodities (cells, motors) is the optimal model for Indian deeptech.

Case Study 12: L&T Technology Services Limited (LTTS)

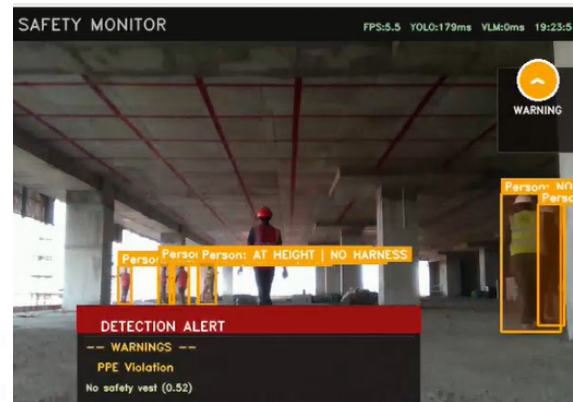
ORGANIZATION DETAILS

Organization Name:	L&T Technology Services Limited (LTTS)
Website:	https://www.ltts.com/
Headquarters:	Vadodara, _Gujarat, India
Sector / Industry:	ER&D



PROJECT TITLE

Autonomous Quadruped Robotics for Safety and Progress Intelligence on Active Construction Sites



Quadruped robot deployed on an active construction site, powered by LTTS-developed perception and navigation software stack on the Unitree G02W robotic platform

PROJECT DETAILS

Active construction sites present persistent safety, visibility, and productivity challenges due to constant movement of heavy equipment, evolving layouts, uneven terrain, and restricted access zones. Traditional manual inspections expose personnel to operational risks, limit inspection frequency, and provide only fragmented, point-in-time visibility into site conditions. LTTS addressed this challenge by deploying a hybrid wheeled-quadruped robotic system engineered for autonomous navigation and sensing in live construction environments.

The solution enables remote and autonomous site inspections, safety monitoring, and visual data capture without disrupting ongoing work. Deployed on active construction sites, the system improves safety by minimizing human exposure to hazardous zones while enabling more frequent, consistent inspections and enhanced site visibility. The solution is currently deployed and demonstrates strong potential for scalable adoption across construction and infrastructure projects.

BACKGROUND & CHALLENGE

Construction sites are dynamic, safety-critical environments characterized by constant equipment movement, evolving layouts, and constrained human access. Traditionally, site inspections, safety audits, and progress assessments relied on manual walkthroughs conducted by engineers and supervisors. These activities exposed personnel to operational hazards, limited inspection frequency, and resulted in fragmented, point-in-time visibility into site conditions.

Fixed monitoring solutions such as static cameras were ineffective due to frequent layout changes, obstructions, elevation differences, and blind spots. As projects scaled in size and complexity, the need for continuous, reliable, and non-intrusive site monitoring became critical. The core challenge was to enable consistent, real-time inspection and progress intelligence while minimizing human exposure, avoiding operational disruption, and ensuring reliable performance across mixed terrain and constrained spaces.

SOLUTION OVERVIEW

LTTs developed the perception and navigation stack for a hybrid wheeled-quadruped robotic system deployed in live construction environments. The solution is implemented on the commercially available Unitree G02W robotic platform, selected for its robust hybrid mobility suited to uneven terrain, ramps, obstacles, and confined spaces typically found on active construction sites. This hybrid architecture, powered by LTTs’s algorithms, ensures endurance and adaptability, enabling reliable operation across continuously changing site conditions.

The robot is equipped with vision and depth sensors, onboard compute, and autonomous navigation software to conduct routine site inspections, safety monitoring,

and visual documentation without disrupting ongoing construction activities. It supports both predefined autonomous patrols and remote supervision, enabling repeatable inspections and consistent data capture.

LTTs’ differentiation lies in its system-level engineering approach. Beyond mobility, the solution integrates perception intelligence, multi-sensor data fusion, and scalable, hardware-agnostic software architectures that can be deployed across different robotic platforms. This enables enterprises to standardize inspection workflows, enhance situational awareness, and reduce human exposure to hazardous zones, positioning the solution as a scalable construction site intelligence capability rather than a single-purpose robotic deployment.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Manual, scheduled inspections with limited reach	Frequent, autonomous patrols enabling broader site coverage	30-40% ↑
Cost Reduction	High manpower dependency for routine checks	Reduced human effort for repetitive inspections	20-25% ↓
Quality	Inconsistent observations and manual reporting	Standardized visual records and repeatable inspections	35-45% ↑
Downtime	Delays due to access restrictions	Continuous inspections without disrupting site operations	25-30% ↓
Safety	Exposure of personnel to hazardous zones	Reduced human presence in high-risk areas	40-50% ↑

UNIQUE CHARACTERISTICS

- Hybrid wheeled-quadruped mobility designed for mixed-terrain construction environments
- Perception intelligence with multi-sensor data fusion enabling consistent inspection outcomes
- Hardware-agnostic, scalable software architecture supporting multiple robotic platforms
- System-level engineering integrating robotics, autonomy, and inspection workflows
- Designed for safe operation on live construction sites without operational disruption

Case Study 13: Vortex Engineering Works India Pvt. Ltd.

ORGANIZATION DETAILS

Organization Name:	Vortex Engineering Works India Pvt. Ltd.
Website:	www.vortex-clutch.com
Headquarters:	Dombivli, Maharashtra, India Point of Contact (Name, Designation): Mr. Ashok Bhat, Marketing Head Email & Phone: ashoksb@vortex-clutch.com, 9820 495 591
Sector / Industry:	Industrial Machinery/Medical applications

PROJECT TITLE

Enhancing Precision and Safety in Surgical Robots using Permanent Magnet Braking Systems



PROJECT DETAILS

The increasing adoption of surgical robotic systems demands highly precise, reliable, and fail-safe motion control mechanisms. Permanent magnet brakes were deployed within robotic arm joints to provide instant holding torque and fail-safe operation. The solution

was implemented in advanced surgical robotic systems where precision and safety are critical. The key outcome was improved positional accuracy, enhanced patient safety during power interruptions, and reduced system complexity. Current Status: Deployed, Commercial Scale

BACKGROUND & CHALLENGE

Surgical robotic systems operate in highly sensitive environments where precision, stability, and safety are critical. Conventional electromagnetic braking systems require continuous power to maintain holding force,

posing risks during power failure. Space constraints within robotic joints demand compact solutions. The challenge was to ensure zero positional drift and reliable holding without energy consumption, while maintaining compactness and reliability.

SOLUTION OVERVIEW

The solution involved integration of permanent magnet brakes into robotic joints. These brakes provide holding torque using magnetic force without continuous power. When powered, the brake disengages; when power is

lost, it automatically engages. Key components include magnet assembly, armature plate, friction disc, and release coil. This results in fail-safe operation, high precision, compact integration, and low maintenance.

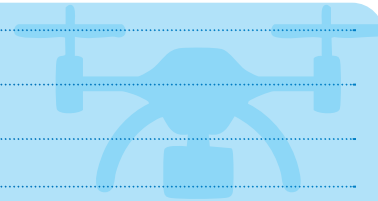
UNIQUE CHARACTERISTICS

- Fail-safe operation during power loss
- Zero power consumption in holding state
- Compact and high torque density design
- High precision with minimal drift
- Low maintenance and long life

Case Study 14: Sirona Robotics

ORGANIZATION DETAILS

Organization Name:	Sirona Robotics
Website:	www.sironarobotics.com
Headquarters:	Singapore



THE CHALLENGE

Blue-collar service roles are structurally under-resourced across every developed economy – and robotics is widely seen as the solution. Yet robots remain difficult to deploy at enterprise scale. The problem is not hardware availability. The problem is integration.

Large enterprises – hospitals, hotel groups, manufacturing plants, chemical processing facilities – operate complex, interconnected systems: ERP, BMS, asset tracking, LIMS, EMR, and more. Robots arrive as point solutions. They cannot read SOPs. They cannot

connect to existing workflows. They cannot generate compliance-grade audit trails. And they cannot be trained on the proprietary operational data that would make them genuinely useful in a specific environment.

The result: Robots that underperform, deployments that fail to scale, and enterprises that revert to manual labour – not because the hardware was wrong, but because the enterprise integration layer did not exist.

THE SOLUTION

Sirona Robotics is building the enterprise middleware layer for robotics deployment. We are hardware-agnostic.

We sit above the robot, connecting it to the enterprise – and making it genuinely operational.

01 VLA MODEL TRAINING

Proprietary Visual-Language-Action models trained on blue-collar physical task data – enabling robots to understand unstructured environments, follow verbal instructions, and execute real-world tasks without hand-coded rules.

Custom datasets built from each deployment environment

02 ENTERPRISE INTEGRATION

Native connectors to ERP, BMS, asset tracking, LIMS, EMR, and other operational systems. SOPs are automatically converted into robot task instructions. No rip-and-replace. Sirona plugs into existing infrastructure.

Hardware-agnostic: works with any robot platform

03 ROBOT-AS-A-SERVICE

Enterprises pay a monthly subscription – no capital expenditure, no maintenance burden, no hardware lock-in. As hardware improves, the fleet upgrades without changing the integration layer or retraining staff.

Sirona owns the hardware; the enterprise owns the outcome

04 PERSON-IN-LOOP (PIL)

Every deployment is governed by a Human-in-Loop framework. Robots operate within authorised parameters only. Staff override, redirect, or halt at any time. Full audit trail maintained for compliance and governance.

Designed for JCI, ISO 17025, GMP, and similar frameworks

LIVE DEPLOYMENTS

HOSPITALITY – Luxury Hotel Group, UAE

Co-Pilot deployed for housekeeping augmentation – linen transport, trolley movement, and supply restocking across guest floors. Sirona integrated with the property management system, converting housekeeping schedules into robot task instructions automatically. Staff direct; the robot executes. Full audit log maintained per shift.

MANUFACTURING – Chemical Processing Plant, UAE

Co-Pilot deployed for QC lab automation – sample handling, trolley logistics, and consumables restocking within a GMP-regulated environment. Sirona integrated with LIMS and SAP, generating a compliance-grade audit trail aligned to ISO 17025 and REACH frameworks. Zero autonomous action – every task is human-authorised.

KEY DIFFERENTIATORS & LEARNINGS

Robots fail at the integration layer, not the hardware layer. Enterprises consistently report the same failure modes: robots that cannot read existing SOPs, cannot connect to operational systems, and cannot generate compliance documentation. Sirona's middleware-first approach addresses the root cause. This is why the model is replicable across hospitality, manufacturing, and healthcare: the compliance demands, system complexity, and human-oversight requirements are structurally identical across all three.

- Hardware-agnostic: works with any robot platform – no vendor lock-in
- Proprietary data flywheel: each deployment generates training data that improves performance across the entire fleet
- Compliance-grade audit trail: designed for ISO, GMP, JCI, and equivalent frameworks from day one
- Zero-capex RaaS model: removes capital risk – the single largest barrier to enterprise robot adoption

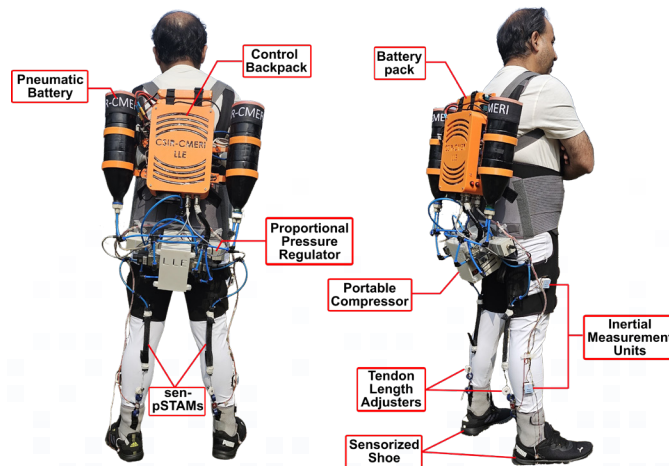
Case Study 15: CSIR-Central Mechanical Engineering Research Institute

ORGANIZATION DETAILS

Organization Name:	CSIR-Central Mechanical Engineering Research Institute
Website:	www.cmeri.res.in
Headquarters:	Durgapur, West Bengal, India
Sector / Industry:	Advanced Manufacturing & Robotics

PROJECT TITLE

A Smart Soft Exosuit (softEXOwalk) for Walking Assistance using Low-Pressure Artificial Muscle Actuation and Rapid Personalization



Wearable soft lower-limb exosuit (SoftEXOwalk) showing front and rear views with key system components

PROJECT DETAILS

Rigid exosuits for lower-limb assistance often suffer from limitations such as restricted mobility, poor compliance with natural human motion, and lack of adaptability across users and tasks.

This work addresses these challenges through the development of a soft, wearable exosuit that employs biologically inspired artificial muscle actuation to enable safe, compliant, and lightweight assistance. The system integrates sensorized actuators and a rapid human-in-the-loop personalization approach, allowing user-specific adaptation without reliance on complex external instrumentation.

Designed as a fully wearable solution, it is intended for assisting lower-limb joints, particularly knee flexion, during level-ground walking. The exosuit also incorporates wearer intention identification for adaptive assistance across varying conditions.

Overall, the work demonstrates the development of a smart, wearable soft exosuit platform combining actuation, sensing, and control in an integrated framework for real-world assistive applications.

The technology is currently at the pilot stage, with strong potential for further deployment and translation.

BACKGROUND & CHALLENGE

With growing demand for mobility assistance in healthcare, industry, and ageing populations, wearable robotic systems are emerging as a key enabling technology. However, conventional rigid exoskeletons remain limited by their bulky structure, restricted mobility, and poor compatibility with natural human movement, affecting user comfort and large-scale adoption. Soft exosuits offer a more wearable and compliant alternative, but their transition from laboratory prototypes to real-world solutions is constrained by

critical challenges. These include the lack of embedded sensing for reliable force estimation, dependence on external instrumentation, and slow, resource-intensive personalization methods. As a result, existing systems struggle to provide adaptive, user-specific assistance in real-time. Addressing these gaps is essential to develop scalable, deployable soft exosuits that can support everyday mobility and contribute to next-generation assistive and rehabilitation technologies.

SOLUTION OVERVIEW

The proposed solution is a smart, wearable soft lower-limb exosuit designed to assist knee flexion during walking using biologically inspired artificial muscle actuation. The system employs low-pressure pneumatic artificial muscles that mimic natural muscle contraction, enabling lightweight, compliant, and safe interaction with the human body. A key innovation lies in the integration

of inhouse developed sensors with these actuators, which provide intrinsic sensing capability to estimate transmitted forces in real time, eliminating the need for external force sensors and reducing system complexity.

The exosuit is built around a textile-based wearable framework that ensures ergonomic anchoring and effective force transmission without restricting natural

motion. It integrates a compact sensing, actuation, and control architecture with onboard computation, enabling real-time operation in a fully wearable configuration. A rapid human-in-the-loop optimization framework is implemented to personalize assistance based on user-specific gait characteristics, significantly reducing calibration time compared to conventional approaches. Additionally, the system incorporates wearer intention

identification to adapt assistance dynamically across walking conditions.

The uniqueness of the solution lies in combining inhouse developed soft actuation with embedded sensing, and fast personalization into a single integrated platform, enabling practical, scalable deployment of soft exosuits for real-world mobility assistance.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Unassisted walking with higher muscle effort	Assisted walking with reduced muscular demand	~15-20% reduction in targeted muscle activity
Cost Reduction	High cost imported exosuits with limited accessibility	Indigenous, low-pressure soft exosuit with reduced hardware complexity	~30-50% (indicative)
Quality	Walking without assistance or with rigid, restrictive exoskeletons	Natural, compliant walking with soft, body-conforming assistance	High (qualitative improvement)
Downtime	Complex setup, rigid alignment, and longer preparation time	Simplified wearable design with quick setup and minimal adjustment	High (qualitative improvement)
Safety	Rigid systems with discomfort and joint misalignment risks	Soft, compliant, low-pressure wearable system enabling safe, body-conforming human-robot interaction	High (qualitative improvement)

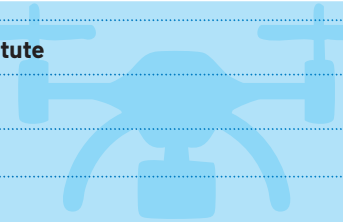
UNIQUE CHARACTERISTICS

- **Soft lower-limb exosuit with muscle-like actuation:** Delivers compliant, body-conforming assistance using low-pressure artificial muscles that mimic biological function.
- **Built-in sensing within soft actuators:** Eliminates external force sensors by enabling real-time force estimation directly from sensorized artificial muscles.
- **Rapid, user-specific personalization:** Achieves fast adaptation through human-in-the-loop optimization, enabling “calibrate-and-go” usability.
- **Fully wearable and untethered system:** Integrates textile design, sensing, computation, and actuation into a compact, real-world deployable platform.
- **Adaptive assistance driven by user intent:** Dynamically adjusts support based on gait and movement, improving effectiveness across walking conditions.

Case Study 16: CSIR-Central Mechanical Engineering Research Institute

ORGANIZATION DETAILS

Organization Name:	CSIR Central Mechanical Engineering Research Institute
Website:	https://www.cmeri.res.in
Headquarters:	Durgapur, West Bengal, INDIA
Sector / Industry:	Strategic and Robotics and Automation Industry



PROJECT TITLE

TenDroneArm: a lightweight tendon driven arm with joint compliance designed for multi-copters/ drones to attain enhanced attitude stability during arm movement and physical interactions.



Predator bird inspired compliantly actuated tendon-driven lightweight Arm for multicopters/ drones attaining enhanced attitude stability during arm movement while flying and during physical interactions with environment

PROJECT DETAILS

Problem Addressed:

(i) Inherent attitude destabilization effect of moving mechanical arms on hovering drones/ multicopters. (ii) Occurrence of instabilities during physical interactions with the environment while handling objects by the drones. (iii) The dynamic effect of share of moving inertia of the arm and maintaining its lightweight design.

Solution Deployed:

A manipulator, inspired by the design of a predatory bird - (i) Attaining inherently better attitude stability by design: reduction of the net angular momentum (thereby, internal reaction moments) due to internal rotations of the involved components (through a novel joint design and placement of prime movers), and implementation of an active centre-of-gravity control. (ii) Employment of Series-Elastic-Actuation and positive tendon drives. (iii)

Base actuation through incorporation of positive tendon drives with decoupled tendon routing over a novel rolling type joint; provision of a clawed gripper with invariant downward orientation through passive means.

Key Outcome:

The manipulator is designed and developed for an 8 to 10kg payload Hex-copter drone to handle objects of weight up to 1kg for sample collection in municipal solid waste management. The R&D is carried out under a CSIR multi-institute Mission Mode network project on application of drone related technologies for municipal solid waste (MSW) management.

Current Status:

✓ Pilot

BACKGROUND & CHALLENGE

Drones with moving mechanical appendages (e.g. manipulators) offer enabling technology for many applications including material handling and retrieval in hazardous and inaccessible areas, food/medicine delivery during disaster management, MSW management etc. Moving arm/ manipulator due to its dynamic effects invariably affects the attitude stability of the drone, resulting into large control effort by the drone thrusters and many-a-times causing a failure in stabilization, leading to crash. Disturbance in the attitude of the hovering drone is mainly caused by (i) internal reaction moments of spinning/ rotating components of the

manipulator, (ii) shifting of the centre of gravity of the system and (iii) interactive forces during object handling. Choosing any off-the-shelf manipulator arm would not address the above mentioned issues. Such a manipulator needs to be carefully designed addressing the stability issues and lightweighting. Challenges include (a) reduction of the internal reaction forces/moments during manipulator movement, (b) attenuation of the contact forces during physical interactions at the end-effector, (c) restricting the movement of the centre-of-gravity, ensuring attitude stability against tilting during the arm motion, and (d) overall lightweighting of the system.

SOLUTION OVERVIEW

The present design of the TenDroneArm is inspired by the leg of a predatory bird featuring long and lightweight but strong links, tendon-drives, variable compliance at task-space and a claw, maintaining a constant downward orientation. The system has a two degrees-of-freedom arm moving in a vertical plane, a one-DoF centre-of-gravity control mechanism and one actuated gripper. The design attempts to reduce the internal reaction moments by lowering the net angular momentum of the spinning rotors of the motors by their placements and the contribution of the other rotating elements by design. The scheme incorporates base actuation, so that the major mass gets lumped at the base, resulting into reduced moving manipulator inertia. A unique Rolling type joint (named as Rollarticular joint) is developed and incorporated in order to decouple the tendon routing with reduced tendon control complexities. Additionally, a

centre-of-gravity control mechanism, ensures minimum tilt of the drone during arm movement with payloads. A passive (actuator-less) mechanism is synthesized to maintain a constant downward orientation of the claws of the gripper. However, one motor drives a quick latching/ jaw-closing and slow opening gripper operation with a simple constant velocity regulation control.

The Series-Elastic-Actuation along with the tendon provides effective compliance at the end-effector. The manipulator exhibits low stiffness at folded configuration and high stiffness at nearly stretched configuration. Physical interactions mostly occur during folded configuration - the high compliance attenuates the impacts during physical interactions and reduces the transmitted disturbance.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Off-the-shelf procured manipulator results into undesirable internal reaction moments and associates with movement of location of CG, causing potential significant disturbance to attitude stability of drones during fly. The drone controllers need to apply large effort to counter/ nullify the disturbance. Also, rigidly actuated arms are invariably associated with destabilizing interaction forces during physical interaction with environment by the manipulator arm.	The present design addresses these issues to enhance attitude stability during motion of the arm through reduction of internal reaction moments, along with a CG control mechanism and lowering the share of moving inertia. The present design offers better response to physically interactive forces through series-elastic-actuation and tendon drive, in turn, variability in task space stiffness at the end-effector.	Significant improvement is expected, however, any quantification is yet to be established in absence of benchmarking criteria.
Cost Reduction	Arms are mostly imported with high customization cost. Arms are generally not specifically designed for drone applications.	Indigenously designed and developed for multicopter/ drone applications for intended payload; reduced controller complexity due to passive mechanism and simpler operation.	Yet to be quantified - requires further techno-commercial analysis

Parameter	Before	After	% Improvement
Quality	Large control effort affecting battery endurance	Enhanced usability with new features, lesser control effort leading to enhancement of battery endurance	Significant
Downtime	(NA)	(NA)	(NA)
Safety	Difficult to attain attitude stability while using conventional/ off-the-shelf manipulator arms.		
	Potentially unsafe for the drones, causing instability, and many-a-times crash.	Improved attitude stability and contact behavior during physical interaction through mechanical design ensuring safety of the drones against potential crash.	Noteworthy, but not quantifiable at present

UNIQUE CHARACTERISTICS

- Base actuation and decoupled tendon routing for low complexity control.
- Novel rolling type joint enables the decoupling of routing of tendons and low friction and allows large joint range.
- Enhanced attitude stability of drone against motion of the mechanical manipulator; eventually reduces the load on the drone controller and thereby improves battery endurance.
- Provision of series-elastic-actuation results into variation of configuration dependent task-space compliance at the end-effector that helps in containing contact force disturbances at the end-effector during physical interactions.

Case Study 17: Zetta WATT Private Limited

ORGANIZATION DETAILS

Organization Name: Zetta WATT Private Limited

Headquarters: Bangalore, India

Sector / Industry: Electric Motor Manufacturing



PROJECT TITLE

Transforming EV Motor Manufacturing through Advanced Motor Winding Automation



Automated Mid-Drive Motor Winding Machine enabling high-speed, precision stator winding with reduced manpower, improved quality, and optimized material usage.

PROJECT DETAILS

Problem Addressed:

Traditional manual winding processes in motor manufacturing were labour-intensive, inconsistent, and difficult to scale with rising EV demand.

Solution Deployed:

Zetta WATT, a motor winding machine manufacturer, developed an Automated Mid-Drive Motor Winding Machine to enable high-speed, precise, and repeatable stator winding.

Where Implemented:

EV motor manufacturing facilities (India & export markets).

Key Outcome:

90% manpower reduction, 92% cycle time reduction, and significant cost and material savings.

Current Status:

✓ Commercial Scale ✓ Export-ready

BACKGROUND & CHALLENGE

With the rapid expansion of the electric vehicle (EV) ecosystem, motor manufacturers are under pressure to scale production while maintaining high precision and efficiency. However, stator winding – a critical process in motor manufacturing – has traditionally been manual, requiring significant labour, time, and skill.

As motor winding machine manufacturers, we observed that customers were struggling with long cycle times, inconsistent quality, high manpower dependency, and

inefficient material utilization. In the baseline scenario, each component required approximately 1.6 hours of manual effort involving 20 operators, leading to high operational costs and limited scalability.

These challenges created bottlenecks in production and prevented manufacturers from meeting global benchmarks in productivity, quality, and cost competitiveness.

SOLUTION OVERVIEW

Zetta WATT, as a specialized motor winding machine manufacturer, developed an advanced Mid-Drive Motor Winding Machine to automate and optimize the stator winding process for EV motors.

The machine integrates precision-controlled winding systems, automated wire handling, and intelligent process control to deliver consistent and repeatable

results. It reduces cycle time drastically to 8 minutes per component, enabling high-throughput manufacturing with minimal human intervention.

The system requires only 1 operator, significantly reducing labour dependency while improving operational efficiency. Advanced engineering ensures optimized copper usage, reducing wastage and improving cost-effectiveness.

Key features include:

- Precision winding head with controlled tension system
- Advanced clamping mechanism ensuring stability under high load
- Programmable automation for repeatable and scalable production

- Compact design optimizing factory floor utilization

As motor winding machine manufacturers, Zetta WATT delivers scalable, export-ready automation solutions tailored for EV and industrial motor production, enabling manufacturers to achieve global standards.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	96 min/component (manual process)	8 min/component (automated)	↑ 92% faster
Cost & Cost Reduction	₹60,00,000/year (manpower)	₹6,00,000/year	↓ 90% cost
Quality	Operator-dependent variability	Consistent, precision-controlled	↑ High consistency
Downtime	High (manual dependency, fatigue)	Minimal (automated, stable process)	↓ Significant
Safety	High manual handling & fatigue risk	Reduced operator intervention	↑ Improved safety

UNIQUE CHARACTERISTICS

- Proprietary clamping mechanism enabling high-tension winding stability
- 92% reduction in cycle time with consistent output quality
- Significant copper optimization reducing raw material costs
- Compact machine design saving valuable factory space
- Export-ready automation solution aligned with EV manufacturing needs

Case Study 18: CDSpace Robotics Pvt Ltd

ORGANIZATION DETAILS

Organization Name: CDSpace Robotics Pvt Ltd

Website: www.cdspace.in

Headquarters: Bangalore, Karnataka India

Sector / Industry: Drones



PROJECT TITLE

SPOT v3 Tactical VTOL Drone for Long Range Surveillance and Strike
Application: Drone for Armed forces



SPOT v3 Tactical Droane

PROJECT DETAILS

Problem Addressed:

Long Endurance Tactical VTOL Drone for Surveillance and Strike Solution Deployed: Under Trials

Where Implemented:

Under trials with Armed Forces

Key Outcome:

Solution for Armed Forces strategic requirements with Indian IPR

Current Status:

✓ Pilot

BACKGROUND & CHALLENGE

Mention baseline situation.

Key IPR is not available with Indian Drone OEM for strategic drones falling in endurance more than 3 hours and range beyond 25km.

SOLUTION OVERVIEW

We have developed a tactical VTOL (Vertical Take off and Landing) Drone which can fly for 6 hours and range beyond 100km. We have total IPR control and no china

dependency for the supply chain. It serves strategic requirements by the Armed forces for surveillance and strike application.

UNIQUE CHARACTERISTICS

- Long Range application with Surveillance and strike capabilities
- Indigenously designed and developed with good IPR control
- No china dependency for supply chain

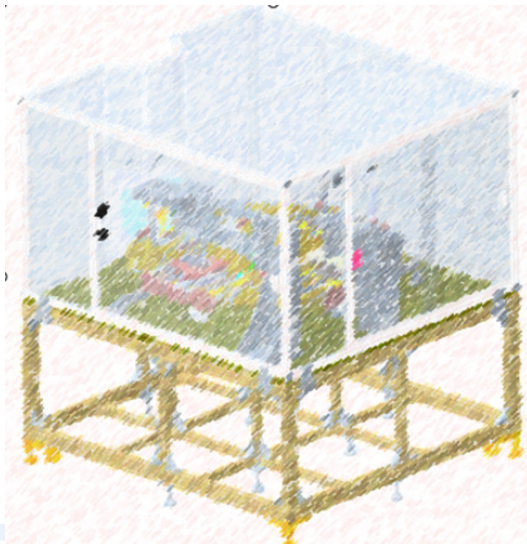
Case Study 19: Merritt Innovative Solutions India Pvt. Ltd.

ORGANIZATION DETAILS

Organization Name:	Merritt Innovative Solutions India Pvt. Ltd.
Website:	www.merritt.in
Headquarters:	Bengaluru, Karnataka, India
Sector / Industry:	Industrial, Transportation, Consumer goods, IoT & manufacturing

PROJECT TITLE

Designing of Automated assembly station for automotive cubby box



Designing of Automated assembly Station for assembly of cubby box.

Image is blurred to safeguard the IP rights

PROJECT DETAILS

Problem Addressed:

Automating the assembly of cubby box with tambour door, with consistent quality and production volume

Solution Deployed:

- Design & detailed engineering of assembly station
- Development & testing of assembly station
- Development electrical & PLC based control system
- Identifying the sources & selection of major components
- Indexing Table
- Hot riveting
- Vision Inspection system

Where Implemented:

Product assembly line of tire-1 supplier of the automotive OEM

Key Outcome:

- The cubby box and tambour door assembly was completely automated with no manual intervention, except for loading and unloading
- High quality was ensured through incorporation of vision inspection system
- The high gloss finish of the tambour door was maintained
- The productivity of one assembly every minute was achieved
- The solution was delivered at 55% the cost of in-house development

BACKGROUND & CHALLENGE

Cubby box door assemblies are widely used in luxury vehicles across Europe, where careful component handling and protection of Class A surfaces are critical. In addition to maintaining high aesthetic quality, it is essential to achieve consistent daily production volumes without compromising surface integrity.

Challenges addressed:

- Preventing contact between the glossy tambour door surface and metallic parts to avoid scratches or damage
- Ensuring reliable and precise hot riveting during assembly to maintain structural integrity and product quality

SOLUTION OVERVIEW

The developed system integrates multiple automated operations to ensure efficient and high-quality assembly of cubby box door units. It performs sequential tasks including sprue cutting, precise joining of the two door halves, and hot riveting to achieve robust structural integrity. A vision-based inspection system is incorporated to verify assembly accuracy and detect any surface defects or damages, ensuring that Class A surfaces remain uncompromised.

All processes are organized into dedicated stations arranged along an indexing bed, with specialized

fixtures positioned at each stage to maintain alignment, repeatability, and cycle time consistency. This modular station-based approach enables smooth workflow and scalability for production demands.

To enhance operator safety and maintain product quality, the entire system is enclosed within a dust-proof and safety-compliant structure. Interlocks are implemented to prevent unauthorized access during operation, minimizing risk while ensuring controlled working conditions. Overall, the solution delivers a reliable, efficient, and quality-focused manufacturing process.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	32 to 35 per shift	96 to 100 per shift	3x
Cost Reduction	INA	INA	55% savings in R&D cost
Quality	80%	96%	83%
Downtime	15 min process time	–	<5 Min process time
Safety	INA	100%	100%

UNIQUE CHARACTERISTICS

- Designing innovative solutions for the preparation and assembly of the cubby box on a single rotary workbench
- Load-balanced and foolproof mechanisms to ensure the protection of the aesthetic surfaces of the parts
- An innovative hot riveting process that protects surrounding features

Case Study 20: SCANXT Scientific Technologies Pvt Ltd

ORGANIZATION DETAILS

Organization Name: SCANXT Scientific Technologies Pvt Ltd

Website: <https://scanxt.com/>

Headquarters: Noida, U.P, India

Sector / Industry: Agri-Tech



PROJECT TITLE

Bhu-Parikshak Soil Testing Machine | Detect - Pest Detection System



Bhu-Parikshak Device



Detect(Pest detection system)

PROJECT DETAILS

Problem Addressed:

Inefficient uniform farming and poor field-level variability assessment

Solution Deployed:

Integrated drone, rover-based soil testing, and AI pest detection system

Where Implemented:

Precision agriculture pilot fields and experimental farm environments

Key Outcome:

Improved decision accuracy, reduced input waste, and enhanced crop productivity

Current Status: ✓ Deployed

BACKGROUND & CHALLENGE

Modern agriculture still relies heavily on uniform application of inputs across entire fields, without fully accounting for variations in soil health, crop condition, and pest distribution. This practice often results in inefficient use of fertilizers and pesticides, higher production costs, and long-term degradation of soil quality and environmental balance. At the same time, farmers face difficulties in detecting crop stress, nutrient deficiencies, and pest attacks at an early stage due to limited access to precise, real-time field data.

Another major challenge lies in traditional soil testing methods, which typically depend on single-point sampling and fail to represent the true variability within a field, leading to less reliable decisions. In addition, the use of separate and unconnected technologies—such as drones for aerial monitoring, manual soil testing tools, and standalone pest detection systems—limits the overall effectiveness of precision agriculture. These gaps clearly indicate the need for a unified smart farming solution that integrates drone-based imaging, rover-enabled multi-point soil sampling using robotic arms, and AI-based pest detection to support more accurate, efficient, and sustainable farm management.

SOLUTION OVERVIEW

The proposed solution is an integrated smart agriculture system that combines drone-based aerial intelligence with rover-based ground-level sensing and AI-driven analytics to enable precise, data-informed farming decisions. A multispectral drone is used to monitor crop health, identify stress zones, and perform targeted spot spraying, ensuring efficient and localized application of agrochemicals. Complementing this, a robotic rover equipped with a robotic arm is deployed for automated soil sampling across multiple locations within the field. This enables collection of geo-referenced samples, which are analyzed using onboard soil testing instruments to accurately assess variability in key parameters such as pH and electrical conductivity.

In addition, an AI-based pest detection system is incorporated to identify the type and severity of insect attacks on crops, supporting timely and appropriate intervention. By integrating aerial imaging, robotic soil sampling, and intelligent pest analysis into a unified platform, the system bridges the gap between ground and aerial data. This holistic approach enhances decision accuracy, reduces dependency on manual processes, minimizes resource wastage, and supports scalable precision agriculture. The solution ultimately enables farmers to optimize inputs, improve crop health, and adopt more sustainable and efficient farming practices.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Baseline yield variability	Optimized yield via precision input	20-35%
Cost Reduction	High input + labor cost	Reduced chemical + automation cost	30-60%
Quality	Inconsistent crop output	Uniform improved crop quality	15-30%
Downtime	Slow manual analysis	Real-time automated insights	25-50%
Safety	High chemical exposure risk	Minimal human exposure	70-90%

UNIQUE CHARACTERISTICS

ScaNxt Bhu-Parikshak (Soil Testing Device)

- Chemical-free soil analysis using NIR spectroscopy, eliminating lab dependency and recurring consumable costs
- Rapid, on-field testing delivering multi-parameter soil health insights within minutes
- AI-driven prediction models converting spectral data into accurate nutrient estimations
- Portable and user-friendly design enabling use by farmers and field agents without technical expertise
- Seamless mobile integration for instant report generation, storage, and accessibility

ScaNxt Detect (Pest Detection System)

- Fully automated, solar-powered system for continuous, unattended field deployment
- Real-time pest identification using ML-based image recognition, including species and life stage detection
- Integrated ETL (Economic Threshold Level) estimation enabling precise and timely intervention decisions
- Scientific pest attraction mechanisms ensuring higher detection accuracy and consistency
- End-to-end IoT pipeline (device → cloud → mobile app) delivering actionable insights and recommendations

Case Study 21: xTerra Robotics Pvt Ltd

ORGANIZATION DETAILS

Organization Name:	xTerra Robotics Pvt Ltd
Website:	https://xterrarobotics.com
Headquarters:	Kanpur, Uttar Pradesh, India (incubated at IIT Kanpur)
Sector / Industry:	Industrial Automation, Nuclear, Automotive, Pharma, Aerospace & Space, Construction, Academic Research

PROJECT TITLE

Svan M2 Quadruped Robot: Autonomous Inspection & Surveillance for Dull, Dirty, and Dangerous Industrial Environments



Svan M2 performing autonomous visual inspection of analog gauges in an industrial facility.

PROJECT DETAILS

Problem Addressed:

Industrial facilities such as nuclear plants, automotive production lines, pharmaceutical factories, and construction sites require continuous inspection of equipment and structural assets in hazardous, confined, or poorly lit environments. Human entry into these zones is dangerous, expensive, and operationally disruptive. Conventional wheeled robots and drones are unable to effectively navigate stairs, confined spaces, or unstructured industrial terrain.

Solution Deployed:

Svan M2, a compact quadruped robot powered by Orion AI V2.0, featuring autonomous blind stair climbing, night

vision, obstacle avoidance, 5 kg payload, and a full-stack AI software layer (computer vision, LLMs, RL). Entirely designed and manufactured in India.

Where Implemented:

BARC (nuclear), TATA Motors (automotive), ACG World (pharma), Siemens Energy (energy), L&T Technology Services (construction), ISRO (space R&D).

Key Outcome:

Eliminated human entry into hazardous zones, enabled 24/7 autonomous inspection, reduced inspection downtime, and delivered actionable digital insights across asset-heavy industries.

BACKGROUND & CHALLENGE

India's critical industrial sectors, including nuclear energy, automotive manufacturing, pharmaceutical production, and large-scale construction, demand continuous inspection of equipment, gauges, pipes, and structural assets. Traditionally, this requires human workers to enter confined spaces, radiation-sensitive zones, and poorly lit or structurally complex environments, exposing them to significant safety risks and increasing operational costs.

Conventional wheeled robots cannot navigate stairs or uneven industrial terrain, while drone-based inspection

lacks the payload capacity and proximity required for close-range sensing. Imported legged robot platforms are expensive, difficult to customize, and dependent on foreign supply chains, making large-scale industrial deployment in India impractical.

xTerra Robotics identified this gap early and recognized that India needed a fully indigenously developed, compact, agile, and intelligent legged robot, engineered from the ground up for real industrial deployment rather than just laboratory demonstration.

SOLUTION OVERVIEW

The Svan M2 is xTerra Robotics’ flagship quadruped robot platform, engineered as a full-stack industrial inspection and surveillance system. At its core is the Orion AI V2.0 software suite, which enables blind locomotion, allowing the robot to navigate stairs up to 13 cm in step height, slopes up to 22°, and confined spaces using only proprioception and IMU data, without relying on cameras for movement. This capability makes it highly effective in dark, visually degraded, or GPS-denied environments.

Key hardware specifications include a 5 kg payload capacity, an operating speed of 1.0 m/s, one hour of endurance, NVIDIA Jetson onboard compute, built-in 2.4 GHz Wi-Fi, obstacle avoidance, and remote operation

capability. The software layer integrates computer vision, large language models, and reinforcement learning to enable fully autonomous mission execution.

The platform supports exchangeable arms and grippers, enabling manipulation tasks through the SCORP variant, India’s first legged mobile manipulator. A Robot Fleet Control Center allows centralized multi-robot monitoring and mission management. Every component, from the proprietary QDD actuators and robot body to the AI autonomy stack, is designed and manufactured in India, with six patents filed and more than seven additional patents in the pipeline.

OUTCOMES & IMPACT

Parameter	Before	After	% Improvement
Productivity	Scheduled manual inspection rounds, 2-3x per shift; human-limited coverage	Continuous autonomous 24/7 inspection; on-demand mission deployment	~3x increase in inspection frequency
Cost Reduction	High OpEx: human personnel, safety equipment, hazard allowances, access shutdowns	Robot-led inspection with minimal human oversight; no shutdown required	35-40% reduction in inspection OpEx
Quality	Inconsistent, operator-dependent visual checks; no digital records	AI-powered computer vision inspection; timestamped logs and digital twin data	Significant; near-zero missed anomalies vs. manual checks

Parameter	Before	After	% Improvement
Downtime	Planned production halts for safe human inspection access	Inspection during live operations; no shutdown required	~60% reduction in inspection-related downtime
Safety	Human workers exposed to radiation, chemical, confined-space, and fall hazards	Zero human entry into hazardous inspection zones; full remote operation	100% elimination of human exposure during inspection tasks

UNIQUE CHARACTERISTICS

- Full-stack, indigenously built platform, with every layer engineered in India, from proprietary QDD actuators and robot mechanics to the Orion AI V2.0 autonomy software. There is no dependence on foreign components or licensed technology, with six patents filed and more than seven in the pipeline.
- Blind locomotion enabled by Orion AI V2.0 allows the Svan M2 to navigate stairs up to 13 cm, slopes up to 22°, and completely dark, confined spaces using only proprioception and IMU data, without relying on cameras for movement. This serves as a deliberate engineering advantage in visually degraded industrial environments.
- SCORP, India's first legged mobile manipulator, extends the Svan M2 platform by integrating a lightweight robotic arm and interchangeable grippers, enabling physical interaction, sample retrieval, and valve operation in remote or hazardous sites.
- Validated across some of India's most demanding deployments, the system is trusted by organizations such as BARC in the nuclear sector, Tata Motors in automotive manufacturing, ISRO in space research and development, ACG World in pharmaceuticals, Siemens Energy, and L&T Technology Services. It has been deployed across more than 12 customers, including over eight IIT and NIT research institutions.
- The Svan M2 is delivered as a complete system rather than just a standalone robot, comprising the Orion AI autonomy software, a Robot Fleet Control Centre for centralized multi-robot mission management, and a modular payload system including sensors, cameras, and robotic arms. It is supported by initiatives and institutions such as NVIDIA Inception, IIT Kanpur, NYU Tandon, and Google Cloud for Startups.





Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed Organization, with around 9,700 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 318 national and regional sectoral industry bodies.

For 130 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with the Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialised services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains, including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2025-26, CII has identified "Accelerating Competitiveness: Globalisation, Inclusivity, Sustainability, Trust" as its theme, prioritising five key pillars. During the year, CII will align its initiatives to drive strategic action aimed at enhancing India's competitiveness by promoting global engagement, inclusive growth, sustainable practices, and a foundation of trust.

With 70 offices, including 12 Centres of Excellence, in India, and 9 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 250 counterpart Organizations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

Confederation of Indian Industry

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