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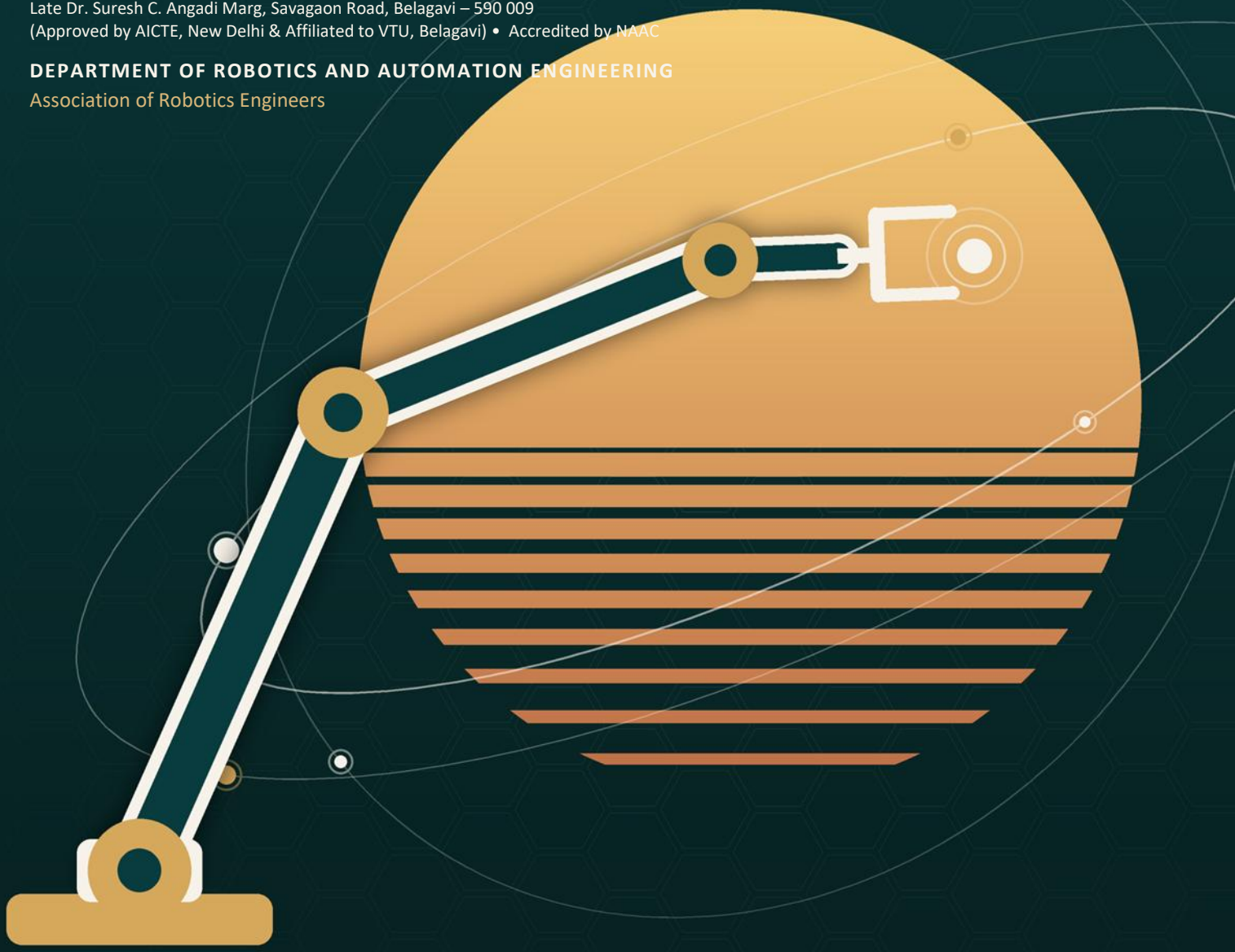
ANGADI INSTITUTE OF TECHNOLOGY AND MANAGEMENT

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DEPARTMENT OF ROBOTICS AND AUTOMATION ENGINEERING

Association of Robotics Engineers



ROBOVERSE

2026 • INAUGURAL EDITION • VOLUME 1, ISSUE 1

Ideas. Intelligence. Innovation.

A Technical Magazine of the Association of Robotics Engineers

ROBOTICS • ARTIFICIAL INTELLIGENCE • AUTOMATION • INDUSTRY 4.0

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Vision and mission

ANGADI INSTITUTE OF TECHNOLOGY AND MANAGEMENT

VISION

To become a premier institute committed to academic excellence and global competence for the holistic development of students.

MISSION

M1 Develop competent human resources, adopt outcome-based education (OBE) and implement cognitive assessment of students.

M2 Inculcate the traits of global competencies (such as domain expertise, accountability, ethics, problem solving ability, communication skills, leadership qualities and life-long learning) amongst the students.

M3 Nurture and train our students to have domain knowledge, develop the qualities of global professionals and to have social consciousness for holistic development.

DEPARTMENT OF ROBOTICS AND AUTOMATION ENGINEERING

VISION

To provide quality education in Robotics and Automation, enabling students to acquire strong technical knowledge, practical skills, and innovative thinking necessary for their overall growth and professional success.

MISSION

M1 Provide quality education in Robotics and Automation with strong domain knowledge and hands-on skills, delivered by qualified faculty in line with the latest technological advancements.

M2 Adopt innovative, student-centered teaching methods to nurture analytical thinking, creativity, and problem-solving abilities.

M3 Create a supportive learning environment that helps students develop professional competence, leadership qualities, ethical values, and a spirit of lifelong learning.

MESSAGES

Message from the Chairman's desk



Hon'ble Smt. Mangal Angadi
Chairman
SAEF & Ex. Member of Parliament

Education is, above all, a commitment to excellence in teaching and learning. At Angadi Institute of Technology and Management (AITM), Belagavi, we work to give students a holistic education that brings together academics, co-curricular activities, sports and life skills. Our aim is to balance modern infrastructure with globally accepted standards, so that innovation and excellence can grow side by side.

We believe AITM is the right place for young minds to explore, grow and realise their potential. We welcome your involvement and support as we help our students become capable professionals and responsible citizens.

It gives me great pleasure to see the Department of Robotics and Automation Engineering launch its first technical magazine, ROBOVERSE. Robotics and automation are changing how the world builds, moves and heals, and a magazine like this gives students a place to follow those changes, test their ideas and put them into words. I congratulate the department and the editorial team on a fine beginning and wish them every success.

Message from the Director's desk



Dr. Spoorti Angadi Patil
Director
Suresh Angadi Education Foundation (SAEF)

At AITM we believe that education goes beyond the classroom. It is about inspiring curiosity, nurturing creativity and helping students learn to think for themselves. "You can teach a student a lesson for a day; but if you can teach him to learn by creating curiosity, he will continue the learning process as long as he lives."

Every robot begins with someone asking "why?" or "what if?". The Department of Robotics and Automation Engineering gives that curiosity a workshop: laboratories to build in, projects to test ideas in, and now a magazine to share them in.

ROBOVERSE is a lively platform for students to explore emerging technologies, express new ideas and share what they have learnt. It reflects the department's commitment to learning, innovation and excellence. I congratulate the department and the editorial team on this commendable effort, and I am confident it will inspire many young minds to explore, invent and excel.

Curiosity, once created, keeps learning alive for a lifetime.

Message from the Administrator's desk



Shri Raju Joshi
Administrator
Suresh Angadi Education Foundation (SAEF)

Educational institutions play a vital part in shaping individuals and in the growth of society. At AITM we see education as a continuous process of building character, confidence and curiosity, not something confined to classrooms. We try to create an environment that inspires students to think critically, act responsibly and pursue excellence in everything they do.

I am delighted that the Department of Robotics and Automation Engineering has brought out its first technical magazine, ROBOVERSE. Building a robot takes mechanical, electronic and software skills working together, and this magazine reflects the same teamwork between our students and faculty. It gives students a wonderful chance to share their ideas, write about their projects and engage with the latest in robotics and automation.

Initiatives like this build teamwork, communication skills and a passion for lifelong learning, which are the qualities that matter most in today's world. I appreciate the efforts of the department and the editorial team in bringing this magazine to life, and I wish them continued success in all their future ventures.

Message from the Principal's desk



Dr. Anand B. Deshpande
Principal & Director
AITM, Belagavi

An institute is judged by its academic atmosphere and by what its students and staff achieve in teaching and learning, research, innovation, placements and results. AITM has long been known for its academic credentials together with the all-round growth of its students.

The new generation of engineers must learn to balance strong technical ability with managerial, communication and interpersonal skills. This matters most in robotics and automation, where a good solution depends on mechanics, electronics, software and people working together.

The institute has reached a series of milestones with the help of bright students, dedicated staff and an encouraging management. In the Department of Robotics and Automation Engineering, students build real machines, and faculty members carry out research that is published in reputed journals. ROBOVERSE adds one more way for that work to be seen. We promise a rich academic experience and excellent facilities, along with professional practice and genuine care for our students.

Message from the HOD's desk



Dr. Pooja V. Angolkar
Professor & HOD
Dept. of Robotics and Automation, AITM, Belagavi

Our department is committed to nurturing innovative minds and preparing students to meet the challenges of the rapidly evolving world of robotics, automation and intelligent systems. With a blend of strong academic foundations, hands-on learning and exposure to the latest technologies, we aim to shape competent engineers who can contribute meaningfully to industry and society.

We emphasise holistic development by combining technical expertise with creativity, teamwork and ethical responsibility. Our dedicated faculty, modern laboratories and industry collaborations give students an environment that encourages research, innovation and entrepreneurship.

ROBOVERSE is our students' window on that work: their projects, their questions and their first attempts to explain what they have learnt. The future belongs to those who can merge imagination with technology, and I welcome you to read, contribute and be part of this journey.

CHIEF EDITOR'S NOTE

Why ROBOVERSE?

A note from the chief editor

Every engineering department has stories worth telling: a robot that finally followed its line, a PLC program that ran at the first attempt, a late-night debugging session that ended with a working gripper. Too often these stories end on a lab shelf or in a phone gallery. ROBOVERSE exists to give them a home.

This first issue is a beginning, not a finished product. We set out to publish what students actually know and do, explained clearly, credited properly and checked for accuracy. Inside you will find features on artificial intelligence in industrial robotics and the factory of the future, a worked guide to robot kinematics, a look at PLCs, sensors and control, digital twins and 3D printing, careers in robotics, and a challenge corner for you to try.

Several pages of this issue, including the student project gallery and the department record, are laid out and waiting for your content. The call for contributions on the last page tells you how to send it.

My thanks to the institute leadership for its support, and to the faculty reviewers and the student team who shaped this issue in a short time.

Dr.Pooja. Angolkar
Chief Editor, ROBOVERSE
Department of Robotics and Automation Engineering

Three principles

Original work first. We would rather publish a modest project that a student built and understood than a polished article copied from elsewhere.

Accuracy and credit. Technical claims are checked, sources are cited and every contributor is named.

An open door. Any student, from any semester, can contribute. Faculty mentors are here to help you improve your writing, not to turn you away.

In this issue

- AI in industrial robotics and the factory of the future
- Forward and inverse kinematics, with a worked example
- PLCs, sensors and control
- Digital twins and 3D printing
- Careers, a quiz and a design challenge

Did you know?

- The word "robot" comes from the Czech *robota*, meaning forced labour.
- A rigid body needs six numbers to fix its position and orientation, which is why general-purpose arms have six joints.
- ISO 10218 is the international safety standard for industrial robots; ISO/TS 15066 covers collaborative robots.

HISTORY

From Unimate to cobots

A short timeline of industrial robots, from a word in a play to machines that work beside people.

1920 — **Karel Čapek's play R.U.R. introduces the word "robot"**
From the Czech robota, meaning forced labour.

1954 — **George Devol files the patent behind the Unimate**
A programmable transfer arm; the patent is granted in 1961.

1961 — **The first Unimate goes to work at a General Motors plant**
It handles hot die-cast parts in New Jersey.

1969 — **Victor Scheinman's Stanford Arm**
An electrically driven, computer-controlled arm.

1973 — **KUKA's Famulus**
The first industrial robot with six electromechanically driven axes.

1978 — **Unimation develops PUMA**
The Programmable Universal Machine for Assembly.

2008 — **Universal Robots introduces the UR5**
An early commercial collaborative robot (cobot).

2011 — **"Industry 4.0" enters the vocabulary**
The term emerges from German industrial strategy.

OUTCOMES

Program outcomes (POs)

What every graduate of the Robotics and Automation Engineering programme should be able to do.

PO1 Engineering Knowledge
Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem Analysis
Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/Development of Solutions
Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and cultural, societal, and environmental considerations.

PO4 Conduct Investigations of Complex Problems
Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO5 Modern Tool Usage
Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 The Engineer and Society
Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO7 Environment and Sustainability
Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of the need for sustainable development.

PO8 Ethics
Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO9 Individual and Team Work
Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication
Communicate effectively on complex engineering activities with the engineering community and society at large, including writing effective reports and design documentation, making effective presentations, and giving and receiving clear instructions.

PO11 Project Management and Finance
Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Lifelong Learning
Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

OUTCOMES

Program specific outcomes

What is specific to a Robotics and Automation Engineering graduate.

PSO1	Apply the knowledge of robotics, artificial intelligence, machine learning, and control systems to design and improve smart machines capable of solving real-world problems.
PSO2	Integrate skills in automation, mechatronics, IoT, CAD/CAM, and renewable energy to develop practical and innovative solutions for industry, research, and entrepreneurial ventures.
PSO3	Develop teamwork, leadership, ethical values, and management abilities to address societal needs and contribute responsibly to the field of robotics and automation.

The department at a glance

Learning by doing

- Workshops on IoT fundamentals and advanced IoT for smart automation
- Technical talks by academicians and industry experts
- Internships and mentorship, including at DRDO Bengaluru
- Industrial visits to Ashok Iron Works, GTTC Belagavi and the VTU Skill Centre
- Laboratories for robotics, automation, IoT, embedded systems, control engineering and manufacturing processes

Innovation and partnerships

- Student team “FireGuard Innovators” selected for the AICTE–Ministry of Education IDE Bootcamp at GITAM University, Bengaluru
- MoUs with WEEFA Robotics, Singapore, and the Singapore University of Technology and Design (SUTD)
- Student association VRUDDHI, which runs technical events, competitions and expert lectures
- Curriculum spanning robotics, AI and ML, IoT, PLC and SCADA, control systems, mechatronics and smart manufacturing

Strengthening Global Academic Partnerships: AITM–Dongguk University, South Korea

As part of the Department of Robotics and Automation Engineering's efforts to strengthen international academic engagement, an initiative was undertaken to establish collaboration between Angadi Institute of Technology and Management (AITM), Belagavi, and Dongguk University, Seoul, South Korea.

The Memorandum of Understanding (MoU) represents an important step towards exploring opportunities for academic interaction, knowledge exchange, collaborative research and engagement in emerging technologies.

This initiative reflects the department's commitment to expanding global academic connections and creating opportunities for students and faculty to engage with the international engineering and research community.

FEATURE

How AI is transforming industrial robotics

Robots that once repeated a fixed path are learning to see, judge and adapt. Here is what that means on the shop floor.

For most of its history the industrial robot has been a superb repeater and a poor improviser. Teach it a path, hold the part in a fixture, and it will repeat the same motion millions of times with sub-millimetre repeatability. Shift the part by a few centimetres, or let a reflective surface confuse a sensor, and the programme fails. Artificial intelligence is changing that equation, not by replacing the robot's precise motion control but by giving it better eyes and better judgement.

From taught points to perceived scenes

Machine vision is where most factories first meet AI. Classical vision relied on hand-tuned thresholds and edge detectors that needed carefully controlled lighting. Deep-learning models, notably convolutional networks and more recently transformer-based vision models, learn to recognise objects from examples. A camera above a bin can now identify and locate randomly oriented parts, and an estimate of each part's position and orientation lets the robot compute a grasp.

The same approach powers visual inspection. A model trained on images of good and defective parts can flag scratches, missing components or weld defects that rule-based systems overlook.

The sense–perceive–decide–act loop

It helps to picture an intelligent robot cell as a loop (Figure 1). Sensors capture the scene; perception turns pixels or point clouds into objects and poses; a planner or a learned policy chooses a grasp and a trajectory; the controller executes it; and monitoring confirms the outcome. AI usually enters at the perception and decision stages. The motion-control and safety layers beneath remain deterministic, and that is by design.

Learning to act

Two ideas dominate current research. **Imitation learning** lets a robot learn from human demonstrations, which is far quicker than writing a programme for every variation. **Reinforcement learning** lets it improve through trial and reward, usually in simulation first.

Because real robots wear out and real mistakes are expensive, engineers train in physics simulators and then transfer the result to hardware, randomising lighting, friction and object shapes during training so the policy copes with the gap between the simulated and the real world. This 'sim-to-real' approach is now a standard part of the toolbox.

FIGURE 1 • THE LOOP OF AN INTELLIGENT ROBOT CELL



Figure 1. *Perception and decision-making are the stages where learning-based methods are used most; execution and safety remain deterministic.*

Beyond the gripper: maintenance and quality

AI is just as valuable away from the arm. Vibration, motor-current and temperature signals from gearboxes and bearings can be analysed for the signature of developing wear, so maintenance is planned instead of suffered. This is **predictive maintenance**, and for many plants it pays back before any vision-guided robot does. In quality control, statistical and machine-learning models relate process parameters to defect rates and suggest corrections in near real time.

Working safely alongside people

Collaborative robots share space with workers. Standards such as ISO 10218 and ISO/TS 15066 describe how this can be done: limiting force and power, monitoring speed and separation, or stopping when a person is detected. AI-based perception can improve a robot's awareness of human presence, but a learned model can fail in unexpected ways, so safety functions are still built from certified, deterministic components. For students the lesson is that *intelligent* does not mean *unchecked*.

> *The intelligence is in the perception and the decision. The precision is still in the control.*

Honest challenges

- **Data.** Models need representative, well-labelled data, and factory conditions drift over time.
- **Explainability.** Engineers must be able to understand why a system rejected a part or chose a grasp.
- **Integration.** Connecting vision, PLCs and robot controllers reliably is as hard as the AI itself.
- **Skills.** Plants need people who understand both the machine and the model.

Try it this semester

- Detect coloured or shaped objects on a table using OpenCV and a webcam.
- Install ROS 2 and simulate a mobile robot or an arm in Gazebo.
- Train a small image classifier on photos of your own lab components and test it under different lighting.
- Log accelerometer data from a motor, then add a deliberate imbalance and look for the change.

INDUSTRY PERSPECTIVE

The factory of the future

Connected machines, flexible cells and people at the centre: what the next generation of manufacturing looks like and what it asks of engineers.

Walk through a modern plant and the difference is less about any single machine than about how the machines talk to each other. **Industry 4.0**, a term that emerged from German industrial strategy in about 2011, describes factories in which physical processes are tied to digital systems: sensors measure, networks connect, software analyses, and decisions flow back to the shop floor. The factory of the future is that idea made ordinary.

Cyber-physical systems and the industrial internet of things

A cyber-physical system couples a machine with computation and communication so that it can report its state and respond to instructions. Add low-cost sensors, standard industrial networks and gateways, and every machine becomes a source of data: spindle load, cycle time, energy use, vibration, temperature. Interoperability standards such as OPC UA, and lightweight messaging protocols such as MQTT, allow equipment from different vendors to share data in a common form.

From the automation pyramid to a connected stack

Traditionally, factory systems were arranged as a pyramid (Figure 2): field devices at the bottom, controllers above them, then supervisory systems (SCADA and HMIs), manufacturing execution systems and finally enterprise software. Information moved upward in slow batches.

The connected factory loosens that rigid hierarchy. Edge computers near the machines process data locally for speed, cloud platforms analyse fleets of machines and share results across sites, and digital twins mirror assets in software. The lower levels still do what they always did, reliably and in real time; what changes is how freely their data can travel.

FIGURE 2 • THE AUTOMATION PYRAMID AND THE CONNECTED STACK

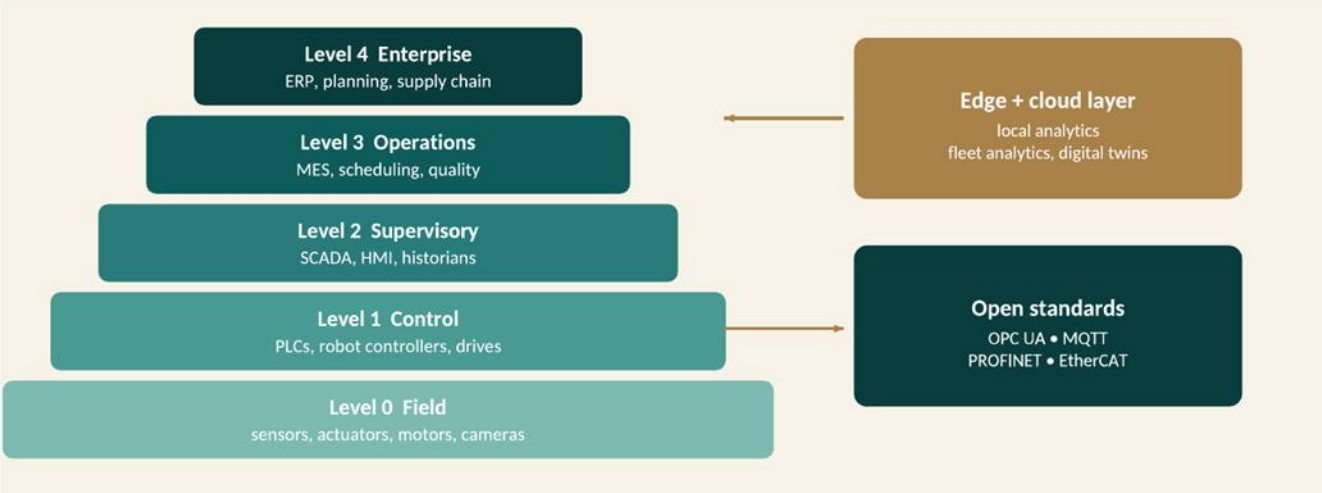


Figure 2. *Real-time control stays at the lower levels; edge and cloud layers add analytics and twins, linked through open standards.*

Flexible cells, mobile robots and mass customisation

Customers increasingly expect variety, and variety breaks lines built for a single product. The response is flexibility: robot cells that can be reprogrammed quickly, modular tooling and **autonomous mobile robots** (AMRs) that carry materials without fixed conveyors. Unlike automated guided vehicles that follow fixed paths, AMRs build maps and navigate around obstacles. With quick-change grippers and vision-guided picking, they let a plant switch between product variants with little downtime.

Human-centred manufacturing

Industry 5.0 names a shift in emphasis: automation should support human skills, sustainability and resilience, not only efficiency. In practice this means collaborative robots that take over heavy and repetitive work, augmented-reality instructions for assembly and maintenance, and dashboards that give operators real information. People move from performing every operation to supervising, improving and solving problems.

> *The factory of the future is not a factory without people. It is a factory that makes better use of them.*

What it means for engineers

- **Fundamentals first:** sensors, actuators, control and kinematics do not go out of date.
- **Comfort with data:** signals, databases and basic machine learning.
- **Networks and security:** connected machines widen the attack surface.
- **Cross-disciplinary communication:** mechanical, electrical, software and operations teams must work as one.

An illustrative day in a smart plant

A hypothetical scenario. At 6:00 the scheduling system releases an order for three bracket variants. Mobile robots deliver the right blanks to a CNC cell, and a vision-guided cobot loads the machine. A sensor notices rising spindle vibration, so maintenance schedules a tool change in the next planned pause rather than after a failure. In-line inspection images reveal a small drift in dimensions, and a quality model recommends an offset before any part is rejected. Each element exists today.

Key terms

AMR: autonomous mobile robot that maps and navigates its own route.

Edge computing: processing data close to the machine instead of in a distant data centre.

MES: manufacturing execution system, which tracks and controls production on the floor.

OPC UA: a vendor-neutral standard for exchanging industrial data.

SCADA: supervisory control and data acquisition, used to monitor and control processes.

STUDENT INNOVATION

Student project gallery

Prototypes, experiments and builds from our labs, explained by the students who made them.

This gallery is the heart of ROBOVERSE. This year it showcases five final-year major projects from the Department of Robotics and Automation Engineering, each with its team, faculty guide, photograph and a short technical explanation.

A good showcase explains the problem, the design choices and what the team learned, including what did not work. Teams are invited to complete the remaining sections.

To complete your entry

- How it works: 250–400 words in total
- At least three photographs or figures
- A caption for every image
- Sources for any borrowed material



Photograph: Agrisaksham Bot

PROJECT 1 • MAJOR PROJECT, B.E. ROBOTICS AND AUTOMATION, 2025–26

Agrisaksham Bot

TEAM

Sanjana R. Desai 2AG22RA007, 7th sem
Shraddha A. Pawar 2AG22RA009, 7th sem
Tejashwini S. Yaragatti 2AG22RA011, 7th sem
Srushti Bellad 2AG23RA412, 7th sem

FACULTY GUIDE

Dr. Pooja Angolkar, Professor and Head, Dept. of Robotics and Automation, AITM

What it does

The Agrisaksham Bot is a voice-controlled agricultural robot designed to help farmers perform farming activities easily. It uses a Raspberry Pi as the main processing unit, along with voice recognition, IoT and robotic components.

How it works

1. Voice command: the farmer gives a voice command in a supported regional language or English, such as sowing, spraying or ploughing.
2. Speech recognition: the Raspberry Pi processes the voice input and identifies the command using speech recognition and natural language understanding.
3. Command processing: the Raspberry Pi interprets the command and sends the required instructions to the robot's control system.
4. Robot movement: the control system operates the motors and other connected components to move the robot and perform the selected task.
5. Agricultural operations: based on the command and the implemented hardware, the robot can support activities such as sowing seeds, spraying crops and ploughing.
6. IoT integration: IoT communication enables remote operation and control, allowing farmers to send commands from different locations, depending on the system's connectivity.
7. Task execution: the robot performs the selected operation with reduced manual effort, helping make agricultural work easier and more efficient.

Results and learning

[Test results, challenges faced and what the team would improve. 250–400 words in total.]



Photograph: Multi-Language Interactive Ticket Dispensing Robot

PROJECT 2 • MAJOR PROJECT, B.E. ROBOTICS AND AUTOMATION, 2025–26

Multi-Language Interactive Ticket Dispensing Robot

TEAM

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Bhavani V. Revankar 2AG23RA401, 7th sem
Shilpa S. Shettar 2AG22RA008, 7th sem
Soumya S. Biradar 2AG22RA010, 7th sem

FACULTY GUIDE

Dr. Pooja Angolkar, Professor and Head, Dept. of Robotics and Automation, AITM

What it does

An interactive robot that dispenses tickets and talks with the user in more than one language, using voice interaction, a display and a ticket printer.

How it works

[Main components, control logic, software and tools used. Add a block diagram if possible.]

Results and learning

[Test results, challenges faced and what the team would improve. 250–400 words in total.]



Photograph: Delivery Robot Using Live Stream

PROJECT 3 • MAJOR PROJECT, B.E. ROBOTICS AND AUTOMATION, 2025–26

Delivery Robot Using Live Stream

TEAM

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Jay Patil 2AG23RA406, 7th sem
Spandan Patil 2AG23RA411, 7th sem
Aadesh Patil 2AG22RA005, 7th sem

FACULTY GUIDE

Prof. Suneel K. Nagavi, Assistant Professor, Dept. of Robotics and Automation, AITM

What it does

A delivery robot with an on-board carrying compartment that is guided using a live video stream, so items can be sent to a destination under remote supervision.

How it works

[Main components, control logic, software and tools used. Add a block diagram if possible.]

Results and learning

[Test results, challenges faced and what the team would improve. 250–400 words in total.]



Photograph: Minesweeper

PROJECT 4 • MAJOR PROJECT, B.E. ROBOTICS AND AUTOMATION, 2025–26

Minesweeper: Wireless Land Mine Detection and Tracking Robot with Video Surveillance

TEAM

Vinayak V. Mathapati 2AG23RA414, 7th sem
Chetan S. Bhasme 2AG23RA403, 7th sem
Vishal J. Kennurkar 2AG23RA415, 7th sem

FACULTY GUIDE

Dr. Pooja Angolkar, Professor and Head, Dept. of Robotics and Automation, AITM

What it does

A wirelessly operated robot that detects and tracks land mines and sends back video from the site, so a hazardous area can be inspected from a safe distance. The robot carries an alert buzzer and a status light ring.

How it works

[Main components, control logic, software and tools used. Add a block diagram if possible.]

Results and learning

[Test results, challenges faced and what the team would improve. 250–400 words in total.]



PROJECT 5 • MAJOR PROJECT, B.E. ROBOTICS AND AUTOMATION, 2025–26

Semi-Autonomous Road Maintenance Robot

TEAM

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Saloni Chavan 2AG22RA006, 7th sem
Channamma D. 2AG23RA402, 7th sem
Samarth Lohar 2AG23RA409, 7th sem

FACULTY GUIDE

Prof. Pallavi Kulkarni, Assistant Professor, Dept. of E&C, AITM

What it does

A semi-autonomous robot built to assist with road maintenance work, combining automatic operation with operator control.

How it works

[Main components, control logic, software and tools used. Add a block diagram if possible.]

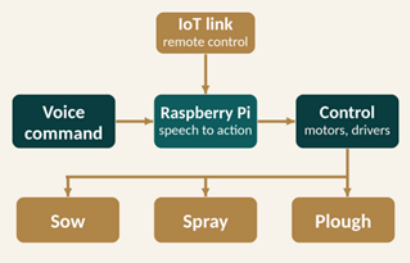
Results and learning

[Test results, challenges faced and what the team would improve. 250–400 words in total.]

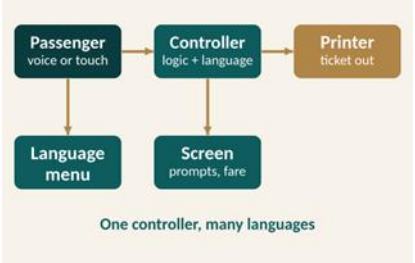
STUDENT INNOVATION

Technical illustration gallery

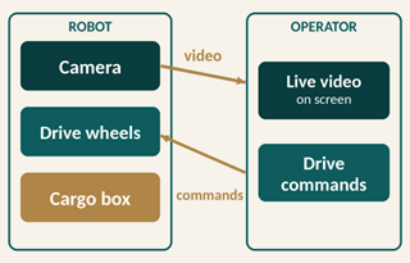
Concept diagrams drawn by the ROBOVERSE design team for this issue. Student drawings, CAD renders and circuit diagrams can replace them in later editions.



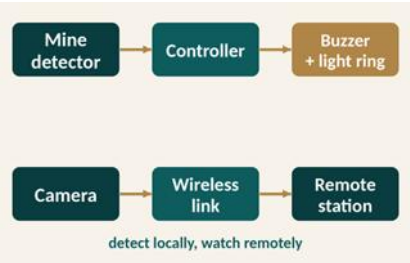
Agrisaksham Bot: voice-to-action flow
From a spoken command to sowing, spraying or ploughing.
ROBOVERSE design team (concept diagram)



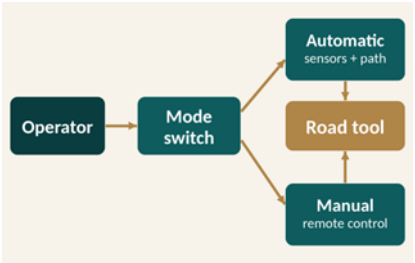
Ticket robot: interaction flow
Language choice, screen and printer all run through one controller.
ROBOVERSE design team (concept diagram)



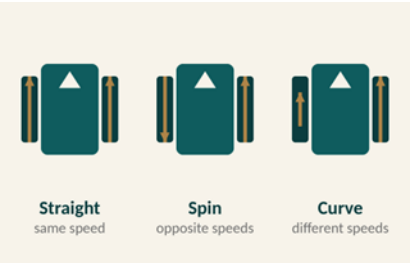
Delivery robot: live-stream loop
Video flows to the operator; drive commands flow back.
ROBOVERSE design team (concept diagram)



Minesweeper: detect, alert, watch
Local alerts and remote video work side by side.
ROBOVERSE design team (concept diagram)



Road maintenance robot: two modes
Automatic operation with a manual override.
ROBOVERSE design team (concept diagram)



How a two-wheeled robot steers
Differences in wheel speed make it go straight, spin or curve.
ROBOVERSE design team (concept diagram)

ENGINEERING EXPLAINED

Forward and inverse kinematics

Where is the robot's hand, and how do the joints put it there? Two questions, one planar arm and a complete worked example.

Every robot arm must answer two questions. The first: if the joint angles are known, where is the end-effector? The second: if the end-effector must reach a given point, what should the joint angles be? The first is **forward kinematics** (FK) and the second is **inverse kinematics** (IK). Kinematics describes motion without considering the forces behind it, so these relations depend only on geometry: the lengths of the links and the arrangement of the joints.

How many joints?

A rigid body in space needs six numbers to fix its position and orientation: three translations and three rotations. A general-purpose arm therefore needs at least six joints. Our example is a planar two-link arm with two degrees of freedom; it can place its tip anywhere in a ring-shaped region but cannot also control the tip's orientation.

Forward kinematics of a two-link arm

Place the base at the origin. Let the links have lengths L_1 and L_2, let θ_1 be the first joint angle measured from the x-axis, and let θ_2 be the second joint angle measured relative to the first link. Then the tip is at:

$$x = L_1 \cos\theta_1 + L_2 \cos(\theta_1 + \theta_2)$$
$$y = L_1 \sin\theta_1 + L_2 \sin(\theta_1 + \theta_2)$$

Each term is the projection of one link on the axes. For longer chains the same idea is organised with homogeneous transformation matrices, one per joint. The **Denavit–Hartenberg (DH)** convention describes each link with four numbers (link length, link twist, link offset and joint angle); multiplying the matrices gives the pose of the end-effector relative to the base.

FIGURE 3 • A PLANAR TWO-LINK ARM, WITH ITS TWO IK SOLUTIONS

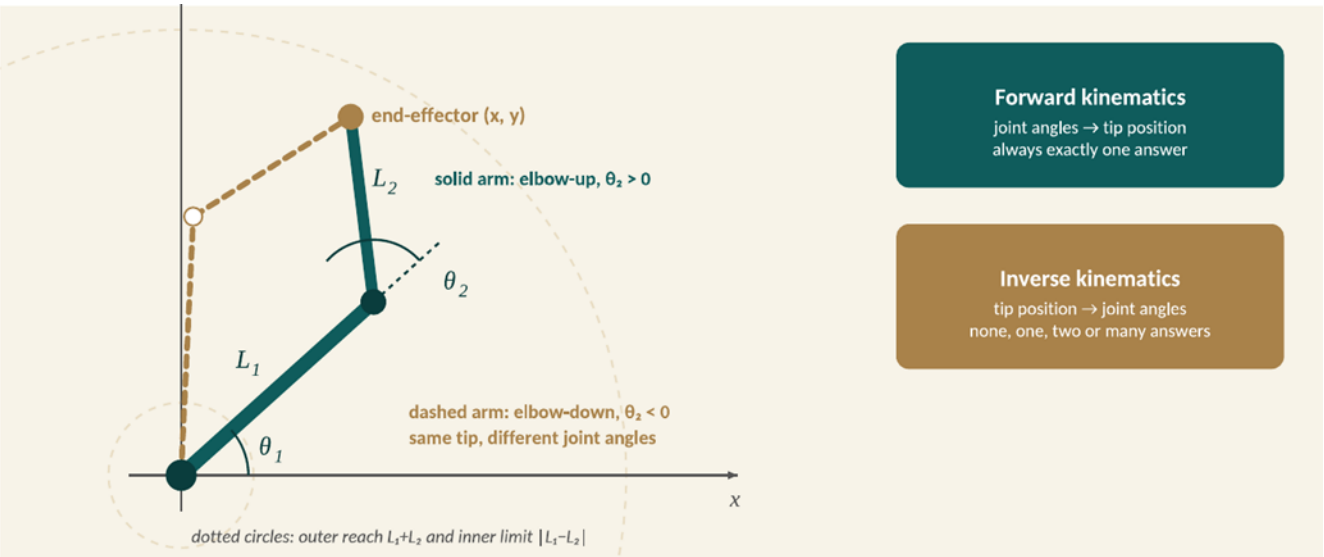


Figure 3. *A planar two-link arm and its two inverse-kinematics solutions: elbow-up (solid) and elbow-down (dashed) reach the same tip with different joint angles.*

Inverse kinematics: the harder question

Running the equations backwards is where it gets interesting. For the two-link arm a closed-form solution exists. The cosine rule first gives the elbow angle, and the shoulder angle follows:

$$\cos\theta_2 = (x^2 + y^2 - L_1^2 - L_2^2) / (2L_1L_2)$$

$$\theta_1 = atan2(y, x) - atan2(L_2 \sin\theta_2, L_1 + L_2 \cos\theta_2)$$

Three observations. First, $\theta_2 = \pm \arccos(\ldots)$, so there are generally two solutions: elbow-up and elbow-down (Figure 3). Second, if the value of $\cos\theta_2$ falls outside $[-1, 1]$ the target is unreachable. Third, use atan2 rather than a plain arctangent, so the correct quadrant is kept.

Singularities

The Jacobian matrix J relates joint velocities to tip velocity. For the two-link arm, $\det J = L_1 L_2 \sin\theta_2$. When θ_2 is 0° or 180° (arm fully stretched or folded) the determinant is zero: the arm is at a **singularity**, loses the ability to move in one direction, and tiny tip motions would demand very large joint speeds. Motion planners steer away from such configurations.

Beyond two links

Many six-axis industrial arms have a wrist designed so that closed-form IK exists. For general arms, numerical methods such as the Jacobian pseudo-inverse and damped least squares are used, and software libraries such as KDL and MoveIt hide much of the work. The principles you have seen here still apply.

A worked example

Let $L_1 = 0.40$ m and $L_2 = 0.30$ m. Take $\theta_1 = 30°$ and $\theta_2 = 45°$.

Step	Calculation	Result
FK: x	$0.40 \cos 30° + 0.30 \cos 75°$	0.424 m
FK: y	$0.40 \sin 30° + 0.30 \sin 75°$	0.490 m
IK: cos θ_2	$(0.1799 + 0.2399 - 0.16 - 0.09) / 0.24$	0.707
IK: elbow-up	$\theta_2 = +45.0°$, $\theta_1 = 30.0°$	matches the starting angles
IK: elbow-down	$\theta_2 = -45.0°$, $\theta_1 = 68.2°$	also reaches (0.424, 0.490)

Reachability check. The outer reach is $L_1 + L_2 = 0.70$ m and the inner limit is $|L_1 - L_2| = 0.10$ m. A target at (0.80, 0.20) lies 0.825 m from the base and is out of reach.

Try it: a few lines of Python

```
import math

def ik(x, y, L1=0.4, L2=0.3, positive=True):
    c2 = (x*x + y*y - L1*L1 - L2*L2) / (2*L1*L2)
    if abs(c2) > 1:
        return None   # out of reach
    t2 = math.acos(c2) * (1 if positive else -1)
    t1 = math.atan2(y, x) - math.atan2(
        L2*math.sin(t2), L1 + L2*math.cos(t2))
    return math.degrees(t1), math.degrees(t2)
```

Call ik(0.424, 0.490) and then check the answer with the forward equations.

Check your understanding

A planar arm has $L_1 = L_2 = 0.5$ m. Find the joint angles that place the tip at (0.5, 0.5).

Answer. $\cos\theta_2 = (0.25 + 0.25 - 0.25 - 0.25) / 0.5 = 0$, so $\theta_2 = \pm 90°$. Elbow-up: $\theta_2 = +90°$ and $\theta_1 = 45° - 45° = 0°$. Elbow-down: $\theta_2 = -90°$ and $\theta_1 = 45° + 45° = 90°$. Either way, the forward equations return (0.5, 0.5).

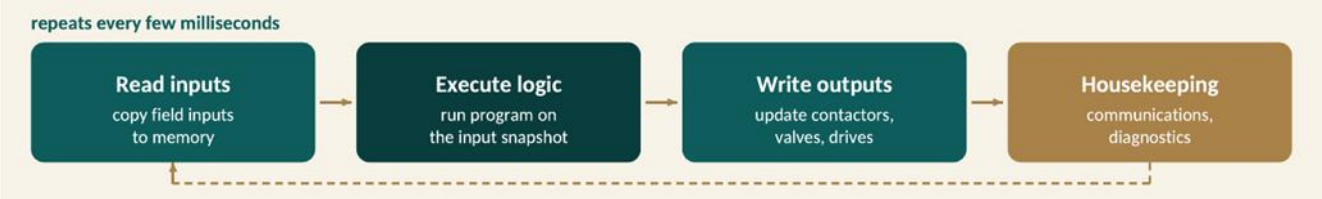
---Dr. Pooja Angolkar

AUTOMATION SPOTLIGHT

PLCs, sensors and control systems

The nervous system of every automated machine: how inputs become decisions and decisions become motion.

THE PLC SCAN CYCLE



A robot arm gets the headlines, but around it sits a quieter set of machines: **sensors** that report what is happening, a **controller** that decides what to do, and **actuators** that do it. In most factories the controller is a programmable logic controller (PLC), a rugged industrial computer built to run continuously, tolerate electrical noise and respond predictably.

How a PLC thinks: the scan cycle

Unlike a general-purpose computer, a PLC runs its program in a fixed, repeating cycle called the **scan**. It reads every input into memory, executes the logic using that snapshot, writes the results to the outputs and then performs housekeeping such as communications and diagnostics. A typical scan takes a few milliseconds, so the controller reacts to the plant almost continuously. Because inputs are sampled once per scan, very fast events need special high-speed inputs or interrupt tasks.

Five languages, one standard

The IEC 61131-3 standard defines Ladder Diagram (LD), Function Block Diagram (FBD), Structured Text (ST), Sequential Function Chart (SFC) and Instruction List (IL), the last of which is deprecated in the current edition. **Ladder** resembles the relay wiring diagrams it replaced, so technicians can read it at a glance, and it remains the most widely used language in discrete manufacturing. Structured Text suits calculations and data handling.

A classic: the start–stop circuit

Figure 4 shows the first circuit every automation student learns. Pressing START energises the motor coil M1. The M1 contact in parallel with START "seals in" the rung, so the motor keeps running after START is released. STOP is wired as a normally closed contact, which means a pressed button *or* a broken wire both de-energise the coil: a fail-safe habit worth adopting from day one.

FIGURE 4 • THE START–STOP CIRCUIT



Figure 4. *A start–stop (seal-in) ladder rung. NO = normally open, NC = normally closed.*

Sensors: how the machine knows

Sensor	Principle	Typical use
Inductive proximity	Metal near the coil changes an oscillator	Detecting metal parts without contact
Capacitive proximity	Change in capacitance	Levels, non-metal objects
Photoelectric	Light beam broken or reflected	Presence and counting on conveyors
Ultrasonic	Time of flight of sound	Distance and level
Encoder	Optical or magnetic pulses; absolute types keep position when power is off	Joint position and speed
Load cell	Strain changes electrical resistance	Weight and gripper force
Thermocouple / RTD	Junction voltage or resistance vs temperature	Temperature
Camera / LiDAR	Images or laser time of flight	Inspection, localisation, guidance

Actuators: how the machine acts

Actuator	Strengths	Typical use
Stepper motor	Simple open-loop positioning; can lose steps if overloaded	3D printers, small positioning axes
Servo motor and drive	Closed-loop, precise, high torque for its size	Robot joints, CNC axes
Brushless DC motor	Efficient, long life, needs electronic commutation	Mobile robots, drones, compact joints
Pneumatic cylinder	Fast, simple and low cost; limited position control	Clamping, pick-and-place, grippers
Hydraulic actuator	Very high force	Heavy machinery, presses

Closing the loop: control

An **open-loop** system sends a command and hopes. A **closed-loop** system measures the result, compares it with the target and corrects the difference, called the error $e(t)$. The most widely used closed-loop controller is the PID controller:

$$u(t) = K_p\, e(t) + K_i \int e(t)\, dt + K_d\, de(t)/dt$$

Gain	Effect when increased	Watch out for
Kp	Faster response	More overshoot
Ki	Removes steady-state error	Oscillation, integral windup
Kd	Damps overshoot	Amplifies sensor noise

Robot joints typically use cascaded loops: an outer position loop commands an inner velocity loop, which commands an inner current (torque) loop. Tuning from the inside out is standard practice.

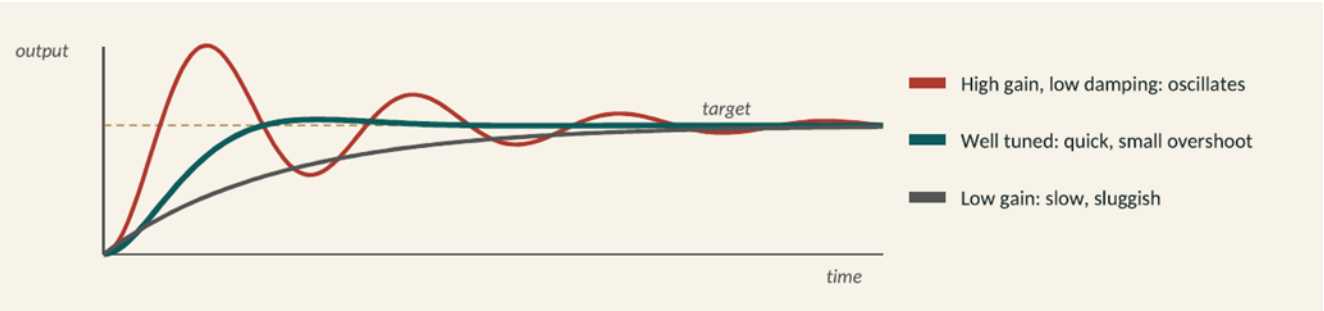
Where robots and PLCs meet

In a typical cell the PLC acts as the conductor. It starts and stops the conveyor, reads the part-present sensor, tells the robot controller which programme to run through an industrial network such as PROFINET or EtherNet/IP, and waits for a "done" signal before releasing the part. Clear handshakes and well-defined states keep the cell predictable.

Safety note

Emergency stops and guarding must use safety-rated devices, such as safety relays or safety PLCs, and not ordinary program logic. Follow the applicable standards and your institute's lab rules.

FIGURE 5 • HOW GAIN AND DAMPING SHAPE A STEP RESPONSE (ILLUSTRATIVE)



---Mrs. Shweta Kalkundri & Mr. Suneel Nagavi

EMERGING TECHNOLOGY

Digital twins and additive manufacturing

A virtual copy to test ideas and a 3D printer to make them real: two technologies that shorten the road from design to working hardware.

What is a digital twin?

A digital twin is a virtual representation of a physical asset, process or system that is kept in step with the real thing through data. Three levels are often distinguished. A **digital model** has no automatic data link. A **digital shadow** receives live data from the physical object, but nothing flows back. A **digital twin** exchanges data in both directions, so the virtual model can influence the physical system as well as mirror it (Figure 6).

What twins are used for

- **Virtual commissioning.** Test PLC and robot programmes against a simulated cell before the hardware exists, reducing collisions and commissioning time.
- **Predictive maintenance.** Compare actual behaviour with what the model expects and flag the difference.
- **What-if analysis.** Try a new layout or schedule without stopping production.
- **Training.** Let operators and students practise safely.

Building one at student scale

A twin of a student robot can start simply: a CAD model with joint limits loaded into a simulator such as Gazebo, the kinematic model from this issue, and joint data streamed from the real robot through ROS 2 topics. Begin by mirroring one thing well, such as joint angles, before adding physics, wear and cost.

A twin is only as good as its data and modelling assumptions. Check it against the real machine regularly, and treat any disagreement as information.

FIGURE 6 • THE DIGITAL TWIN LOOP

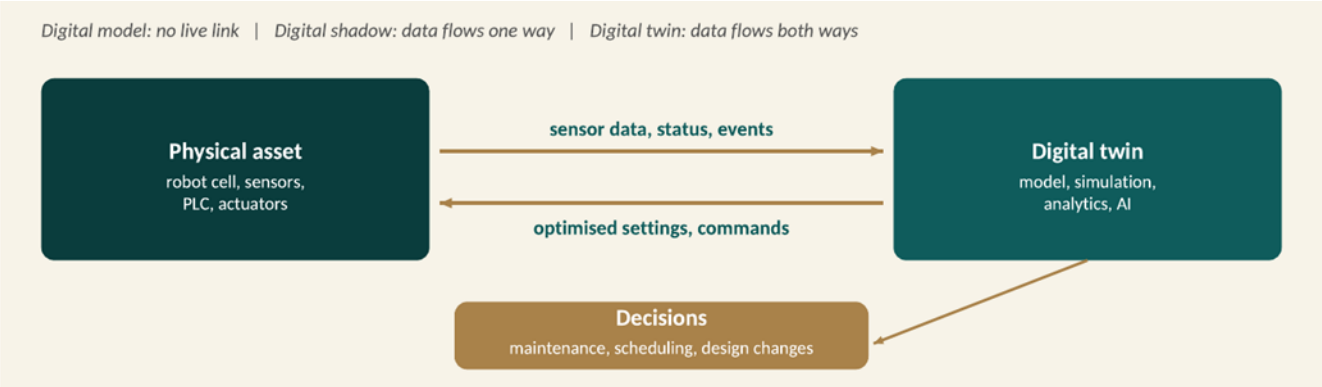


Figure 6. *Data flows up from the physical asset; optimised settings and commands flow back; decisions follow from the twin's analysis.*

Additive manufacturing in brief

Additive manufacturing (AM), commonly called 3D printing, builds a part layer by layer from a digital model, in contrast to subtractive methods such as machining that cut material away. The ISO/ASTM 52900 standard groups the technologies into seven process categories. Those most students meet are summarised below.

Process	How it works	Typical use
FDM / FFF (material extrusion)	Heated thermoplastic filament is deposited layer by layer	Low-cost prototypes, jigs, grippers
SLA / DLP (vat photopolymerisation)	UV light cures liquid resin	Fine detail, smooth surfaces
SLS (powder bed fusion)	Laser sinters polymer powder	Strong functional parts, no supports
Metal PBF (SLM / DMLS)	Laser melts metal powder	Complex, lightweight metal parts
Binder jetting	Binder is deposited on a powder bed	Sand moulds, models, sintered metal

Why it suits robotics

Robots are full of small, custom, low-volume parts: grippers and fingers, sensor mounts, brackets, enclosures and fixtures. AM lets a team design, print and test a new gripper in hours instead of waiting for a machined part. Lattice and hollow structures can reduce the weight a robot must carry, and one printer can produce parts of very different shapes without new tooling.

Design for AM: practical rules

- **Mind the orientation.** Printed parts are usually weaker between layers than along them, so orient the part so that loads follow the layers.
- **Control overhangs.** Keep overhangs below about 45° from the vertical or add supports.
- **Allow for tolerance.** Expect dimensional variation of a few tenths of a millimetre; print a test fit before the final part.
- **Add fillets** at sharp internal corners to spread stress.
- **Choose the material for the job.** PLA is easy for prototypes; PETG, ABS or nylon suit tougher parts.

Closing the loop

Digital twins and additive manufacturing work best together. Simulate a gripper in the twin, print it, test it with sensors on the real robot, feed the measurements back and refine the model. A design cycle that once took weeks becomes a matter of days.

Choosing a filament

Material	Strengths	Watch out for
PLA	Easy to print, little warping, good detail	Brittle; softens at low temperature
PETG	Tougher and more flexible than PLA; good layer bonding	Can string; scratches easily
ABS	Strong, impact and heat resistant	Warps; needs an enclosure and ventilation
Nylon	Tough, wear resistant, low friction	Absorbs moisture; keep it dry
TPU	Flexible and rubber-like	Slow printing; ideal for soft gripper pads

Safety when 3D printing

Print in a ventilated space. The hot end and the bed can cause burns, so never reach in while they are hot, and do not leave a printer unattended while it heats. Follow your lab's rules.

Before you press print

- Is the bed level and clean?
- Is the filament dry and the right type?
- Did you check orientation, infill and supports?
- Is the first layer sticking?
- Have you planned a test fit?

Student challenge

Design a 3D-printed two-finger gripper. Print it at two infill levels (for example 20% and 60%), measure the holding force with a load cell or spring scale, and report the strength-to-weight trade-off. The best write-ups will be considered for next year's student project gallery.

----Dr. Aravind Muddebihal

CAREERS

Women in robotics and engineering careers

Role models, pathways and the skills that open doors.

Robotics needs every kind of talent, and the field has been shaped by women whose work ranges from social robots to soft robotics and human–robot interaction. Three examples show how wide the field is.

Cynthia Breazeal is a professor at MIT and a pioneer of social robotics. As a student she built Kismet, an expressive robot head that responded to people, and she later co-founded the home robot company Jibo.

Daniela Rus directs MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL). Her research includes modular, soft and distributed robots and ways for machines to learn and cooperate.

Ayanna Howard is known for research in human–robot interaction, including robots that support children's therapy, and for work on fairness in AI. She is dean of the College of Engineering at The Ohio State University.

Their paths differ, but each combined strong fundamentals with curiosity about people, not only machines. That combination is available to every student in our department.

What helps everyone thrive in engineering

- Visible role models and mentors at every stage
- Team roles shared by skill and interest, not stereotype
- A lab culture where questions are welcome and credit is given
- Early exposure to projects, competitions and industry

VOICES FROM OUR DEPARTMENT

Short profiles of women students, alumnae or faculty. Obtain written permission for every photograph and quotation.



Ms. Saanvi Savaanur
V sem- 2024-25 batch

"I fell for robotics the day a line follower I built finally took its first clean turn. I am proudest of a PLC-controlled conveyor my team got running after many failed tries. My advice: keep a debugging diary, because every bug you write down is one you will fix faster next time."



Ms. Darshana Koli
VII sem- 2023-24 batch

"Watching a robot arm repeat a motion perfectly made me want to know how it thinks. My favourite build is a gesture-controlled robotic arm, where I learned that sensors lie until you calibrate them. Do not wait to feel ready: start the project, and the skills arrive along the way."



Ms. Gouri Naik
2022-26 batch

"I chose robotics because it joins coding, electronics and mechanics in one machine. I am proud of a small obstacle-avoiding rover that failed three times before it worked. Ask questions in the lab, share your code, and never treat a failed test as a failed project."

Careers in robotics and automation

Robotics is not one job; it is a family of roles that share a language of sensing, control and mechanisms. These are some of the main ones.

Role	What you do	Skills that help
Controls / PLC engineer	Program and commission PLCs, drives and HMIs for production lines	Ladder and ST, sensors, networks, control theory
Robotics software engineer	Write perception, planning and control software	C++/Python, ROS 2, kinematics, testing
Automation design engineer	Design cells, fixtures, grippers and layouts	CAD, mechanisms, standards, safety
Machine-vision engineer	Build inspection and guidance systems	Optics, OpenCV, deep learning basics
Embedded / mechatronics engineer	Develop motor control and sensor electronics	Microcontrollers, circuits, firmware
Commissioning and service engineer	Install, tune and support systems on site	Troubleshooting, communication, documentation
Data / ML engineer for manufacturing	Turn plant data into predictions and decisions	Python, statistics, databases, domain knowledge
Entrepreneur	Build a product or service for a real need	All of the above, plus curiosity about customers

A skills roadmap for four years

Year	Focus	Suggested activities
First	Foundations	Basic programming (Python/C), electrical and mechanical fundamentals, simple Arduino or microcontroller projects
Second	Building blocks	Sensors and actuators, CAD, control basics, first line-follower or manipulator project, 3D printing
Third	Systems	PLC programming, kinematics, ROS 2, machine vision, a mini-project with a faculty guide, competitions
Fourth	Depth and proof	Capstone project, internship, an article or showcase in ROBOVERSE, certifications, interview preparation

Where to start learning

Topic	How to begin
PLC programming	Practise ladder logic on a free software PLC such as OpenPLC or CODESYS before touching hardware
ROS 2 and simulation	Work through the official ROS 2 tutorials and simulate a robot in Gazebo
Machine vision	Follow the OpenCV tutorials, then build a colour- or shape-sorting demo
Control systems	Simulate PID loops in Python or MATLAB/Simulink; look for NPTEL courses on control and robotics
CAD and 3D printing	Model a part in a CAD tool, slice it and print it; then improve the design

Competitions and platforms to try

Platform	What it offers
Smart India Hackathon	A national hackathon where teams build solutions to problem statements from government bodies and industry.
e-Yantra (IIT Bombay)	A robotics outreach initiative for engineering students, with hands-on, competition-style learning.
DD Robocon	India's national robotics contest, which selects the team for the ABU Asia-Pacific Robot Contest.
RoboCup	An international competition with robot soccer, rescue and work-oriented leagues.
NPTEL	Free video courses from the IITs, including control systems and robotics.

Before you apply: a quick checklist

- Can you explain one project end to end: the problem, your design choices, what failed and what you changed?
- Can you sketch a PID loop, a ladder rung and a two-link arm, and say what each does?
- Is your portfolio link on your resume, with working code and clear photographs?
- Have you asked a faculty guide or senior to review your resume and mock-interview you?

Skills self-check

Tick the box that fits you today and revisit it each semester.

Skill	Not yet	Learning	Confident
Programming (Python / C)	☐	☐	☐
Electronics, sensors and actuators	☐	☐	☐
PLC and control basics	☐	☐	☐
Kinematics and ROS 2	☐	☐	☐
CAD and 3D printing	☐	☐	☐
Writing and presenting your work	☐	☐	☐

BEYOND THE CLASSROOM

Department achievements

Workshops, industrial visits, competitions and certifications from the year. Entries are reserved for verified department records.

TO BE FILLED FROM RECORDS

Workshops and training programmes

Date	Activity	Details and participants
14 Aug 2026	*Technical talk: Industrial Automation and Robotics*	*K.L.E. Society's Chidanand B. Kore Polytechnic, Chikodi. Dr. Aravind B. Muddebihal and Prof. Krishnakumar A. Jere covered sensors, PLCs, HMIs, manipulators and Industry 4.0.*
15 May 2026	*Technical talk (online): Internet of Things*	*Dr. Abhilash Desai, SDM College of Engineering & Technology, Dharwad, on IoT architecture, MQTT/HTTP/BLE and edge/cloud computing, with live Q&A.*
16–17 Mar 2026	*Hands-on workshop: Advanced IoT for Smart Automation*	*Organised by ARE; sessions by Mr. Ayush Patil on Arduino, sensors, Blynk and ThingSpeak. Students built basic IoT projects.*
22–23 Sep 2025	*Workshop: IoT Fundamentals, Sensor Interfacing and Smart Connectivity*	*Seminar Hall, under ARE. Covered sensors, Arduino and cloud monitoring, with project demonstrations and shared source code.*
23 May 2025	*Awareness programme on Outcome Based Education (OBE)*	*Led by Dr. Pooja V. Angolkar on Bloom's Taxonomy and assessment.*

Industrial visits and industry interaction

Date	Organisation	Highlights and learning
11 Sep 2026	*Creintors Automation Solution Pvt. Ltd. (CASPL), Belagavi*	*Students observed PLC-based systems, control panels and automation solutions, linking classroom learning to industrial practice.*
21 Feb 2026	*Ashok Iron Works Pvt. Ltd. (Plant-III), Machhe*	*Organised by ARE. Students saw casting, machining and quality control, gaining exposure to real manufacturing operations.*
Aug 2025	*DRDO, Bengaluru (internship)*	*Seven students completed a four-week internship in drones and robotics under mentor Dr. T. Ram Prabhu.*
22 Apr 2025	*VTU Skill Centre, Machhe, Belagavi*	*Hands-on exposure to PLCs, SCADA interfaces and robotic arms, key Industry 4.0 technologies.*
22 Nov 2024	*Government Tool Room and Training Centre (GTTC), Belagavi*	*Students saw industrial equipment and automation systems at work.*

Competitions and events

Date	Event	Team, result and prize
Jun 2026	*14th Graduation Day*	*The first batch of Robotics and Automation Engineering graduates received their degrees.*
6–10 Apr 2026	*AICTE-MoE IDE Bootcamp (Edition 3, Phase-I)*	*Team FireGuard Innovators (five students) was selected for the bootcamp at GITAM University, Bengaluru; mentor Dr. Pooja Anagolkar.*
May 2026	*YUVA 2026, solo dance*	*Manthan Harake (II year) won Second Prize at the event organised by KLE's College of Business Administration, Lingaraj College, Belagavi.*
26–27 Jul 2024	*Paper presentations at ICNFMS-2024*	*Six students presented papers, including "Green Materials for Robots" and "Wireless Robot", at the conference hosted by Ballari Institute of Technology and Management.*
2024	*AMTECH Expo, Bengaluru*	*A five-student team presented a research poster on machine-learning-based wear analysis of AlSi10Mg alloy.*

Certifications and student achievements

Date	Achievement	Student(s) and details
Jun 2026	*14th Graduation Day*	*The first batch of Robotics and Automation Engineering graduates received their degrees.*
6–10 Apr 2026	*AICTE-MoE IDE Bootcamp (Edition 3, Phase-I)*	*Team FireGuard Innovators (five students) was selected for the bootcamp at GITAM University, Bengaluru; mentor Dr. Pooja Anagolkar.*
May 2026	*YUVA 2026, solo dance*	*Manthan Harake (II year) won Second Prize at the event organised by KLE's College of Business Administration, Lingaraj College, Belagavi.*
26–27 Jul 2024	*Paper presentations at ICNFMS-2024*	*Six students presented papers, including "Green Materials for Robots" and "Wireless Robot", at the conference hosted by Ballari Institute of Technology and Management.*
2024	*AMTECH Expo, Bengaluru*	*A five-student team presented a research poster on machine-learning-based wear analysis of AlSi10Mg alloy.*

Moments from the year



Mr. Manthan Harake receives 2nd Place in Dance competition



Students at Crentiors Automation for industrial visit



Dr. Aravind Muddebihal as resource person at C.B Kore Polytechnic, Chikkodi



1st Batch Graduation day



Hands on workshop on IoT by Ayush Patil



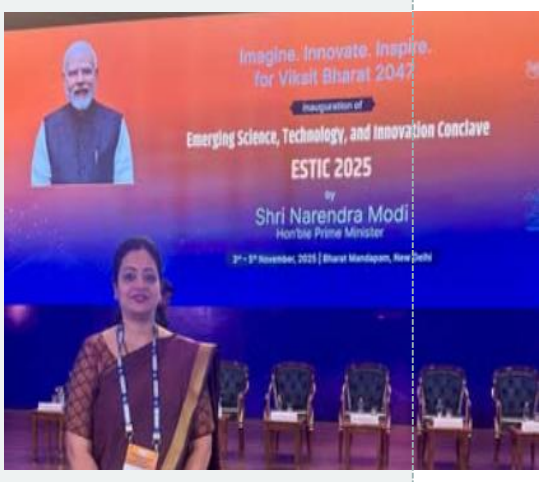
Interaction with Industry Mentor, Dr. T Ramprabhu, DRDO Blore



Students at Ashok Iron Plant-III for industrial visit



Students participation in National level Bootcamp



Dr.Pooja at Bharat Mandapam New Delhi for ESTIC-2025

RESEARCH

Research at AITM Robotics and Automation

Robotics, artificial intelligence, additive manufacturing and smart technologies: the work behind the department.

The Department of Robotics and Automation Engineering at AITM, Belagavi, promotes research, innovation and industry-oriented development in emerging areas of robotics, automation, artificial intelligence, additive manufacturing and smart technologies. This section summarises the department's research record as published on its website.

Research highlights

26 INTERNATIONAL JOURNAL PUBLICATIONS

8 INTERNATIONAL CONFERENCE PUBLICATIONS

3 BOOK CHAPTERS

1 PATENT GRANTED

Research areas

- Robotics and automation
- Artificial intelligence and machine learning
- Additive and digital manufacturing
- Industrial automation and control systems
- IoT and smart automation
- Tribology and materials characterisation
- Machine learning for manufacturing
- Advanced manufacturing technologies

Faculty research contributions

Faculty	Journals	Conf.	Book ch.	Patents	Citations	Awards	Proposals
Dr. Pooja Angolkar	13	8	3	1	26	1	7
Dr. Aravind Muddebihal	10	2	–	–	13	–	1
Prof. Suneel Nagavi	3	–	–	–	–	–	1
Prof. Shweta Kalkundri	–	–	–	–	–	–	–

Research proposals submitted

Faculty and students are encouraged to take part in externally funded research, consultancy and innovation projects. Proposals address emerging challenges in robotics, artificial intelligence, additive manufacturing, automation and smart manufacturing.

Programme	Organisation	Submitted by	Proposal title	Grant	Date
Conference	ATAL-VANI	Dr. Pooja Angolkar / Dr. Aravind Muddebihal	Programmable Industrial Ecosystems: AI and Robotics for Industry 5.0	₹2,00,000	30 May 2026
VGST-ECRA	VGST	Dr. Pooja Angolkar / Dr. Malagouda Patil	Experimental Investigation and Deep Learning Based Prediction of Tribological Properties in Additively Manufactured Samples	₹50,00,000	19 Jan 2026
AMT-DST	ANRF-DST	Dr. Pooja Angolkar / Dr. Anand Deshpande	AI-Based Metal Printing Using Deep Learning	₹50,00,000	30 Aug 2025
FDP	VGST	Dr. Pooja Angolkar / Dr. Malagouda Patil	Artificial Intelligence Enabled Robotics for Advanced Manufacturing and Automation	₹3,00,000	14 Jan 2025
FDP	ATAL	Dr. Pooja Angolkar / Dr. Malagouda Patil	FDP proposal	₹3,50,000	28 Mar 2025
FDP	ATAL	Dr. Pooja Angolkar / Dr. Malagouda Patil	FDP proposal	₹3,50,000	29 May 2024
K-FIST	VGST	Dr. Pooja Angolkar / Prof. Suneel Nagavi	Establishing State-of-the-Art AI-Based Robot Laboratory	₹20,000	19 Jun 2024

Research publications: journals

Faculty have published in international journals indexed in SCI and Scopus, in robotics, AI, machine learning, additive manufacturing, advanced materials, composites, tribology and automation.

Year	Title	Faculty	Journal	Indexing
2026	Coupled Effects of In-Plane Fiber Waviness and Circular Cutout on Axial Buckling Behavior of Glass-Epoxy Composites	Dr. Aravind Muddebihal	Polymer Composites	SCI, Scopus – Q1
2026	Realization of Introducing Non-Woven Veil on Interlaminar Radial Strength of Glass Epoxy L-Bend Composites	Dr. Aravind Muddebihal	Fracture and Structural Integrity	Scopus – Q2
2025	Microstructural Analysis of Spin Arc Welding on Hastelloy C-276	Dr. Pooja Angolkar	Canadian Metallurgical Quarterly	SCI, Scopus – Q3
2025	Studies on High Temperature Wear Behavior of Additively Manufactured Ti-6Al-4V Alloy Using Machine Learning Models	Dr. Pooja Angolkar	Journal of Materials Engineering and Performance	SCI, Scopus – Q2
2025	Dual Microcapsules Self-Healing Performance in Glass Epoxy Composite Under Flexural Load	Dr. Aravind Muddebihal	Polymer Composites	SCI, Scopus – Q1
2025	Glass-Carbon Hybrid Veil Interleaving to Enhance Fracture Toughness and Shear Strength in Glass Epoxy Composites: An Experimental Study	Dr. Aravind Muddebihal	Theoretical and Applied Fracture Mechanics	SCI, Scopus – Q1
2025	Performance of Glass Epoxy Composites Under Combined Effect of In-Plane Fiber Waviness with Circular Cutout Through Tensile Test and Image Processing Technique	Dr. Aravind Muddebihal	Polymer Composites	SCI, Scopus – Q1
2024	Techniques of Creating In-Plane Fiber Waviness in Composites and Its Mechanical Performance – A Review	Dr. Aravind Muddebihal	Engineering Research Express	SCI, Scopus
2024	Interleaving Carbon-Glass Veil in Glass Epoxy Composite for Improved Mode-I Fracture Toughness – A Hybrid Approach	Dr. Aravind Muddebihal	Fracture and Structural Integrity	SCI, Scopus – Q2
2023	Tribological Properties of Additively Manufactured Al-Si Alloys and Steels	Dr. Pooja Angolkar	Materials Science Forum	Scopus – Q4
2023	Effect of Build Orientation and Heat Treatment on the Erosion Behavior of Al10SiMg Fabricated Using Laser Powder Bed Fusion	Dr. Pooja Angolkar	Tribology in Industry	SCI, Scopus – Q3
2023	Low Velocity Impact Toughness, Fracture Toughness and Mechanical Properties of Hevea Brasiliensis Husk Cellulose Toughened Stacked Aramid/Sisal Fibre Composites	Dr. Pooja Angolkar	Biomass Conversion and Biorefinery	SCI, Scopus – Q2
2023	Cyclone Dust Collector for Foundry	Dr. Aravind Muddebihal	Intl. Advanced Research Journal in Science, Engineering and Technology	–

Year	Title	Faculty	Journal	Indexing
2022	Effect of Build Direction and Surface Finish on Wear Behavior of AlSi10Mg Alloy Fabricated by Laser Powder Bed Fusion	Dr. Pooja Angolkar	Metallurgical Research and Technology	SCI, Scopus – Q2
2021	Design and Fabrication of Pepper Thresher Machine	Dr. Aravind Muddebihal	Intl. Advanced Research Journal in Science, Engineering and Technology	–
2018	Weight Optimization of Steam Turbine Casing Using Optistruct Tool	Dr. Pooja Angolkar	IJMPERD	Scopus
2016	Application of Dual Response and Tolerance Analysis Approaches for Robust Design of Spot-Welding Process	Dr. Pooja Angolkar	IJMET	Scopus

Quartile rankings may vary depending on the database, subject category and reporting year.

Student publications, 2026

This year's final-year projects were also written up and published in the International Research Journal of Modernization in Engineering Technology and Science (IRJMETS), a peer-reviewed journal.

Title	Student authors
Semi-Autonomous Road Maintenance Robot	Saloni Chavan, Gouri Naik, Samarth Lohar, Channamma H. D.
Minesweeper: Wireless Land Mine Detection and Tracking Robot with Video Surveillance	Vinayak V. Mathapati, Chetan S. Bhasme, Vishal J. Kennurkar
Delivery Robot Using Live Stream	Ayush K. Patil, Aadesh S. Patil, Spandan S. Patil
Agrisaksham Bot	Sanjana R. Desai, Shraddha A. Pawar, Tejashwini S. Yaragatatti, Srushti S. Bellad
A Smart Multilingual Voice Based Ticket Vending System	Vaishnavi V. Patil, Bhavani V. Revankar, Shilpa S. Shettar, Soumya S. Biradar
Text Evaluation Using AI	Sankarsh A, Anup M, Javeed I, Huzaifa M

Research publications: conferences

Year	Title	Conference	Faculty	Published in
2025	Deep Generative Modeling for Unsupervised IoT Intrusion Detection: A VAE-GAN Approach with HDBSCAN Profiling	9th IEEE International Conference on Information and Communication Technology (CICT 2025), IIITDM Kancheepuram	Dr. Pooja Angolkar	IEEE Xplore
2025	Predictive Modeling of Wear Behaviour of Ti-8Al-1Mo-1V Aero-Engine Compressor Blade Alloy	2nd International Conference on Business Intelligence, Computational Mathematics, and Data Analytics (IBCD 2025), Pune	Dr. Pooja Angolkar	Springer Nature
2025	Mechanical Performance of Glass Fiber Epoxy Laminates with Embedded Circular and Square Cutouts	International Symposium on Recent Advances in Materials Joining and Manufacturing Process (MJMP 2025)	Dr. Aravind Muddebihal	Materials Research Forum
2024	Triboinformatics Modeling of Additively Manufactured AlSi10Mg Using Machine Learning	4th Indian International Conference on Industrial Engineering and Operations Management (IEOM), Hyderabad	Dr. Pooja Angolkar	IEOM Proceedings
2024	Size Optimization of Self-Healing Microcapsules for FRP Composite 3D Printing	International Conference on Manufacturing, Materials Science and Engineering (ICMMSE 2024)	Dr. Aravind Muddebihal	Conference chapter
2023	Impact of Heat Treatment on Wear Behaviour of Stainless Steel Printed Using Laser Powder Bed Fusion	8th North American International Conference on Industrial Engineering and Operations Management (IEOM), Houston, USA	Dr. Pooja Angolkar	IEOM Proceedings
2023	Tribological Properties of Additively Manufactured Al-Si Alloy and Steels	International Conference on Advancements in Materials, Manufacturing and Automation (AMMA 2023), Amrita Vishwa Vidyapeetham	Dr. Pooja Angolkar	Materials Science Forum
2022	Effect of Build Orientation on the Wear Behaviour of 17-4 PH Stainless Steel Printed Using Laser Powder Bed Fusion	2nd Indian International Conference on Industrial Engineering and Operations Management (IEOM), Warangal	Dr. Pooja Angolkar	IEOM Proceedings

Book chapters

Year	Title	Book	Faculty	Indexing
2025	Challenges and Innovations in 3D Printed Bio-Organs and Their Materials	Springer Tracts in Additive Manufacturing	Dr. Pooja Angolkar	Scopus (SpringerLink)
2021	Polymer Matrix Composites Processing and Characterization	Polymer Matrix Composites Processing and Characterization	Dr. Pooja Angolkar	ISBN book

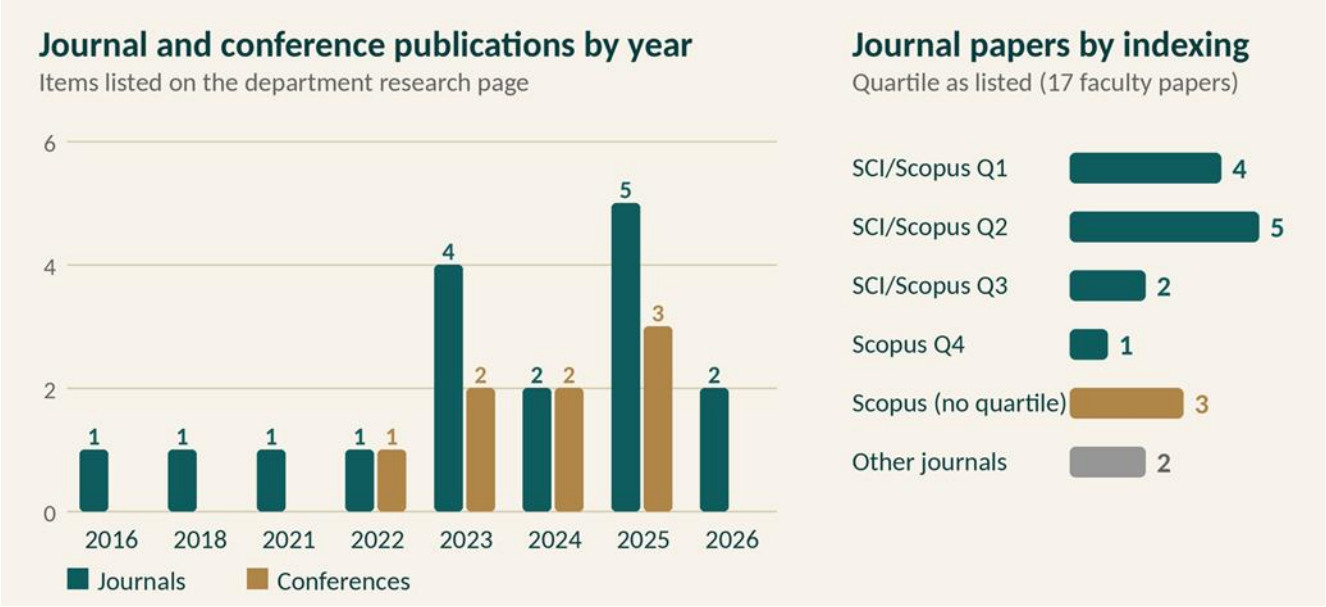
Patents

Patent title	Inventors	Number	Year	Status
A Kind of Thermal Conductivity Measuring Device for Bad Conductors	Pooja Angolkar and others	Indian Patent 202141045433	2021	Patent granted
Design and Development of Lab-Scale Industrial Waste FFFP Shredding Machine	Dr. P.S. Shivakumar Gouda, Dr. Aravind B. Muddebihal and others	Application 202441008428 A	2024	Under process
Process of Developing Eco-Friendly Nonwoven Natural Fiber Veil	Dr. P.S. Shivakumar Gouda, Dr. Aravind B. Muddebihal and others	Application 202441002474 A	2024	Under process

Ph.D. guidance

Name of the guide	Qualification	Scholars (assessment year 2024–25)
Dr. Pooja Angolkar	Ph.D.	2

Research at a glance, in charts



CHALLENGE CORNER

Challenge corner

Twelve questions to test what you know. Answers are on the next page, no peeking.

Robotics quiz

1. What is the name for a robot configuration where the arm loses the ability to move in some direction?

- **A.** Workspace
- **B.** Singularity
- **C.** Payload
- **D.** Repeatability

2. How many degrees of freedom are needed to place a rigid body at any position and orientation in 3D space?

- **A.** 3
- **B.** 4
- **C.** 6
- **D.** 9

3. Which IEC 61131-3 language resembles relay wiring diagrams?

- **A.** Structured Text
- **B.** Ladder Diagram
- **C.** Sequential Function Chart
- **D.** Function Block Diagram

4. Which sensor detects a metal object without touching it?

- **A.** Inductive proximity sensor
- **B.** Thermocouple
- **C.** Load cell
- **D.** Ultrasonic level sensor

5. The ability of a robot to return accurately to a taught point is called:

- **A.** Resolution
- **B.** Payload
- **C.** Repeatability
- **D.** Backlash

6. Which term of a PID controller removes steady-state error?

- **A.** Proportional
- **B.** Integral
- **C.** Derivative
- **D.** None of these

7. The word “robot” was popularised by a 1920 play by which writer?

- **A.** Isaac Asimov
- **B.** Karel Čapek
- **C.** Jules Verne
- **D.** Arthur C. Clarke

8. Which additive process cures liquid resin with UV light?

- **A.** FDM
- **B.** SLS
- **C.** SLA
- **D.** Binder jetting

9. In robotics, what does ROS stand for?

- **A.** Robot Operating System
- **B.** Remote Output Signal
- **C.** Rotary Orientation Sensor
- **D.** Real-time Open Servo

10. Which is a vendor-neutral standard for industrial data exchange?

- **A.** OPC UA
- **B.** Bluetooth
- **C.** HTTP only
- **D.** USB

11. DH parameters are named after:

- **A.** Denavit and Hartenberg
- **B.** Dijkstra and Hamilton
- **C.** Doppler and Hooke
- **D.** Dirac and Heisenberg

12. Which encoder keeps the correct position after power is switched off?

- **A.** Incremental
- **B.** Absolute
- **C.** Tachometer
- **D.** Potentiometer-free

Score yourself

10–12 Robotics ready. **7–9** Strong foundation. **4–6** Keep building. **0–3** Start with the articles in this issue, then try again.

Design challenge: the one-motor gripper

The brief. Design a low-cost gripper, driven by a single motor or servo, that can pick up three very different objects: a raw egg, a steel bolt and a plastic bottle cap, without damaging the egg.

What to submit. A sketch or CAD image, a description of the mechanism, a bill of materials with estimated cost, and a test plan. Prototype photographs are welcome but not required.

What we will look for. Originality, correct engineering reasoning, and a clear explanation. Selected entries will appear in next year's issue.

Technical puzzles

Puzzle 1: Reach. A planar two-link arm has two links of 0.5 m each. What are its maximum and minimum reach from the base?

Puzzle 2: Steps. A stepper motor has a step angle of 1.8°. How many full steps make one revolution? How many microsteps per revolution at 1/16 microstepping?

Puzzle 3: Seal-in. In the start–stop ladder rung in the PLC article, what happens if the STOP button's wire breaks, and why is that the safer behaviour?

Puzzle 4: Encoder. An incremental encoder produces 1,000 pulses per revolution per channel. Using quadrature decoding (counting both edges of both channels), how many counts per revolution does the controller see?

Plan your gripper: bill of materials

Part	Qty	Material / specification	Estimated cost (₹)
Motor or servo	1		
Linkage, gears or cam			
Fingers and pads	2		
Frame and fasteners			
Controller and power			
Total			

Plan your gripper: test plan

Object	Grip method	Result (pass / fail)	Notes
Raw egg			
Steel bolt			
Plastic bottle cap			

Answer key

Quiz: 1-B, 2-C, 3-B, 4-A, 5-C, 6-B, 7-B, 8-C, 9-A, 10-A, 11-A, 12-B

Puzzle 1: maximum 1.0 m (fully stretched), minimum 0 m (folded back on itself).

Puzzle 2: 200 steps per revolution; 3,200 microsteps at 1/16 microstepping.

Puzzle 3: The normally closed contact opens, the coil drops out and the motor stops, so a wiring fault leads to a safe stop.

Puzzle 4: 4,000 counts per revolution (4 × 1,000).

Next year's invitation

Have a better puzzle, a sharper quiz question or a challenge of your own? Send it to the editorial team. The best contributions will appear in ROBOVERSE 2027, with your name on them. Details are on the last page.

Glossary

Term	Meaning
Actuator	A device that turns a control signal into motion or force, such as a motor or cylinder.
AMR	Autonomous mobile robot: maps its surroundings and navigates its own route.
Cobot	A collaborative robot designed to work safely close to people.
Degrees of freedom	The number of independent motions a mechanism can make.
Digital twin	A virtual model kept in step with a physical asset, with data flowing both ways.
DH parameters	Four numbers per link that describe an arm's geometry: link length, twist, offset and joint angle.
Edge computing	Processing data close to the machine instead of in a distant data centre.
Encoder	A sensor that reports the position or speed of a shaft.
End-effector	The tool at the end of a robot arm, such as a gripper or a welding torch.
FK / IK	Forward kinematics (joint angles to tip position) and inverse kinematics (tip position to joint angles).
HMI	Human–machine interface: the screen or panel an operator uses to monitor and control a machine.
Jacobian	A matrix relating joint velocities to the velocity of the tip.
PID controller	A feedback controller that combines proportional, integral and derivative action on the error.
PLC	Programmable logic controller: a rugged industrial computer that runs control logic in a repeating scan.
ROS 2	An open-source framework of tools and libraries for building robot software.
SCADA	Supervisory control and data acquisition: software for monitoring and controlling processes.
Sim-to-real	Training or testing in simulation and then transferring the result to a real robot.
Singularity	An arm configuration in which it loses the ability to move in some direction.

CLOSING PAGES

Contributors and acknowledgements

Every name matters. This page records everyone who made the issue.

Student contributors

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How an article reaches the page (proposed workflow)

Step	What happens	Who
1 Submit	The author sends a Word document and images by email.	Student or faculty author
2 Review	A faculty reviewer checks technical accuracy and sources.	Faculty editorial board
3 Edit	Language and length are edited; the author approves substantial changes.	Section editors
4 Layout	Text, figures and captions are laid out in the issue.	Design and media team
5 Approve	The chief editor signs off the final proofs.	Chief editor
6 Publish	The issue is printed and shared as a PDF for internal circulation.	Editorial team

CALL FOR CONTRIBUTIONS

Your turn.
Write for ROBOVERSE.

For students and faculty members of the department

What we publish

- Technical articles and technology explainers
- Student projects, prototypes and case studies
- Original diagrams, technical illustrations and photographs
- Career perspectives and research summaries in accessible language
- Quizzes, design challenges and innovation ideas

Editorial principles

- Original work, or work you have permission to republish
- Cite sources for technical claims and borrowed figures
- Permission for identifiable photographs and graphics
- No confidential information without approval
- Authors approve substantial edits and the final version

Submission guidelines

Item	Requirement
Short technical article	300–500 words
Feature article	600–800 words
Project showcase	250–400 words + photographs
File format	Word document
Images	High resolution, with captions
Author details	Name, semester / designation, affiliation, email
References	Reliable sources for technical facts

How to submit

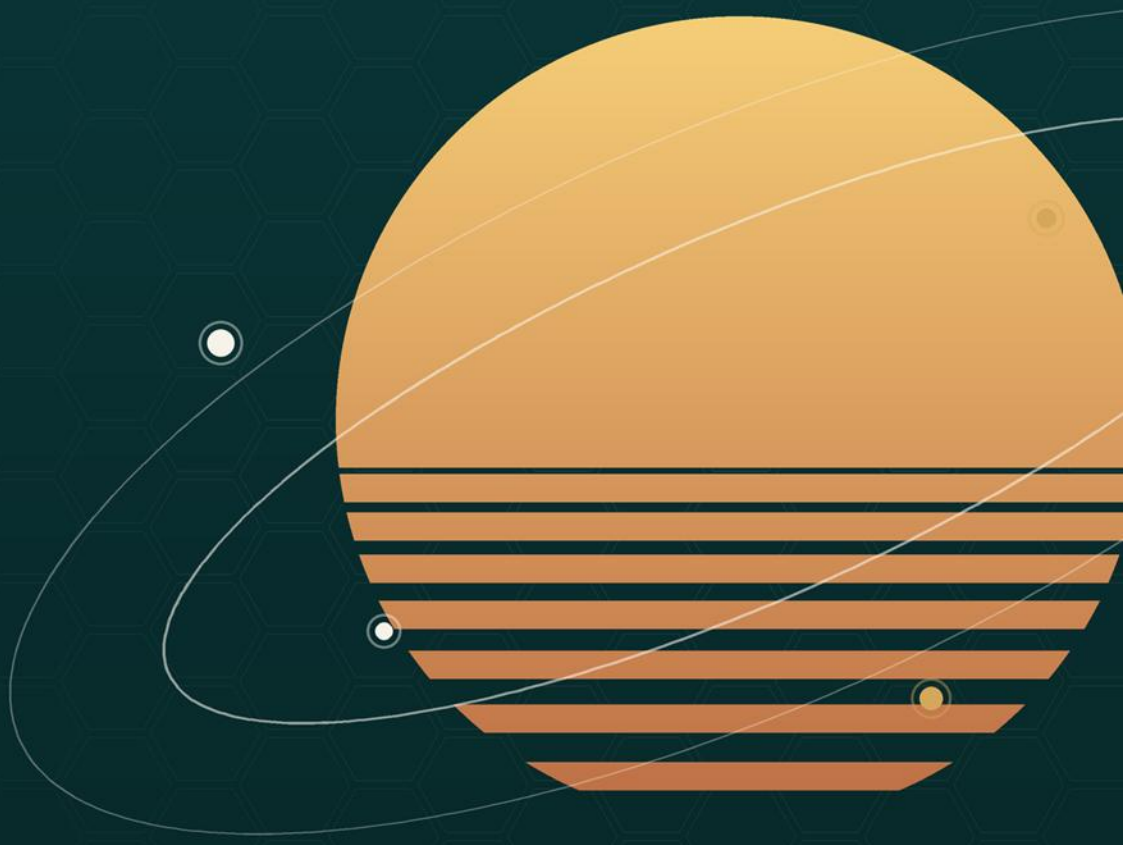
Email your Word document and images to: robotics.hod@aitmbgm.ac.in

Faculty reviewers will respond with feedback. Accepted contributions appear in the full annual edition.

Key dates for the next issue

Milestone	Date
Call for contributions opens	17. 10. 2026
Final drafts and images due	June 2027
Next issue released	Oct 2027

ASSOCIATION OF ROBOTICS ENGINEERS



ROBOVERSE

ROBOTICS & AUTOMATION TECHNICAL MAGAZINE 2026

ANGADI INSTITUTE OF TECHNOLOGY AND MANAGEMENT

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