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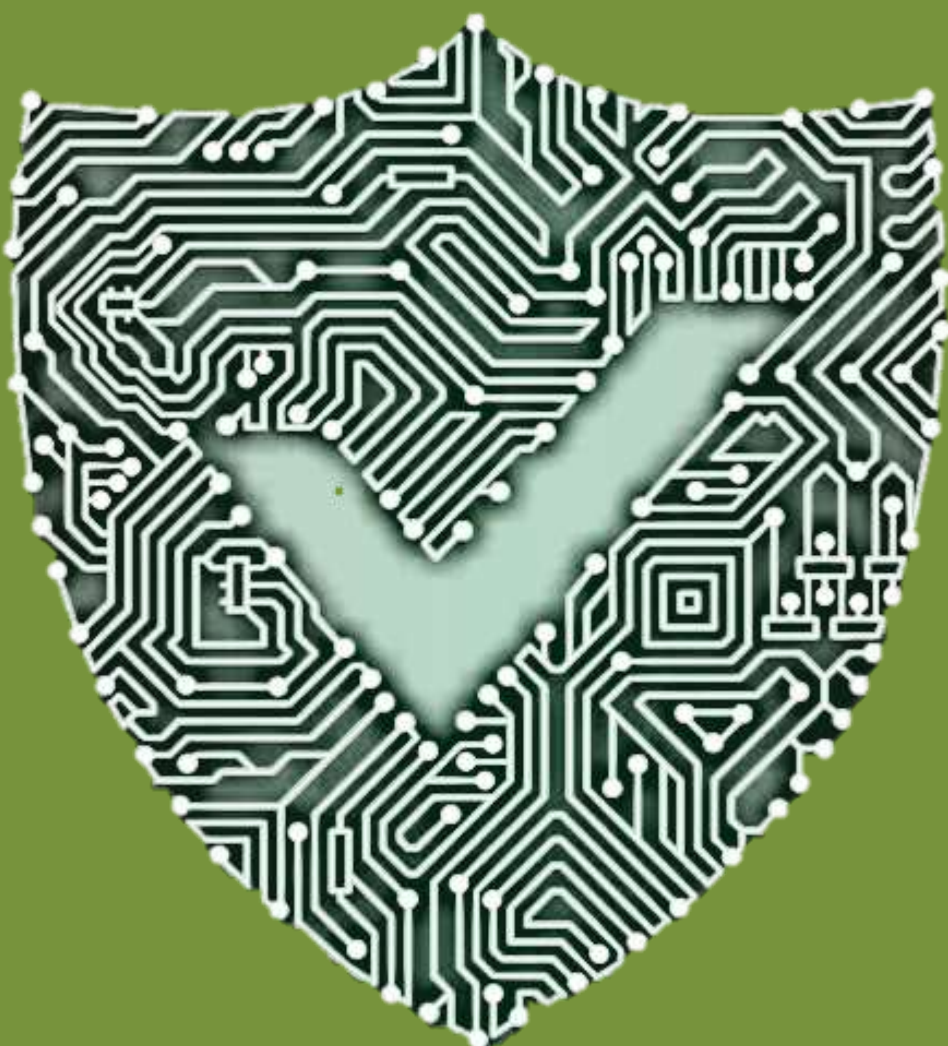
TECHTRONICS



Department Of Mechatronics Engineering

DECEMBER 2024

TECHTRONICS

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Department of Mechatronics Engineering

JYOTHI ENGINEERING COLLEGE, CHERUTHURUTHY

THRISSUR 679 531

VISION OF THE INSTITUTE

Creating eminent and ethical leaders through quality professional education with emphasis on holistic excellence.

MISSION OF THE INSTITUTE

- To emerge as an institution par excellence of global standards by imparting quality engineering and other professional programs with state-of-the-art facilities.
- To equip the students with appropriate skills for a meaningful career in the global scenario.
- To inculcate ethical values among students and ignite their passion for holistic excellence through social initiatives.
- To participate in the development of society through technology incubation, entrepreneurship and industry interaction.

VISION OF THE DEPARTMENT

Create eminent and ethical leaders committed to profession and society in the field of Mechatronics through quality professional education to excel in industrial automation and innovation.

MISSION OF THE DEPARTMENT

- To impart orientation to meet the challenges of the modern industry and provide motivation for research.
- To provide quality education to create graduates with professional and social commitment.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO I : Graduates shall have fundamental and advanced knowledge in electronics and communication engineering along with knowledge in mathematics, science and computing and get employed in national or international organizations or government agencies.

PEO II : Graduates shall have ability in analyzing, designing and creating innovative solutions which lead to a lifelong learning process or higher qualification, making them experts in their profession thus helping to solve electronics & communication engineering and social problems.

PEO III: Graduates shall have good organizing capabilities, presentation skills, communicating ability, leadership, team work and ethical practices.

PROGRAMME SPECIFIC OUTCOMES (PSO's)

Graduate possess:

- Professional skills: Associate the concepts related to Electronics, Communication, Embedded Systems, Signal Processing and VLSI to solve real life problems.
- Problem solving ability: Comprehend technology advancement to analyze and design systems using modern design tools for the benefit of the society.
- Lifelong learning and ethical Values: Have good communication skills, work as a team, develop leadership qualities, become professionals or entrepreneurs with ethical values.

PROGRAMME OUTCOMES (POS)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. 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 the public health and safety, and the cultural, societal, and environ-mental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and re- search methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and mod- ern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and

the consequent responsibilities relevant to the professional engineering practice.

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

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the 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.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Prof. Dr ANOOPA JOSE CHITTILAPPILLY

HOD

The discipline of Mechatronics Engineering, by its very nature, demands integration, innovation, and foresight. Here in the department, we are committed to fostering a learning ecosystem where mechanical, electrical, computer, and control systems coalesce. Our robust curriculum, supported by an exceptional faculty, is meticulously crafted to ensure that every student not only grasps the core principles but also masters the practical application necessary for complex problem-solving. We empower our students to be the architects of the future, ready to tackle the complexities of Industry 4.0 and beyond. I strongly urge all our young engineers to seize the numerous resources available—engage deeply in specialized labs, collaborate on interdisciplinary research, and leverage our strong industrial connections. My sincere applause goes to the editorial team for the successful launch of TECHTRONICS. This magazine serves as a vibrant mirror reflecting the technical prowess and creative spirit of our department. May it continue to inspire and document the journey of excellence.

MAGAZINE COMMITTEE MEMBERS

NYNI K. A.
Assistant Professor

JAIN VARGHESE
Assistant Professor

JITHIN GEORGE
JEC21MC013

GRACE MARIA GEORGE
JEC21MC011

"We would like to thank all the staff and students of the Mechatronics Department for their constant effort in the launching of the Magazine.

We are also thankful to our management and principal for their support and encouragement. We are grateful to our reviewers for their frank opinions and constructive suggestions, from our colleagues and students."

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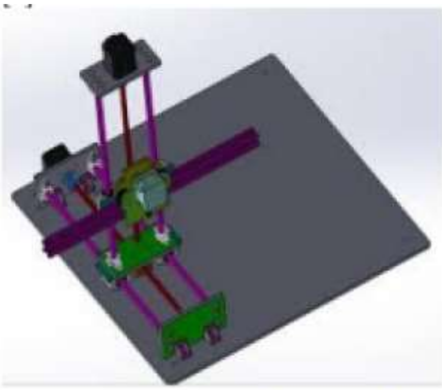
CARTESIAN AXIS ROBOT CONTROL SYSTEM IN INDUSTRIAL APPLICATIONS

Rince Mathew

Cartesian robots are transforming industrial automation with their ability to execute precise linear movements along the X, Y, and Z axes. This student-led seminar explored the control systems that drive these robots, focusing on multi-axis coordination, object recognition, and cost-effective implementation strategies. Through a detailed literature review, the project examined PID control for stable positioning, image processing for intelligent sorting, and the integration of PLC and Arduino platforms for warehouse automation. The seminar highlighted the importance of sensor fusion, mechanical design, and robust control algorithms in achieving high-performance outcomes. Discussions emphasized how simplified designs and open-source software can enable low-cost robotics without compromising functionality. By adding extra axes, Cartesian robots can perform complex tasks such as unloading plastic injection machines and executing intricate assembly operations. A key takeaway was the successful integration of image processing with robotic control, allowing machines to identify and classify objects based on visual cues—crucial for quality control and automated sorting. The project also explored how these robots can be seamlessly integrated with other automation systems like conveyors and machine tools, creating flexible and efficient manufacturing cells.

Looking ahead, the seminar underscored the potential of machine learning and artificial intelligence to further enhance adaptability and decision-making in robotic systems. This project offers a compelling glimpse into the future of smart factories, where Cartesian robots play a pivotal role in scalable, intelligent automation.

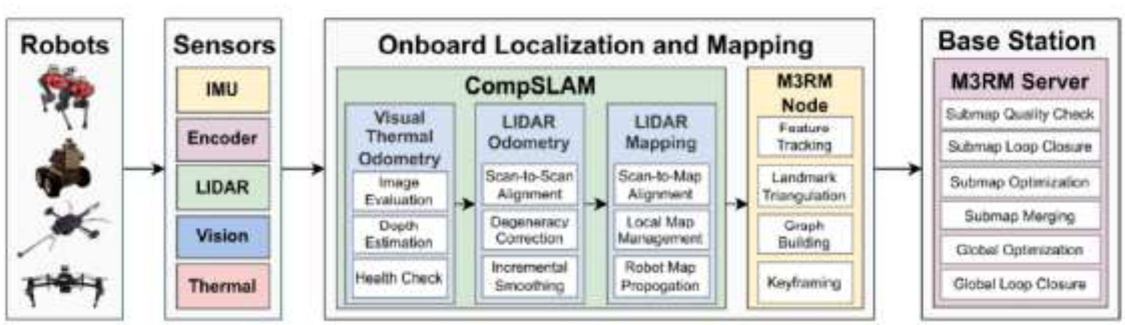


(c) Low Cost Cartesian Robot Final Design

SLAM BASED AUTONOMOUS NAVIGATION

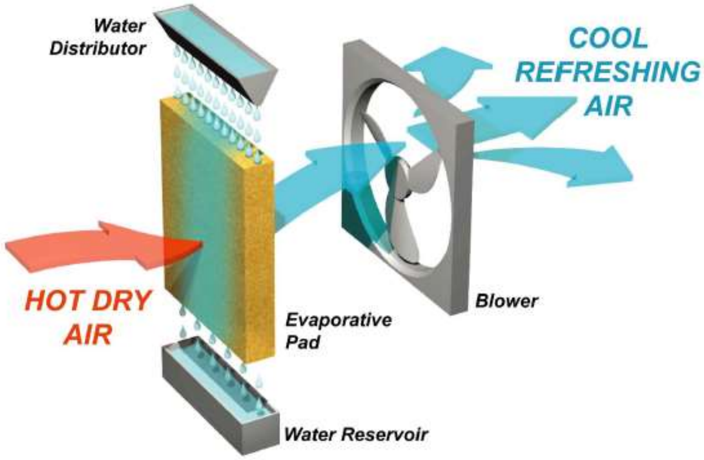
Grace Maria George

Autonomous navigation is a cornerstone of modern robotics, enabling machines to move intelligently without human intervention. Central to this capability is SLAM (Simultaneous Localization and Mapping), a technique that allows robots to map their surroundings while tracking their own position. This student project investigates SLAM architectures with a focus on LIDAR-centric systems, particularly suited for environments lacking ambient light or GPS access. The seminar explored how LIDAR-based SLAM offers superior depth perception and mapping accuracy in foggy, dusty, or poorly lit conditions. Compared to visual-only SLAM, which performs well in structured, well-lit spaces, LIDAR systems demonstrated greater robustness in extreme scenarios. Hybrid approaches integrating visual, LIDAR, and inertial sensors emerged as the most reliable, compensating for individual sensor limitations. Key algorithms such as LOAM, LIO-SAM, and ORB-SLAM were analyzed. LOAM and LIO-SAM, which fuse LIDAR with IMU data, showed exceptional performance in long-term mapping with minimal drift. ORB-SLAM, while effective in visual environments, struggled in dynamic or low-visibility settings due to its reliance on visual cues. This seminar not only compares SLAM techniques but also outlines the steps to implement a robust autonomous system. With applications ranging from disaster response to industrial automation, the insights gained here pave the way for smarter, more resilient navigation systems in the future.



A COMPREHENSIVE METHODS ON COOLING SYSTEMS IN INDUSTRIAL MACHINES

Adarsh Raphy



Effective cooling is vital for maintaining the performance, longevity, and energy efficiency of industrial machinery. This seminar explored a wide range of cooling techniques—air, liquid, and hybrid systems—highlighting their principles, advantages, and limitations. Selection of the appropriate method depends on factors like heat dissipation needs, environmental conditions, and cost constraints. The seminar emphasized recent innovations such as Variable Refrigerant Flow (VRF) systems, which offer precise temperature control and energy savings. Smart cooling technologies now enable remote monitoring, predictive maintenance, and real-time optimization. Engineers use tools like Computational Fluid Dynamics (CFD) to simulate heat transfer and identify hotspots, ensuring optimal system design. Sustainability was a key theme, with growing interest in natural refrigerants and eco-friendly techniques like evaporative and adiabatic cooling. The seminar also examined control systems, from microcontrollers in basic setups to PLCs in complex industrial environments, capable of managing multiple sensors and actuators. Emerging technologies such as nanotechnology and ferrofluids were discussed for their potential to revolutionize heat management. These innovations promise enhanced thermal conductivity and smarter cooling responses. By analyzing current research and practical applications, the seminar provided valuable insights into designing efficient, adaptable, and sustainable cooling systems for future industrial machines.

OBJECT DETECTION SENSORS

Amal Krishna

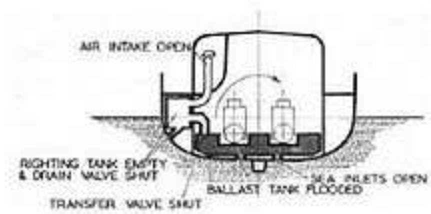
Object detection sensors are revolutionizing how machines perceive and interact with their surroundings. This seminar explored a wide array of sensor technologies—cameras, LiDAR, radar, ultrasonic, and thermal imaging—highlighting their critical role in industries ranging from robotics and transportation to healthcare and environmental monitoring.

A major focus was on search and rescue applications, where sensors like infrared and thermal cameras detect body heat even in low visibility conditions. Ground Penetrating Radar (GPR) emerged as a standout technology, capable of revealing hidden objects beneath rubble or terrain. Sensitive microphones and electromagnetic induction sensors further enhance detection by capturing faint sounds and identifying buried utilities, ensuring safe navigation during rescue missions. The seminar also examined gas sensors, including CO_2 and O_2 detectors, which help identify human presence and potential hazards like leaks. These sensors provide vital data for assessing structural integrity and environmental safety. In industrial contexts, GPR aids in mapping underground infrastructure, while oxygen and carbon dioxide sensors optimize emissions and air quality in automotive, medical, and smart building systems. Thermal cameras were highlighted for their versatility in surveillance, firefighting, and diagnostics, offering clear visuals in smoke-filled or dark environments. Together, these technologies form a multi-layered detection system that enhances safety, efficiency, and decision-making. This project underscores how sensor integration is reshaping modern engineering, empowering smarter systems and safer environments across diverse domains.

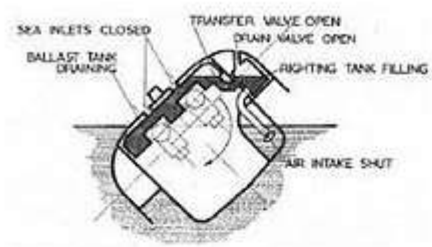
SELF-RIGHTING MECHANISM OF BOAT

Muhammed Hijas

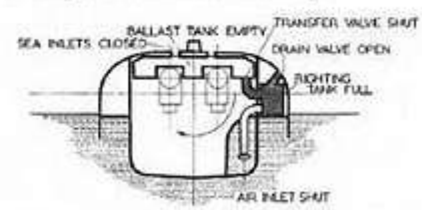
Patrol boats operating in extreme maritime conditions face significant risks of capsizing, making self-righting mechanisms a critical design feature. This study investigates how varying deckhouse heights influence stability, identifying a minimum height of 2.07 m as essential for maintaining an effective self-righting moment. Traditional static stability assessments often fail to capture real-world complexities, so advanced methodologies—such as enhanced static stability analysis and numerical simulations validated through towing tank experiments—were explored to provide more accurate predictions. The research highlights the importance of center of gravity and buoyancy in optimizing self-righting performance, particularly in narrow-beamed vessels prone to excessive rolling. Three key techniques were examined: inherent self-righting designs, inflatable bag systems, and movable ballast solutions. Inflatable bags, made from heavy-duty polymer fabrics, rapidly inflate with CO_2 upon capsizing to provide additional buoyancy, while sophisticated control systems integrate sensors and algorithms to monitor vessel orientation and manage stabilization in real time.



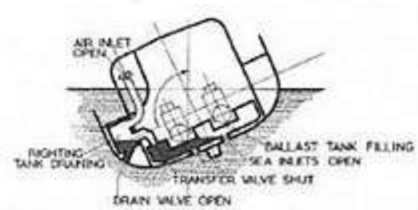
a: Upright & commencing roll to starboard.



b: 130 degrees – ballast transfer under way.



c: 180 degrees – ballast transfer complete & self-righting commences. Boat continues rolling to starboard.



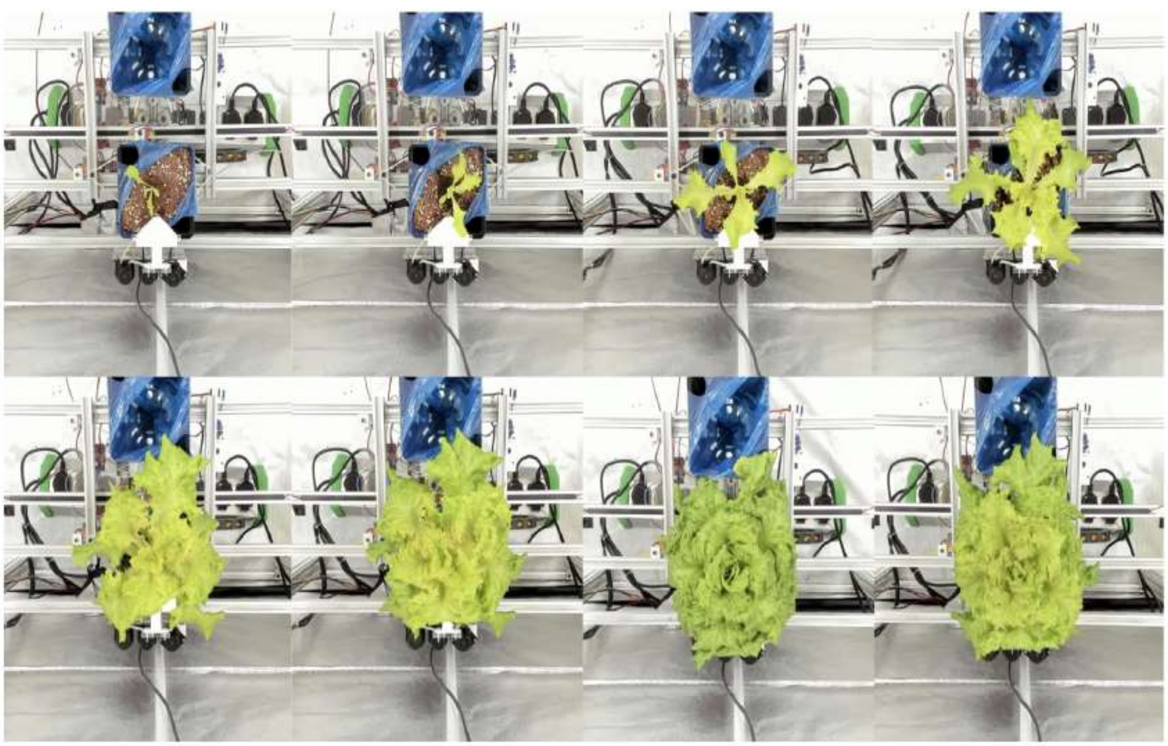
d: Boat returns upright having rolled to starboard through 360°.

Ballast-based methods and hull design also play vital roles. Strategically placed weights lower the center of gravity, generating torque to restore balance, while wide-beam hulls and catamaran structures enhance buoyancy and stability. Together, these approaches ensure vessels can recover quickly and safely after overturning. Ultimately, the study underscores the need for integrated solutions combining empirical testing with advanced computational simulations. By tailoring self-righting strategies to vessel type and operational context, engineers can design patrol boats that withstand unpredictable maritime challenges, safeguarding lives and assets during critical missions such as search and rescue or law enforcement.

MATERIAL HANDLING SYSTEM FOR MICROGREENS

Jithin George Thomas

Microgreens, prized for their rapid growth, rich flavor, and high nutritional value, have become a staple in health-conscious diets and gourmet cuisine. Despite their popularity, cultivating these delicate plants presents unique challenges. Traditional handling methods often involve labor-intensive processes, inefficient storage, and poor inventory tracking, which compromise quality and increase waste. To address these issues, this seminar explores the design of an automated material handling system tailored for microgreens production.



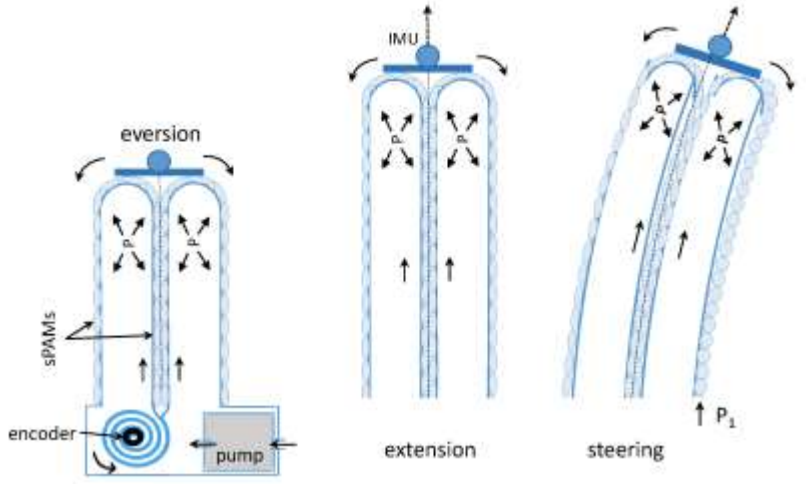
The proposed system integrates a simplified vertical conveyor mechanism that streamlines operations from seed storage and germination to harvesting and packaging. By leveraging vertical stacking, growers can maximize space utilization, making the system ideal for urban and indoor farming environments where space is limited. Real-time inventory management ensures precise tracking, while automated monitoring of soil moisture, humidity, and temperature maintains optimal growing conditions. This minimizes damage to crops and enhances both quality and shelf life. Automation also reduces reliance on manual labor, freeing workers to focus on higher-value tasks such as quality assurance and system oversight. The integration of sensors and smart controls provides consistent environmental regulation, accelerating growth cycles and improving yield uniformity. Furthermore, sustainable practices, such as efficient energy use and reduced waste, make the system adaptable to the rising demand for fresh, high-quality produce. Ultimately, the vertical conveyor-based material handling system represents a scalable, efficient, and sustainable solution for microgreens farming. By combining automation, precision, and environmental control, it empowers growers to meet market demands while ensuring long-term success in competitive agricultural industries.

BIO MIMICRY OF ROBOTS

Sudheesh Dev

Biomimicry—the art of emulating nature's designs and strategies—has opened new frontiers in robotics. By studying biological systems, engineers are developing robots that are more efficient, adaptable, and capable of navigating complex environments. This seminar explored how biomimicry is revolutionizing fields such as healthcare, environmental science, and disaster response, with a particular focus on exploration and Search and Rescue (SAR) applications.

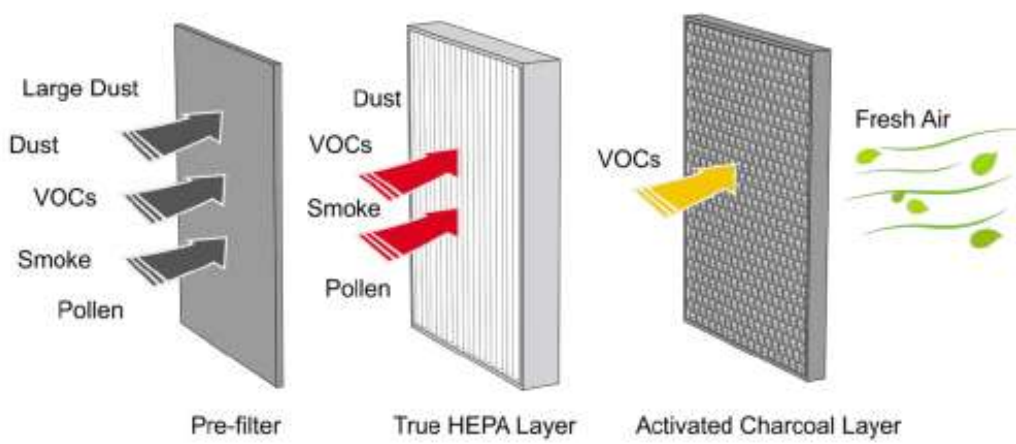
One standout innovation is the vine robot, inspired by the growth patterns of natural vines. Unlike traditional robots that rely on wheels or tracks, vine robots extend through inflation, allowing them to maneuver into narrow, cluttered spaces without complex locomotion. Their soft, tubular structure conforms to irregular surfaces, making them ideal for unstable environments like collapsed buildings or rubble fields. These robots offer unmatched flexibility and adaptability, reaching areas inaccessible to rigid SAR robots. Their minimal surface pressure and plant-like extension mechanisms make them highly effective in low-stability zones. By mimicking the way vines grow and navigate, these robots can perform delicate tasks with precision and resilience. The seminar emphasized how biomimicry fosters innovation by translating nature's solutions into robotic capabilities. Vine robots exemplify this approach, offering a promising future for rescue missions and exploration in hazardous terrains. As robotics continues to evolve, biomimicry stands as a powerful design philosophy, bridging the gap between nature and technology to solve human challenges with elegance and efficiency.



AIR FILTRATION SOLUTIONS: EXPLORING CONVENTIONAL AND NOVEL APPROACHES

R Devanand

Air pollution is a growing global concern, especially in urban areas where emissions from vehicles, industries, and construction contribute to hazardous air quality. Pollutants such as particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs) are linked to serious health issues, making air filtration a public health imperative. This seminar explored both conventional and emerging filtration technologies designed to combat these airborne threats. Traditional systems like HEPA filters, activated carbon filters, and catalytic converters have proven effective in removing specific pollutants. HEPA filters excel at capturing PM, while carbon filters absorb VOCs, and catalytic converters neutralize toxic gases. However, these systems face limitations in high-pollution environments, especially when dealing with fine particulates and complex chemical compositions. To address these gaps, advanced technologies such as PECO (Photo Electrochemical Oxidation) and transparent PAN nanofiber filters have



emerged. PECO breaks down pollutants at a molecular level using nanocatalysts, while PAN filters maintain visibility and capture fine particles—ideal for urban applications. Innovations like solar-powered filtration systems are also being explored to enhance energy efficiency and accessibility. The seminar emphasized a multifaceted approach to air purification, integrating various technologies to tackle diverse pollutants. As awareness of indoor air quality grows, future research will focus on improving filter durability, expanding molecular-level purification, and developing sustainable, smart filtration systems. These advancements are essential for building healthier, more resilient cities and improving overall quality of life.