KAMARAJ COLLEGE OF ENGINEERING & TECHNOLOGY ®

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

S.P.G.Chidambara Nadar - C.Nagammal Campus

S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

**Department of Mechatronics Engineering**

# MECHATRONZ

**2023 - 2024**

## DEPARTMENT OF
# MECHATRONICS ENGINEERING

### VISION

To make the department of Mechatronics Engineering unique in the field of research and development towards industrial automation & robotics.

### MISSION

To impart highly innovative and technical knowledge in Mechatronics Engineering to the urban and unreachable rural students through "Total Quality Education".

### PROGRAMME EDUCATIONAL OBJECTIVES

Graduates will be able to apply their multi-disciplinary knowledge to formulate, design, develop and analyse Mechatronics System. Graduates will be able to come up with solution for any real time problems in the field of Mechatronics Engineering and allied areas demanded by the Industry and Society. Graduates will be able to get familiarized with economical issues in Mechatronics Engineering and work in multi-disciplinary teams with ethical code of conduct.

### PROGRAM SPECIFIC OUTCOMES

**PSO1:** Graduates will be able to apply their knowledge in sensors, drives, actuators, controls, mechanical design and modern software & hardware tools to design and develop cost-effective mechatronics systems.

**PSO2:** Graduates will be able to become technocrats and entrepreneurs, building the attitude of developing new concepts on emerging fields and pursuing higher studies.

# PROGRAM OUTCOMES

*Engineering Graduates will be able to*

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

**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.

**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 environmental considerations.

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

**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**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.

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

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

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

**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.

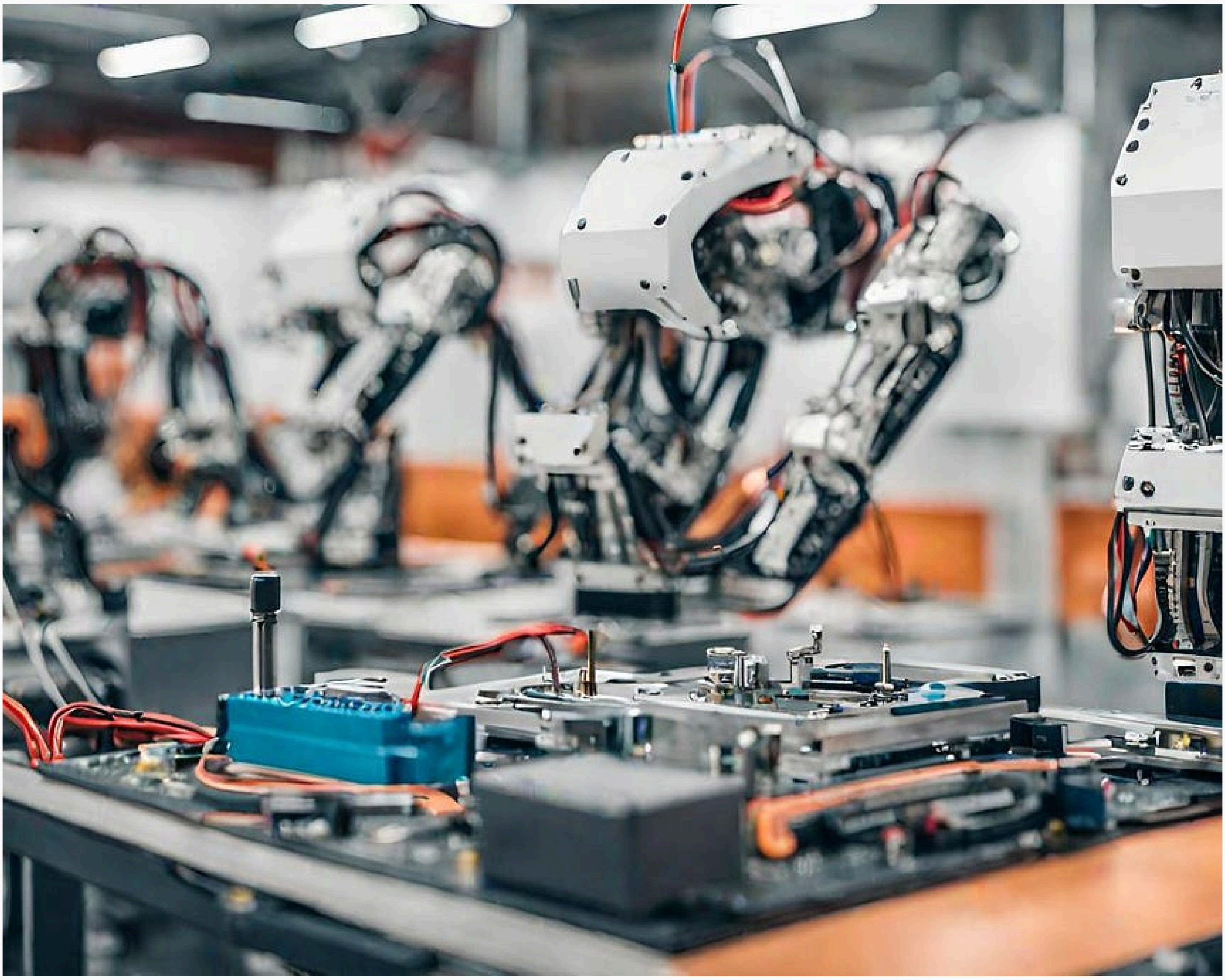
**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**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.

About the Department of

# MECHATRONICS ENGINEERINIG

Our college, with a vision to promote quality technical education to rural communities, was established in the year 1998 with four engineering branches. Recognizing the importance of core engineering disciplines, our long-standing aspiration to introduce a Mechatronics Engineering program was realized in the academic year 2014–2015. Mechatronics Engineering is a well-recognized interdisciplinary course that is gaining significant importance in the industrial world. What sets this program apart from other B.E. programs are its unique features and practical approach. Students of this program are this program also provides exposure to Bio-Mechatronics, which integrates mechanical systems with human physiology. Students will undertake their final year projects in leading industries, enabling them to apply theoretical knowledge to real life problems. This industrial exposure prepares them to tackle more challenging and innovative application-oriented projects based on real world situations. Through this project work, students develop decision-making skills, adaptability, and the ability to work in diverse team environments. Well-equipped with computer skills. Trained in operating microcontrollers and programmable logic controllers (PLCs). Experienced in handling industrial sensors, as well as hydraulic, pneumatic, and electric drives. Skilled in mechanical structure design and learning various mechanisms involved in manufacturing processes.



# about the
# MECHATRON'Z

This magazine presents a comprehensive overview of the Department of Mechatronics Engineering and its activities for the academic year 2023-2024

The structure of mechanics, The pulse of electronics, The brain of intelligence.

**DEPARTMENT OF**
# MECHATRONICS ENGINEERING

## Faculty profile

| S.No | Name of the Faculty with Designation | Qualification | Specializatin |
|---|---|---|---|
| 1 | Dr. K. Kannan,<br>Professor & Head | M.E., Ph.D., | Digital Image Processing, Machine Vision, Embedded System and Robotics |
| 2 | Dr.M.Sudalaimani,<br>Associate Professor | M.E., Ph.D., | Automation and Control Systems |
| 3 | Dr. S. Rajesh Babu<br>Assistant Professor | M.E., Ph.D., | Power Quality, Renewable Energy Systems, Machine Learning |
| 4 | Dr. P. Balasundar,<br>Assistant Professor | M.E., Ph.D., | Manufacturing, Composite Material, Tribology and Powder Metallurgy |
| 5 | Mr. A. Arul Kumar,<br>Assistant Professor | M.E., (Ph.D)., | Renewable Energy Source, Power Electronics Drives and Power Quality |
| 6 | Mr. S. Wesley Moses Samdoss,<br>Assistant Professor | M.E., (Ph.D)., | Robotics, Embedded Systems, IoT, and Machine Learning |
| 7 | Mr. A. Ganesan,<br>Assistant Professor | M.E., | Thermodynamics, Heat Transfer, Fluid Mechanics Refrigeration and Air Conditioning |

# FACULTY PUBLICATIONS

Biomass Conversion and Biorefinery.

"Cellulosic fiber extraction and characterization from derris scandens (Roxb.) benth root for polymer composite reinforcements."

**- M. Prithiviraj, Rathinavel Subbiah, P. Manimaran, K. Kannan**

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International Journal of Engineering Technology and Management Sciences.

"Valet Robot"

**- K. Kannan**

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International Journal of Engineering Technology and Management Sciences

"AI Based Solar Panel Cleaning Robot"

**-K. kannan**

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Indian Journal of Science and Technology.

"Enhancement of Proton Density Magnetic Resonance Images using Histogram Equalization and Unsharp Masking."

**- K. Kannan**

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International Journal of Advanced Networking and Applications

"On The Performance Of Histogram Equalization Techniques In Enhancement Of Proton Density Weighted Magnetic Resonance Image."

**-K. Kannan, S. Wesley Moses Samdoss**

ACS omega

"Fabrication and Testing of Crop Waste Ceiba pentandra Shell Powder Reinforced Biodegradable Composite Films."

**-Kaliraj M, Narayanasamy P, Balavairavan B, Balasundar P**

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Journal for Vinyl Additive Technology

"Effect of alkali-treated Putranjivaroxburghii seed shell filler on physico-chemical, thermal, mechanical, and barrier properties of polyvinyl alcohol-based biofilms."

**-Muthukrishnan K, Selvakumar G, Balasundar P, Balavairavan B, Narayanasamy P, Indran S, Sanjay, SuchartSiengchin**

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Heliyon

"Effect of Voltage and Concentration of Polyetherimide on Surface Morphology and Corrosion Properties of AZ91D by Electro-Spin Coating."

**-S David Blessley, P Narayanasamy, P Balasundar, B Balavairavan**

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TechnischeSicherheit

"Multi-focused Image fusion using Higher Density DWT."

**-K.Kannan, S.WesleyMoses Samdoss, A.Ganesan**

# PATENT

Title: **An Innovative Design of Sustainable Table Using Corporate Waste**
Author (s): Mr. G. Aravindth Aarya & NSS Team of our College

# COPY RIGHT REGISTERED

Tittle: **Manufacturing Technology and Sensors Laboratory Manual**
Author (s): Mr. S. David Blessley, Mr. A. Arulkumar, Dr. K. Kannan, Mr. S. Wesley Moses Samdoss
Title: **Mechatronics Laboratory Manual for Mechanical Engineers**
Author (s): Dr. K. Kannan, Mr. S. Wesley Moses Samdoss

# NPTEL CERTIFICATIONS BY FACULTY MEMBERS

| S. No | Name of the Faculty | Name of the Programme | Week |
|---|---|---|---|
| 1 | Dr. K. Kannan | Introduction to Internet of Things | 12 Week |
| 2 | Dr. K. Kannan | Introduction to Industry 4.0 and Industrial IoT | 12 Week |
| 3 | Dr. S.Rajeshbabu | Experimental Robotics | 4 Week |
| 4 | Mr.A.Arulkumar | Introduction to Internet of Things | 12 Week |
| 5 | Mr.A.Arulkumar | Deep Learning | 12 Week |
| 6 | Mr. S. Wesley Moses Samdoss | | 12 Week |

# ACTIVITIES FOR THE ACADEMIC YEAR 2023-2024

Guest Lecture on
**Three Days Faculty Development Program on "Internet of Things"**- 11th July 2023

On 11-07-2023 to 14-07-2023. The program was conducted under the Association of Mechatronics with the objective of enhancing the technical knowledge of faculty members in emerging IoT technologies. The resource person for the program was Er. A. Kesavan, CEO of Quantanics Techserv Pvt Ltd, Madurai. He delivered expert sessions on the fundamentals of IoT, architecture of IoT systems, sensors, connectivity protocols, and real-time applications in industrial automation and smart systems. During the sessions, participants were introduced to practical concepts such as IoT device communication, cloud integration, and data monitoring techniques. Demonstrations and interactive discussions enabled faculty members to understand how IoT can be implemented in modern engineering applications including smart homes, smart industries, and autonomous systems.

Guest Lecture on
**Six Days Faculty Development Program on "CME339-Additive Manufacturing"**- 14th July 2023

On 22 July 2023. The event aimed to provide participants with knowledge about modern manufacturing technologies and their industrial applications.
The session featured distinguished resource persons from various academic and industrial institutions, including faculty members from Rajalakshmi Engineering College, Chennai, Ayya Nadar Janaki Ammal College, Sivakasi, and experts from CADD Centre, Madurai and Amrita Vishwa Vidyapeetham. The speakers shared their expertise on the principles, design techniques, and practical applications of additive manufacturing in modern industries.

**Guest Lecture on: Advanced Training on "Industrial Pneumatic Controls"**
**03rd July 2023**

On 03 August 2023. The objective of the program was to enhance the understanding of pneumatic systems used in modern industrial automation. The session was conducted by Er. S. Sasikumar, Deputy Manager – Training & Marketing at SMC Corporation (India) Pvt. Ltd., Chennai. The resource person delivered an informative session on the fundamentals and advanced concepts of pneumatic control systems used in manufacturing industries.

**Guest Lecture on**
**Drones Technology 13th July 2023**

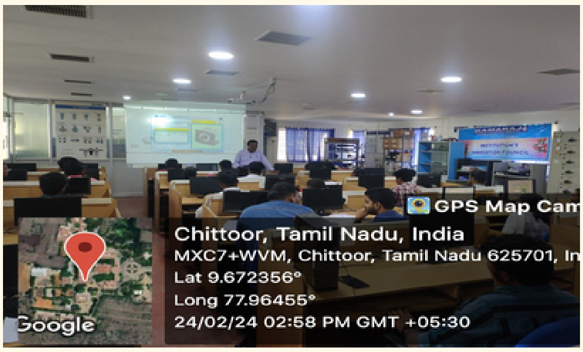
Drone technology, also known as Unmanned Aerial Vehicle (UAV) technology, has rapidly transformed from a military-focused innovation into a powerful tool across multiple industries. During the insightful session conducted by Er. Gopi Kupparao, Chief Operating Officer of You Can Fly, Puducherry, students were introduced to the vast potential and real-world applications of drones.


**Guest Lecture on**
**“Stress Management in Natual Ways”**
**21 - 09 - 2023**

Guest Lecture on “Stress Management in Natural Ways” was delivered by Mr. G. Maran, Proprietor of Natural Way Foods and Medicines, Sivakasi. He explained simple and effective natural techniques such as healthy diet, meditation, and lifestyle changes to reduce stress. The session emphasized the importance of mental well-being for a balanced and healthy life.


**Guest Lecture on Advanced Training on “ Industrial Pneumatic Controls” for the students (EEE & MECH) of THIYAGARAJAR COLLEGE OF ENGINEERING, Madurai. Batch - 1 23 - 02 - 2024 & 24 - 02 - 2024**

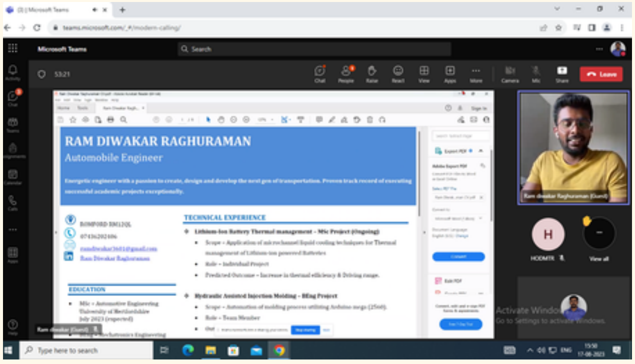
The training provided students with in-depth knowledge of pneumatic systems, industrial automation practices, and real-time applications used in modern industries. Students gained practical exposure to pneumatic components, control techniques, and system design, enhancing their technical skills and industry readiness.



# ALUMNI LECTURE

**Alumni interaction on "Awareness about higher studies in abroad for Mechatronics Engineering" 17 - 08 - 2023**

An alumni interaction session on "Awareness about Higher Studies Abroad for Mechatronics Engineering" was organized for the students to provide guidance on pursuing international education opportunities. The session was delivered by Mr. R. Ram Diwakar, B.E., M.Sc. (Automotive Engineering), currently associated with the University of Hertfordshire, London, United Kingdom.




**Alumni Interaction On "Higher Studies Opportunities In Abroad For Mechatronics Engineers" 19 - 09 - 2023**

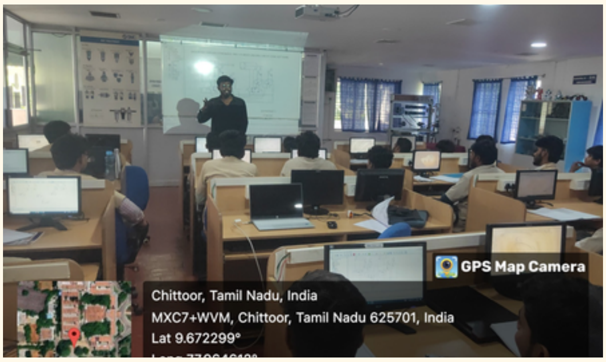
An alumni interaction session on "Higher Studies Opportunities in Abroad for Mechatronics Engineers" was organized to guide students in exploring global education pathways. The session was delivered by Mr. Prince Yona R L C (2018–2022 Batch), currently pursuing M.Sc. in General Management at PFH Private Hochschule, Göttingen, Germany. He shared his personal experience on studying abroad, including application procedures, admission requirements, cost of education, scholarship options, and career opportunities.


**Alumni Lecture on "Career Guidance" 30 - 09 - 2023**

A Career Guidance session was organized to help students understand industry expectations and career opportunities in the automotive and software domains. The session was delivered by Mr. Rilwan Fayas P, Specialist – Scrum Master (Automotive Domain) at TATA Elxsi, Trivandrum. He shared insights on career planning, industry trends, the role of Agile and Scrum in the automotive sector, and the skills required to succeed in a competitive job market. The session was highly informative and helped students gain clarity on their career paths.


**Alumni Lecture on "Design of Hydraulic and Pneumatic Circuits" 13 - 03 - 2024**

An alumni lecture on "Design of Hydraulic and Pneumatic Circuits" was organized to enhance students' understanding of fluid power systems and their applications. The session was delivered by Mr. Selvakumaravel E (2019–2023 Batch), currently pursuing M.S. in Robotics and Autonomy at Drexel University, Philadelphia, United States.



Alumni Lecture on "**Unconventional Machining Techniques"**

12 - 04 - 2024

An alumni lecture on "Unconventional Machining Techniques" was organized to provide students with insights into advanced manufacturing processes beyond traditional methods. The session was delivered by Mr. Santhosh S (2019–2023 Batch), currently pursuing M.Tech in Automotive Technology at SRM Institute of Science and Technology, Kattankulathur. He explained various unconventional machining processes such as EDM, ECM, laser machining, and ultrasonic machining, along with their working principles and industrial applications. The session enhanced students' understanding of modern manufacturing techniques and their significance in precision engineering.

# STUDENTS INDUSTRIAL VISIT 2023 - 2024

Industrial Visits 2023

Students from II, III, and IV years participated in industrial visits during October 2023 to gain practical exposure.

On 6th and 7th October 2023, III and IV year students visited Anna Aluminium Co Pvt Ltd, Aluva, and Sea Blue Shipyard, Cochin, Kerala. They learned about aluminium production processes and shipbuilding operations.

On 27th and 28th October 2023, II year students visited Customized Technologies Pvt Ltd, Visvesvaraya Industrial and Technological Museum, and Hindustan Aeronautics Limited in Bangalore. The visit provided insights into precision instruments, science exhibits, and aerospace engineering.

# ISTE EVENTS

**ISTE Sponsored Workshop on "Edge Computing in Manufacturing"**
**Date: 18-08-2023**

An ISTE-sponsored workshop on "Edge Computing in Manufacturing" was organized to provide students with knowledge on emerging technologies in smart manufacturing. The session was delivered by Dr. N. Manivannan, Managing Director, Techland Automation, Tiruchirappalli. He explained the concepts of edge computing, its role in real-time data processing, and its applications in modern manufacturing systems. The workshop helped students understand how edge computing enhances efficiency, reduces latency, and supports Industry 4.0 initiatives.


**ISTE Sponsored Workshop on "CAN Protocol – Design, Development, Testing Tools and Techniques for Automotive and Industrial Applications"**
**Date: 21-02-2024**

An ISTE-sponsored workshop on "CAN Protocol – Design, Development, Testing Tools and Techniques for Automotive and Industrial Applications" was organized to provide students with practical knowledge of communication protocols used in modern automotive and industrial systems. The session was delivered by Dr. N. Manivannan, Managing Director, Techland Automation, Tiruchirappalli. He explained the fundamentals of CAN protocol, its architecture, message framing, and its significance in automotive electronics and industrial automation. The workshop also covered design, development, and testing tools used in real-time applications, helping students gain hands-on insights into embedded communication systems.

# VALUE ADDED COURSE

**Value Added Course on "Advanced Industrial Automation"** A six-day Value Added Course on "Advanced Industrial Automation" was successfully conducted from 07th August 2023 to 12th August 2023 for III Year Mechatronics Engineering students. A total of 29 students actively participated in the program. The course was organized in collaboration with Indwell Automation, Mangalore, offering students valuable industry exposure and practical insights into modern automation technologies.

The training covered key areas such as PLC programming, SCADA systems, industrial sensors, actuators, and automation control techniques. Participants gained hands-on experience in designing and implementing automation systems, enhancing their technical competencies and preparing them for careers in industrial automation and smart manufacturing.


**Value Added Course on Internet of Things (IoT)**

A five-day Value Added Course on Internet of Things (IoT) was successfully conducted from 12th January 2024 to 16th January 2024. The program was organized for II Year Mechatronics Engineering students, with a total of 29 participants actively engaging in the sessions. The course was delivered in collaboration with Quantanics Techserv Pvt. Ltd., Madurai, providing students with industry-oriented knowledge and hands-on exposure to IoT technologies. Throughout the program, participants gained insights into IoT concepts, sensor integration, data communication, and real-time applications in industrial environments. This course enhanced the students' practical skills and prepared them for emerging trends in smart systems and automation.

# PLACEMENT DETAILS (2020 - 2024 BATCH)

| S.No | Student Name | Company Details |
|---|---|---|
| 1 | Ramanavel R | Centizen Inc's Sales and Marketing, Tirunelveli. |
| 2 | Bhuvaneshwaran S | Centizen Inc's Sales and Marketing, Tirunelveli. |
| 3 | Veeranan C | Cloud SCS Technologies Private Limited, Coimbatore. |
| 4 | Anandakrishnan V | Selva Engineering and Automation, Virudhunagar. |
| 5 | Sakthibala K | Selva Engineering and Automation, Virudhunagar. |
| 6 | Rahul G | Raini Industries India Private Limited, Chennai. |
| 7 | Manikandan R | Raini Industries India Private Limited, Chennai. |
| 8 | Harrish Babu K | Quintessence Business Solutions & Services Private Limited (QBSS), Chennai. |
| 9 | Naveen R | Quintessence Business Solutions & Services Private Limited (QBSS), Chennai. |
| 10 | Gemrelton R | BNC Motors, Coimbatore. |
| 11 | Sabarivasan S | Amigoes Die Casting, Coimbatore. |
| 12 | Harish Ramachandran V | Amigoes Die Casting, Coimbatore. |

# PLACEMENT DETAILS (2020 - 2024 BATCH)

| S.No | Student Name | Company Details |
|---|---|---|
| 13 | Esakki Anand R | Amigoes Die Casting, Coimbatore. |
| 14 | Krishna Kumar P | Brave Automation, Madurai. |
| 15 | Karthikeyan S | Vethika Enterprises, Sivakasi. |
| 16 | Naveen Prakash M E | Brave Automation, Madurai. |

# PRIZES WON LIST IN INTER-INSTITUTE EVENTS 2 YEAR STUDENTS

| S.No | Name of the student | Type of the Programme | Organizing Institution | Prizes own |
|---|---|---|---|---|
| 1 | Yogacharan B | Technical Quiz | Coimbatore Institute of Engineering and Technology | FIRST |
| 2 | Sangareswaran B | Project Expo | Coimbatore Institute of Engineering and Technology | FIRST |
| 3 | BIBAKS NOBAL A P | Project Expo | Study World College of Engineering | SECOND |
| 4 | ISAC STEPHEN V | Project Expo | Study World College of Engineering | SECOND |
| 5 | MADHAN KUMAR R | Project Expo | Study World College of Engineering | SECOND |
| 6 | VIJAI R | Project Expo | Study World College of Engineering | SECOND |
| 7 | BALAJI C | Project Expo | Study World College of Engineering | SECOND |
| 8 | MUTHU MANICKAM K | Project Expo | Study World College of Engineering | SECOND |
| 9 | HARIRAJAN K | Technical Quiz | Coimbatore Institute of Engineering and Technology | SECOND |
| 10 | ARUNATH A | Technical Quiz | Coimbatore Institute of Engineering and Technology | SECOND |
| 11 | RAGAVARSHINI S | Project Expo | Thiagarajar College of Engineering | THIRD |
| 12 | TRISHNA K | Technical Activity | Thiagarajar College of Engineering | FIRST |

# PRIZES WON LIST IN INTER-INSTITUTE EVENTS

| S.No | Name of the student | Type of the Programme | Organizing Institution | Prizes own |
|---|---|---|---|---|
| 13 | TRISHNA K | Technical Activity | Thiagarajar College of Engineering | SECOND |
| 14 | RAGAVARSHINI S | Technical Activity | Thiagarajar College of Engineering | FIRST |
| 15 | LOGA ANJANA P | Project Presentation | Thiagarajar College of Engineering | THIRD |
| 16 | RATHIKA SHREE B | Project Presentation | Thiagarajar College of Engineering | SECOND |
| 17 | MATHIYA VEDHA NIRANJAN K | Tehnical Quiz | Hindustan College of Engineering and Technology | SECOND |
| 18 | SHIVA R | Tehnical Quiz | Hindustan College of Engineering and Technology | SECOND |
| 19 | ABINESH S | Tehnical Quiz | Coimbatore Institute of Engineering and Technology | THIRD |
| 20 | GOKUL S | Tehnical Quiz | Coimbatore Institute of Engineering and Technology | THIRD |
| 21 | TRISHNA K | Basket Ball | Chettinad College of Engineering and Technology | SECOND |
| 22 | GOKUL S | Project Presentation | Coimbatore Institute of Engineering and Technology | FIRST |
| 23 | SANKARESHWARAN B | Project Presentation | Coimbatore Institute of Engineering and Technology | FIRST |

# PRIZES WON LIST IN INTER-INSTITUTE EVENTS

| S.No | Name of the student | Type of the Programme | Organizing Institution | Prizes own |
|---|---|---|---|---|
| 24 | MADHAN KUMAR R | Paper Presentation | Francis Xavier Engineering College | SECOND |
| 25 | VIJAI R | Paper Presentation | Francis Xavier Engineering College | SECOND |
| 26 | HARIRAJAN K | Paper Presentation | Coimbatore institute of Engineering and Technology | FIRST |
| 27 | ARUNATH A | Paper Presentation | Coimbatore institute of Engineering and Technology | FIRST |

# PRIZES WON LIST IN INTER-INSTITUTE EVENTS 3 YEAR STUDENTS

| S.No | Name of the student | Type of the Programme | Organizing Institution | Prizes own |
|---|---|---|---|---|
| 1 | ARAVINDRH ARYA G | Project Presentation | AAA College of Engineering and Technology | SECOND |
| 2 | KISHOURE KUMAR D | Project Presentation | AAA College of Engineering and Technology | SECOND |
| 3 | ARAVINDRH ARYA G | Treasure Hunt | AAA College of Engineering and Technology | SECOND |
| 4 | KISHOURE KUMAR D | Treasure Hunt | AAA College of Engineering and Technology | SECOND |
| 5 | ARAVINDRH ARYA G | Technical Event | PSR Engineering College | SECOND |
| 6 | NILESH A | IDEATHON | Sethu Institute of Technology | FIRST |
| 7 | MITHUN KUMAR G S | IDEATHON | Sethu Institute of Technology | FIRST |
| 8 | ARUN PRATAP K | IDEATHON | Sethu Institute of Technology | FIRST |
| 9 | DINESH K | IDEATHON | Sethu Institute of Technology | FIRST |

# STUDENT ARTICLE

# Blockchain Based Secure Communication in Industrial Mechatronic Systems

-Ragavarshini S

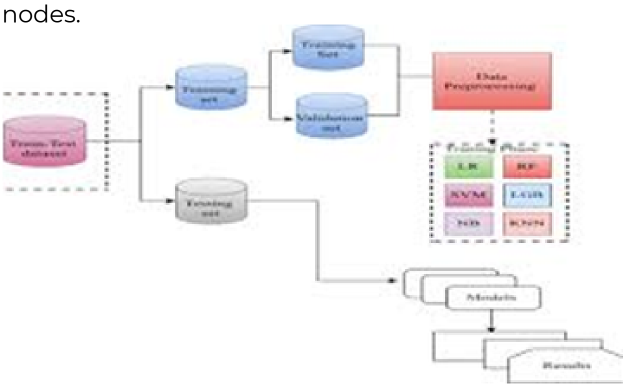

**Abstract:**
Industrial automation systems rely heavily on communication between machines, sensors, and control systems. As industrial networks become more connected, ensuring secure and reliable data exchange becomes a critical requirement. Blockchain offers a decentralized and tamper-resistant method for securing communication in industrial environments. By using distributed ledgers and cryptographic techniques, blockchain can protect data integrity, prevent unauthorized access, and improve transparency in industrial operations. In the field of Mechatronics Engineering, integrating blockchain technology with automated systems can enhance cybersecurity and trust in machine-to-machine communication. This article discusses the principles, architecture, applications, advantages, and challenges of blockchain-based secure communication in industrial mechatronic systems.

**Introduction:**
Industrial automation systems have evolved significantly with the integration of advanced networking technologies and intelligent machines. Modern industrial environments involve communication between sensors, controllers, robots, and cloud platforms. However, increased connectivity also introduces cybersecurity risks such as data tampering, unauthorized access, and system attacks. Traditional centralized security systems may not always provide adequate protection for large-scale industrial networks.

Blockchain technology provides a decentralized approach where data is stored in distributed blocks that are linked together using cryptographic methods. This structure ensures that once data is recorded, it cannot be altered without the consensus of the network.

**Concept of Blockchain-Based Secure Communication:**
Blockchain is a distributed database that stores records in blocks connected through cryptographic hashes. Each block contains a set of transactions and is linked to the previous block, forming a chain of records. This structure ensures that data cannot be modified without altering all subsequent blocks, which is practically impossible in a distributed system. In industrial mechatronic systems, blockchain can used to secure communication between machines and devices. Each device in the network can verify transactions before they are recorded in the blockchain. This verification process prevents unauthorized data manipulation and ensures the authenticity of information exchanged between devices. Smart contracts can also be implemented in blockchain networks to automate specific actions based on predefined conditions. For example, when a sensor detects a particular event, the system can automatically trigger a response without human intervention.

**System Architecture:**
A blockchain-based communication system in industrial environments typically consists of several key components. The first component is the industrial devices, which include sensors, actuators, and robotic systems that generate and exchange data during operation. The second component is the communication network, which enables data transmission between devices and blockchain nodes.



The third component is the blockchain layer, which stores and verifies transaction records. Each transaction is encrypted and validated by participating nodes before being added to the blockchain. This ensures data integrity and prevents unauthorized modifications. Advanced industrial systems may also integrate technologies such as Internet of Things and Cyber-Physical Systems to enhance monitoring and control capabilities. These technologies allow real-time data collection and secure communication between machines and control systems.

### Applications in Industrial Mechatronic Systems

Blockchain-based secure communication has several applications in industrial automation. One important application is secure machine-to-machine communication, where robots and automated equipment exchange operational data. Blockchain ensures that this data cannot be altered or intercepted by unauthorized users. Another application is supply chain tracking, where blockchain records production data, component origin, and manufacturing processes. This improves transparency and helps manufacturers track products throughout the supply chain. In smart factories, blockchain can be used to monitor equipment status, manage production data, and verify system operations. This ensures reliable and secure communication between various automated systems. Blockchain can also support predictive maintenance systems by securely storing sensor data and maintenance records.

### Advantages of Blockchain in Industrial Systems

The use of blockchain technology in industrial mechatronic systems offers several advantages. One of the main benefits is data security, as blockchain uses cryptographic techniques to protect information from unauthorized access. Another advantage is data transparency and traceability. Since every transaction is recorded in the blockchain, it becomes easier to track system activities and verify data authenticity. Blockchain also provides decentralization, which eliminates the need for a central authority to manage system communication. This reduces the risk of single points of failure and improves system reliability. Furthermore, blockchain enhances trust between industrial devices by ensuring that all participants in the network follow the same verification process.

### Challenges and Future Scope

Despite its advantages, blockchain technology also presents several challenges when applied to industrial systems. One major challenge is scalability, as industrial networks may generate a large volume of transactions that need to be processed quickly. Another challenge is computational complexity, since blockchain verification processes may require significant computing resources. This can be difficult for small industrial devices with limited processing power. Energy consumption and integration with existing industrial systems are also important concerns. Researchers are currently exploring lightweight blockchain models and efficient.


### Conclusion

Blockchain-based secure communication provides a reliable and transparent solution for protecting data exchange in industrial mechatronic systems. By using decentralized ledgers and cryptographic verification, blockchain technology ensures data integrity, security, and traceability across industrial networks. Although challenges such as scalability and computational complexity remain, ongoing research is improving the feasibility of blockchain integration in industrial environments. As industries move toward more connected and intelligent systems, blockchain technology will play an important role in ensuring secure and trustworthy communication in future smart factories

# MULTI MODAL SENSOR INTEGRATION FOR INTELLIGENT ROBOTIC PERCEPTION

*Integrating multi-modal sensors to enable robots with enhanced perception and real-time decision-making capabilities.*


**Abstract**

Robotic systems require accurate perception of their surroundings to perform tasks efficiently and safely. Traditional robots often rely on a single sensor, which may not provide sufficient information about complex environments. Multi-modal sensor integration combines data from different types of sensors to improve the robot's ability to perceive and understand its environment. By integrating sensors such as cameras, LiDAR, ultrasonic sensors, and inertial measurement units, robots can achieve more reliable and accurate perception. In the field of Mechatronics Engineering, multi-modal sensor integration plays a crucial role in enabling intelligent robotic systems. This article discusses the principles, architecture, applications, advantages, and challenges of multi-modal sensor integration for intelligent robotic perception.


**Introduction**

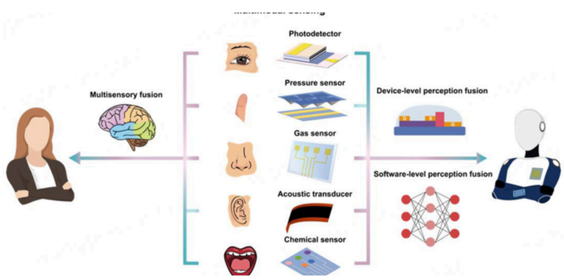
Robotic perception refers to the ability of robots to sense and interpret information from their environment. Accurate perception is essential for tasks such as navigation, object recognition, obstacle avoidance, and manipulation. However, relying on a single sensor may not provide sufficient information for complex environments. For example, cameras provide detailed visual information but may struggle in poor lighting conditions. Similarly, LiDAR sensors can measure distances accurately but cannot always identify object textures or colors. To overcome these limitations, modern robotic systems combine data from multiple sensors. Multi-modal sensor integration enables robots to collect different types of information and combine them into a comprehensive understanding of the environment. This approach improves reliability and allows robots to operate effectively in dynamic and uncertain conditions.

### Concept of Multi-Modal Sensor Integration

Multi-modal sensor integration involves combining information from different sensing devices to create a unified perception model. Each sensor contributes unique data that complements the others. For instance, a camera can capture images and detect object features, while a LiDAR sensor measures the distance and shape of surrounding objects. An inertial measurement unit (IMU) provides information about the robot's orientation and motion. By integrating these different data sources, the robotic system can generate a more accurate representation of the environment. The process of combining sensor data is known as Sensor Fusion. Sensor fusion algorithms analyze data from different sensors and merge them into a single reliable output that can be used for decision-making.

### System Architecture

A multi-modal sensor integration system consists of several interconnected components. The first component is the sensor layer, which includes devices such as cameras, LiDAR sensors, ultrasonic sensors, and IMUs. These sensors collect raw data from the environment.




The second component is the data processing layer, where the raw sensor data is filtered and analyzed. Algorithms process the collected information to extract useful features such as object position, motion, and orientation. The third component is the sensor fusion module, which integrates data from different sensors into a unified perception model. This module ensures that the robot receives consistent and accurate environmental information. The final component is the control system, which uses the processed sensor data to guide the robot's actions. Robotic platforms often use software frameworks such as Robot Operating System to manage communication between sensors, processing algorithms, and control modules.

### Applications in Intelligent Robotics

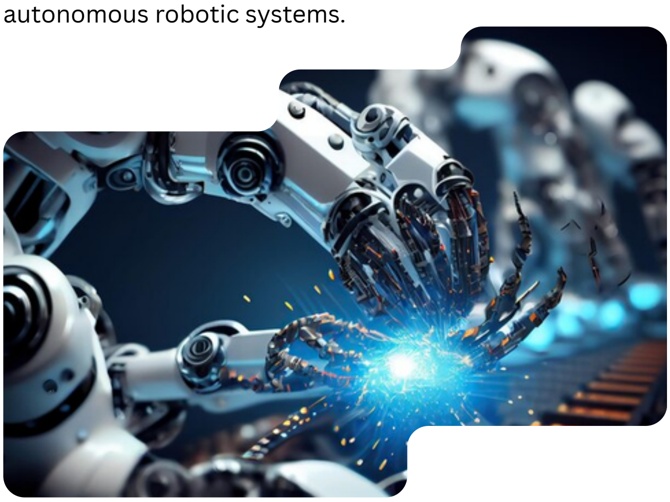
Multi-modal sensor integration is widely used in modern robotic applications. One important application is autonomous navigation, where robots must detect obstacles, map their surroundings, and determine their position. Combining camera and LiDAR data improves the accuracy of navigation systems. Another application is object detection and recognition. Cameras provide visual information about object appearance, while depth sensors measure object distance. Integrating these sensors enables robots to identify and manipulate objects more effectively. In industrial automation, robots equipped with multiple sensors can monitor production processes, inspect products, and ensure quality control. Multi-modal sensing also plays a key role in service robots, such as delivery robots and healthcare assistants, where understanding the environment is essential for safe interaction with humans.

### Advantages of Multi-Modal Sensor Integration

The integration of multiple sensors provides several advantages in robotic systems. One major advantage is improved perception accuracy, as combining data from different sensors reduces uncertainty and measurement errors. Another benefit is greater robustness, since the system can continue functioning even if one sensor fails or provides unreliable data. Multi-modal sensing also improves environmental awareness, allowing robots to detect complex features such as object shape, distance, and movement. Furthermore, sensor integration enables robots to operate in challenging conditions such as low lighting, dynamic environments, or cluttered spaces.

### Conclusion

Multi-modal sensor integration plays a vital role in enabling intelligent robotic perception. By combining data from different sensors, robots can achieve a more accurate and reliable understanding of their environment. This capability is essential for tasks such as navigation, object detection, and human–robot interaction. Although challenges such as computational complexity and synchronization remain, ongoing advancements in sensor technology and intelligent algorithms will continue to improve the performance of robotic perception systems. As robotics technology evolves, multi-modal sensor integration will remain a key component in the development of advanced autonomous robotic systems.



# Human-Centered Mechatronic System Design for Industry 5.0

-Loga Anjana P

**Abstract**

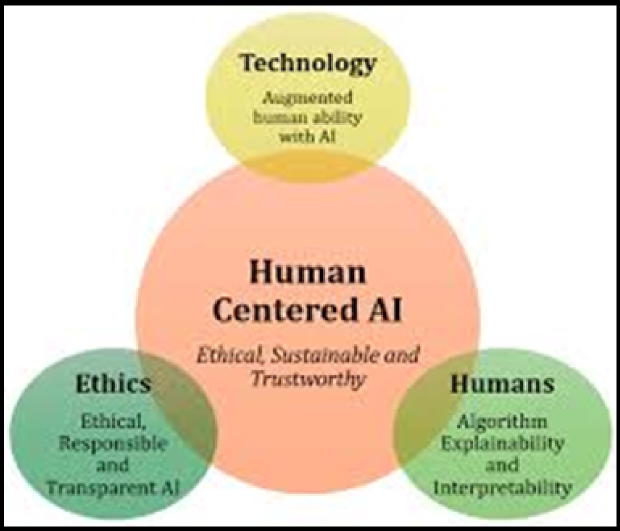
The rapid evolution of industrial automation has transformed the way manufacturing systems operate. Earlier industrial revolutions mainly focused on improving productivity through mechanization, mass production, and automation. However, the concept of Industry 5.0 introduces a new approach that emphasizes collaboration between humans and intelligent machines. In this context, human-centered mechatronic system design plays a crucial role in ensuring that automation technologies enhance human capabilities rather than replace them. These systems integrate sensors, actuators, control systems, and intelligent algorithms while prioritizing safety, ergonomics, and user interaction. This article discusses the principles, design architecture, applications, and challenges of human-centered mechatronic systems in modern industrial environments.

**Introduction**

Industrial development has progressed through several stages, from mechanization in the first industrial revolution to smart automation in the fourth industrial revolution. While advanced automation technologies have improved efficiency and productivity, they have also raised concerns regarding workforce displacement and limited human involvement in decision-making processes.To address these challenges, the concept of Industry 5.0 focuses on human–machine collaboration rather than complete automation. In this new paradigm, machines are designed to assist human workers by improving safety, precision, and productivity. Human-centered system design ensures that technology adapts to human needs and capabilities. In the field of Mechatronics Engineering, the integration of mechanical systems, electronics, and intelligent control technologies provides an ideal platform for developing collaborative industrial systems. Human-centered mechatronic systems combine advanced robotics, sensors, and user interfaces to create safer and more efficient workplaces.

**Concept of Human-Centered Mechatronic Systems**

Human-centered mechatronic systems are designed to support human operators by improving interaction, usability, and safety. Unlike traditional automated systems that operate independently, these systems allow humans and machines to work together in a coordinated manner. The primary goal of human-centered design is to ensure that technology enhances human capabilities. This includes designing systems that are intuitive, responsive, and adaptable to different user requirements. In manufacturing environments, such systems can assist workers in tasks that require high precision, repetitive motion, or heavy physical effort. Human-centered systems also focus on ergonomic design to reduce worker fatigue and improve productivity. Sensors and monitoring technologies can be used to track human movement and provide assistance when needed.



**System Architecture and Design Components**

Human-centered mechatronic systems typically consist of several integrated components. The mechanical subsystem includes robotic arms, collaborative robots, and automated tools that interact with human operators. These mechanical systems are designed with safety features such as compliant joints and force-limiting mechanisms. The sensing subsystem plays an important role in detecting human presence and environmental conditions. Sensors such as proximity sensors, vision sensors, and motion sensors allow the system to monitor worker activities and respond accordingly. Technologies such as Computer Vision enable machines to recognize gestures, objects, and human actions. The control subsystem coordinates the operation of different components and ensures smooth interaction between humans and machines. Modern robotic platforms often use frameworks such as Robot Operating System for system integration, communication, and control. The user interface is another important component of human-centered systems. Interfaces such as touch screens, voice commands, and augmented reality displays allow operators to interact with machines easily and efficiently.

**Applications in Industry 5.0**

Human-centered mechatronic systems are widely used in modern industrial environments. One of the most important applications is in collaborative robotics, where robots work alongside human operators to perform assembly tasks. These robots assist workers by handling repetitive operations while humans focus on tasks that require creativity and decision-making. Another application is smart manufacturing, where advanced sensors and intelligent algorithms monitor production processes and provide real-time feedback to operators. This improves product quality and reduces production errors. Human-centered systems are also used in ergonomic assistance systems, such as robotic exoskeletons that support workers during heavy lifting tasks. These systems reduce physical strain and improve workplace safety. In addition, augmented reality systems are used to guide workers during complex assembly or maintenance procedures, improving accuracy and efficiency.

**Conclusion**

Human-centered mechatronic system design plays a vital role in the successful implementation of Industry 5.0. By prioritizing human safety, ergonomics, and collaboration, these systems create a balanced relationship between humans and machines in industrial environments. The integration of advanced sensing technologies, intelligent control systems, and user-friendly interfaces enables efficient and safe manufacturing processes. As research continues to advance, human-centered mechatronic systems will become an essential component of future smart factories, supporting both technological progress and human well-being.

# Soft Robotic Grippers for Fragile Material Handling

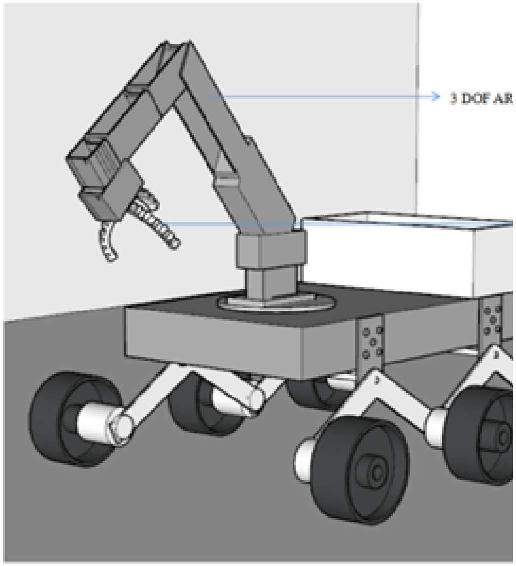
-Rathikashree B

**Abstract**

*Handling fragile materials is a challenging task in automated systems because traditional rigid robotic grippers often apply excessive force that can damage delicate objects. Soft robotic grippers have emerged as an effective solution to this problem by using flexible and compliant materials that can safely adapt to different shapes and surfaces. These grippers are designed using soft elastomeric materials that allow them to bend and conform to objects without causing damage. Soft robotic technology is gaining attention in Mechatronics Engineering because it integrates mechanical design, sensing technologies, and intelligent control systems. This article discusses the design principles, working mechanism, applications, and challenges of soft robotic grippers used for fragile material handling.*

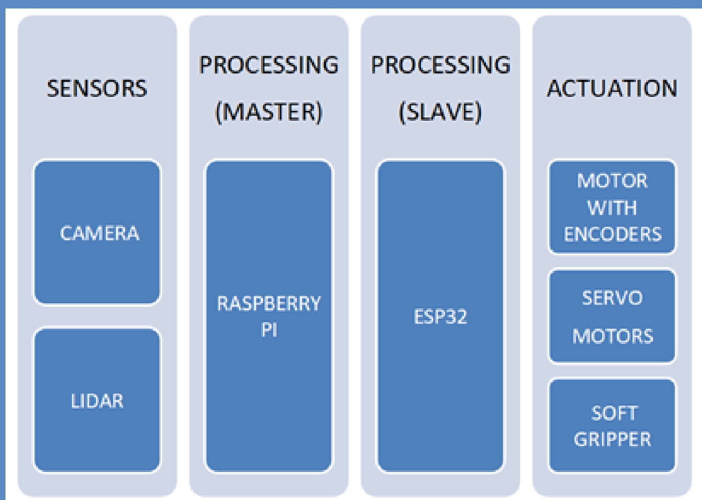
**Introduction**

*Automation has significantly improved productivity in many industries, but handling fragile materials remains a complex task. Traditional robotic grippers are usually made from rigid materials such as metal or hard plastics. While these grippers are suitable for handling solid objects, they may not be ideal for delicate items such as fruits, eggs, glass components, or electronic parts. Excessive gripping force can easily cause cracks, deformation, or breakage. Soft robotics has emerged as a promising solution to this issue. Soft robotic grippers are made from flexible materials that allow them to adapt to the shape and size of the object being handled. The compliant nature of these grippers helps distribute the gripping force evenly across the object surface, reducing the risk of damage. Due to these advantages, soft robotic grippers are increasingly used in industries that require safe manipulation of delicate materials.*




**Design and Components**

*A typical soft robotic gripper consists of several important components that work together to achieve safe manipulation. The primary component is the soft finger structure, which is usually made from elastomeric materials such as silicone or rubber. These materials provide flexibility and allow the fingers to bend easily during actuation. The finger design often includes internal air chambers that expand when pressurized. Another important component is the actuation system, which generates the motion required for gripping. Pneumatic actuators are commonly used because they provide smooth and controllable bending motion. In some designs, cable-driven mechanisms are used to pull the fingers inward to grasp objects. Sensors can also be integrated into the gripper to enhance performance. Force sensors and tactile sensors help measure the contact force applied to the object. These sensors allow the system to adjust the gripping force in real time to avoid damaging fragile items. Advanced robotic systems may also incorporate perception technologies such as Computer Vision to detect and identify objects before grasping them. Control frameworks such as Robot Operating System can also be used to coordinate sensing, motion planning, and actuation.*



***Working Principle***

*The working principle of a soft robotic gripper is based on flexible actuation and adaptive gripping. Unlike rigid robotic fingers, soft fingers bend and wrap around the object during the gripping process. The bending motion is usually achieved through pneumatic actuation, cable-driven systems, or hydraulic mechanisms. in pneumatic systems, compressed air is supplied to chambers inside the soft fingers. When air pressure increases, the chambers expand, causing the fingers to bend and grasp the object. This bending motion allows the gripper to conform to objects with different shapes and sizes. Because the material is soft and compliant, the gripping force is distributed evenly, which prevents damage to fragile objects. The control system regulates the actuation mechanism to ensure stable and precise gripping. Modern soft robotic systems may also integrate sensors to monitor pressure, force, or contact between the gripper and the object.*

***Applications***

*Soft robotic grippers are widely used in applications where delicate handling is required. One of the most common applications is in the food industry, where soft grippers are used to pick fruits, vegetables, and eggs without causing damage. The soft fingers gently conform to the surface of the food item, ensuring safe handling during packaging and transportation.*

*In the electronics industry, soft robotic grippers are used to manipulate fragile components such as microchips, circuit boards, and sensors. These components are often sensitive to mechanical stress, making soft gripping technology highly beneficial.*

*Soft robotic grippers are also used in medical and biomedical fields. They assist in handling biological samples, laboratory materials, and surgical tools. In minimally invasive surgery, soft robotic systems provide greater safety and flexibility compared to rigid instruments.*

*In addition, these grippers are being explored for agriculture automation, where they can harvest delicate crops without causing damage.*

***Challenges and Future Scope***

*Despite their advantages, soft robotic grippers still face several technical challenges. One major limitation is their limited load capacity, as soft materials may not support heavy objects compared to rigid grippers. Another challenge is the durability of soft materials, which may degrade after repeated use or exposure to harsh environmental conditions. Manufacturing and fabrication of soft robotic components can also be complex and costly. Researchers are currently exploring advanced materials, improved actuator designs, and hybrid structures that combine both soft and rigid elements to enhance performance. Future developments in smart materials and artificial intelligence are expected to further improve soft robotic technology. Integration of advanced sensors and intelligent control systems will allow grippers to automatically adjust their gripping strategy based on the properties of the object being handled.*

***Conclusion***

*Soft robotic grippers represent a significant advancement in robotic manipulation for fragile material handling. Their flexible structure and adaptive gripping ability allow them to handle delicate objects safely and efficiently. By integrating sensing technologies and intelligent control systems, these grippers can perform complex manipulation tasks in various industrial environments. Continued research and development in soft robotics will expand their applications across fields such as manufacturing, healthcare, agriculture, and logistics, making them an essential component of future automation systems.*

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