DESIGN AND DEVELOPMENT OF SCARA ROBOT WITH SOFTWARE CONTROLLER

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ABSTRACT

This journal article presents a complete development of a SCARA (Specific Consistence Enunciated Robot Arm) robot. SCARA robots have acquired noticeable quality in the modern world because of their speed and accuracy in terms of assembling and gathering works. This journal centers around the key techniques used in the formation of a SCARA robot, including CAD model designing, Fabrication, Inverse kinematics, Motion profile, and Graphical rendering. The paper starts by talking about the essential standards of SCARA robot design, explaining its enunciated arm structure and specific consistency highlights. We dig into the mechanical plan contemplations, like materials, joint systems, and end-effector choices, to enhance the robot's presentation in assorted applications.
Kinematic examination is a significant part of SCARA robot functionality, and this article presents the significance of inverse kinematics and trajectory calculations for the motion profile. These perspectives are significant in guaranteeing the robot's exact and effective development in different work areas. In addition to the exploration dives into the control frameworks utilized in SCARA robots, underlining the meaning of constant control system. The coordination of cutting-edge technologies is examined to upgrade the robot's versatility and independence.
Useful utilizations of SCARA robots across enterprises are likewise featured, displaying their utility in errands like pick-and-spot tasks, package section, 3D printing. Contextual analyses are given to show fruitful executions and execution measurements. This article tends to raise patterns and future possibilities in SCARA robot plan and improvement, including cooperative mechanical technology. All in all, this diary article offers a complete outline of the plan and development of SCARA robots, filling in as a significant asset for developers, designers, and industry experts trying to outfit the capability of SCARA mechanical technology in different applications and investigate future progressions in this field.

Keywords: - *Inverse Kinematics, Joint Mechanisms, End effectors.*

1. INTRODUCTION

The field of robotics has grown significantly in recent decades and has transformed industries by automating tasks that were previously considered too complex or labor intensive for human operators. Among the various robot architectures, the selective compliance articulated robot arm, commonly known as the SCARA robot, has earned a special place due to its speed and precision in the field of manufacturing and assembly applications. The term "SCARA" covers the main features of the robot - selective enforcement and an articulated arm. This unique combination of features allows SCARA robots to excel in tasks that require both fast repetitive movements and precision in positioning and guidance. Therefore, they have become important tools in fields such as the automotive industry, electronics, the pharmaceutical industry, etc. The design and development of SCARA robots represents an exciting intersection between mechanical engineering, kinematics, control systems and real-world applications. This journal article begins a journey through this multifaceted field, providing an in-depth study of the basic principles, design considerations, kinematic analysis, control mechanisms and practical applications of SCARA robots. Our goal is to provide readers with a comprehensive understanding of the intricacies involved in building and optimizing SCARA robots so that they can fully exploit the potential of this robotic architecture. Delving into the design and development of SCARA robots, we share our work behind the making of this project which can be a great asset in the ever-evolving landscape of industrial automation.

1.1 Background Work:

The concept of articulated robot arms dates back to the middle of the 20th century, when industrial automation was in its infancy. Various robot architectures have been developed over the years to meet the changing demands of manufacturing and assembly processes. One such architecture that has emerged as a key solution for industrial automation is the SCARA robot (Selective Compliance Articulated Robot Arm).

1.2 Rise of SCARA Robots:

- SCARA robots were first presented in the last part of the 1970s, basically because of the requirement for exact, high velocity computerization in ventures like gadgets and semiconductors.
- Their plan was a forward leap, joining the benefits of both Cartesian and enunciated robots.
- The critical development of SCARA robots lies in their enunciated arm structure with two revolute joints and one kaleidoscopic joint. This plan empowers exact situating in the flat plane while offering some consistency in the upward heading.

1.3 Flexibility in Assembling:

- SCARA robots acquired quick acknowledgment in enterprises that requested complex and tedious errands, like pick-and-spot tasks, patching, and in the assembly of sensitive parts.
- Their capacity to definitively control objects in a 2D work area made them appropriate for applications in printed circuit board (PCB) gathering, semiconductor assembling, and bundling.

1. 4 Kinematics and Control Advances:

- The progress of SCARA robots is supported by headways in kinematics and control calculations.
- Research in forward and reverse kinematics worked with exact position and direction control.
- Control frameworks developed to help continuous criticism and versatile techniques, empowering SCARA robots to deal with complex errands with shifting natural circumstances.

1. 5 Market Reception and Incorporation:

- The reception of SCARA robots extended past gadgets and semiconductors to envelop auto, drug, and food businesses.

1.6 Challenges and Ongoing Developments:

- Challenges persist in terms of addressing singularities, enhancing payload capacities, and improving workspace adaptability.
- Recent developments have focused on incorporating advanced sensors, vision systems, and machine learning techniques, paving the way for more sophisticated automation.

2. TECHNIQUES USED

The plan for the improvement of a SCARA robot includes a multidisciplinary approach, joining mechanical designing, kinematics, control frameworks to form an application. The following are a portion of the vital strategies and contemplations utilized in the plan and improvement of SCARA robots:

1. Mechanical Plan:

- Kinematic Design: The initial step is to decide the robot's kinematic structure, characterizing the quantity of levels of opportunity and joint sorts. SCARA robots regularly have two revolute joints and one kaleidoscopic joint.
- Materials Determination: The selection of materials for the robot's parts is basic to guarantee underlying respectability, weight streamlining, and strength.
- End-Effector Configuration: Planning or choosing a fitting end-effector (instrument or gripper) is fundamental for the particular errand the robot will perform.

2. Kinematics and Inverse Kinematics:

- Forward Kinematics: This method ascertains the end-effector's situation and direction in the work area in view of joint points and lengths.
- Inverse Kinematics: Inverse kinematics is utilized to decide the joint points expected to accomplish an ideal end-effector position and direction.

3. Control Frameworks:

- QT Framework: Executing constant control calculations is essential for exact and dynamic control of the robot's developments.
- Trajectory Planning: Generating smooth and efficient trajectories for the robot's movements is essential to minimize cycle time and energy consumption.

4. Programming and Software:

- Programming Languages: C++, which is a POINTERS supporting OOPS language with multi-threading feature is used to create sequences of instructions for the robot to follow.
- Simulation Software: Simulation tool OpenGL library is used for the testing and debugging of the execution of robot programs.

5. Safety Systems:

- Simulation: Simulating the robot in a 3D environment helps to prevent accidents and damage to the robot and its surroundings.
- Emergency Stop Systems: Ensuring that the robot can be halted immediately in case of emergencies is a critical safety consideration.

6. Reasonable Applications:

- Pick-and-Spot Activities: SCARA robots succeed in undertakings including the exact picking and setting of articles in assembling and mechanical production systems.
- Patching and Welding: They are utilized for high-accuracy fastening and welding tasks.
- 3D Printing: SCARA robots have tracked down applications in 3D printing and added substance producing.
- Bundling: They are utilized for bundling and palletizing errands in different enterprises.

7. Cooperative Advanced mechanics:

- Procedures for making SCARA robots cooperative, permitting them to work close by people securely, incorporate power restricting systems and high-level wellbeing highlights.

8. Advanced Research and Development:

- Ongoing research focuses on addressing challenges such as singularity avoidance, improving workspace adaptability, and enhancing payload capacities to expand the capabilities of SCARA robots.

In conclusion, the design and development of SCARA robots require a combination of mechanical, kinematic, control, and application-specific techniques. Advancements in materials, sensors, path planning calculations, and machine learning continue to push the boundaries of what SCARA robots can achieve in the realm of industrial automation.

3.METHODOLOGIES PROPOSED

It is Important to follow a systematic approach, when we are proposing methodologies for the Design and Development of SCARA Robot. The following are some steps and Methodologies that can be followed.

1. Needs Assessment:

- Begins by conducting a thorough assessment. We must understand the specific point of application and requirements for which the SCARA Robot will be used for . Identify the main performance criteria, such as precision, speed, payload capacity, and workspace of the Robot.

2. Conceptual Design:

- Creating a conceptual design with the identified applications and requirements, then the identification of the materials during the initial assessments and research.

3. Kinematic Analysis:

- This is an important step in which we will come to an understanding on how the robot's links and arms move to reach the required end effector positions and we will perform kinematic analysis to determine the forward and inverse kinematics equations of the robot.

4. Mechanical Design:

- Proper 3D mechanical design must be created with proper material selection and dimensions acquired in the research of the 3D design which can be done using any of the CAD Modelling Software.

5. Prototyping and Testing:

- We must create a prototype using the mechanical design created. Continuous tests and analysis should be done to assess the kinematics, structural integrity, and performance of the Robot. The test results help us in the refinement of the design.

6. Control System Development:

- Develop the control system, including hardware components (e.g., motors, encoders, sensors) and software (control algorithms, programming languages). Ensure the control system allows for real-time feedback and precise motion control.

7. Kinematic Calibration:

- There must be no discrepancies in the calibration of the robots kinematics and this step is very important to ensure the accuracy and reliable performance of the robot

8. Safety Integration:

- Integrating safety mechanisms and systems, including collision detection, emergency stop, and protective barriers, to ensure safe operation in the environment

9. Software Programming:

- Writing optimized codes for controlling the movement and tasks of the robot and implementing trajectory planning algorithms for smooth and refined efficient motion.

10. Sensor Integration:

- Sensors, such as encoders, force/torque sensors, and vision systems are integrated to provide feedback and enhance the robot's perception in its surrounding environment

11. Application-Specific Development:

- Customizing the robot to do a specific application. This may involve changing the end-effectors or tooling and changing the programming of the robot for the intended tasks.

12. Testing and Validation:

- continuous tests and validations must be done to ensure the quality of the robot and to analyze the occurrence of failure and strengthen our design.

13. Documentation and User Manuals:

- Create detailed documentation, user manuals, and training materials for users and maintenance personnel.

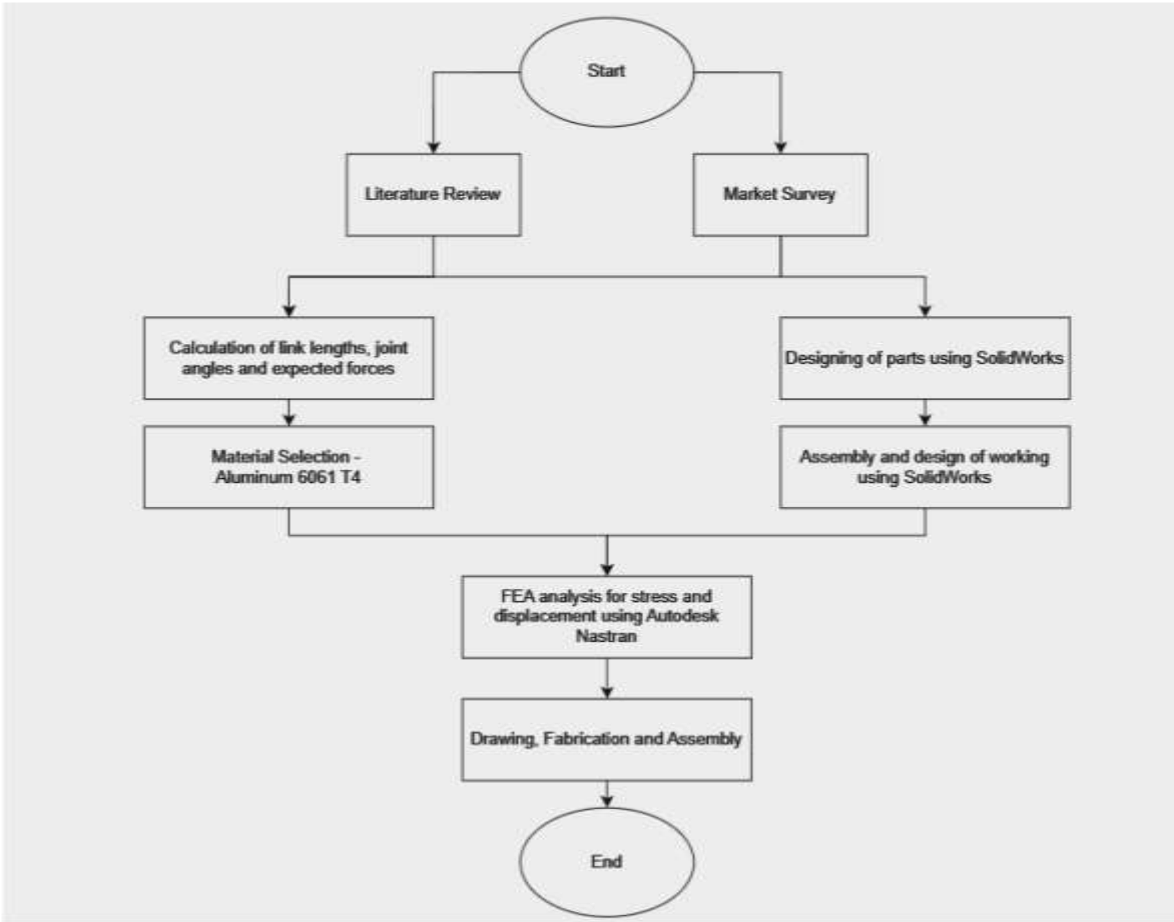
14. Deployment and Integration:

- Deploy the SCARA robot in its intended industrial or manufacturing environment. Integrate it into the existing production line or workspace.

15. Training and Support:

- Provide training for operators and maintenance staff in how to use and maintain the robot effectively and efficiently. Offering support and assistance.

By following these methodologies, the design and development of a SCARA robot can be carried out in an effective manner, resulting in a robot that meets the specific needs of its intended application and contributes to increased efficiency and productivity in industrial settings.



Proposed Work Plan

4. CONCLUSIONS

In conclusion this journal offers an overview of the design and creation process of SCARA (Selective Compliance Articulated Robot Arm) robots. It sheds light on the approaches and techniques involved in their development. From understanding the principles of kinematics and mechanical design to implementing control systems, sensors and real-world applications this journal explores the intricate world of SCARA robotics.

As SCARA robots increasingly find their place, in industries spanning electronics to automotive their precision and versatility prove invaluable for enhancing productivity and ensuring quality. How ever designing and developing these robots come with challenges such as addressing complexities, prioritizing safety considerations and keeping up with evolving automation technologies.

Never the less the methodologies and techniques discussed in this journal provide a roadmap for engineers, researchers and professionals in navigating the intricacies of SCARA robot development. With advancements in materials, sensors and machine learning, on the horizon—exciting possibilities arise for more sophisticated and adaptable SCARA robots. This will undoubtedly propel automation into realms of efficiency and innovation.

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