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DESIGNING AND 3D PRINTING OF AN ARTICULATED MECHANISM FOR ENHANCED MOBILITY APPLICATIONS

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Abstract: The advent of additive manufacturing has revolutionized the production of complex mechanical systems, enabling the design and fabrication of articulated mechanisms with unprecedented flexibility and precision. This paper presents the comprehensive design process, prototyping, and evaluation of a 3D-printed articulated mechanism intended for enhanced mobility applications. Emphasizing parametric design methodologies and material considerations, the study highlights the integration of multiple degrees of freedom within a compact, durable structure. Performance assessments validate the feasibility of the mechanism, offering insights into future improvements and applications in fields such as robotics, prosthetics, and consumer products.

Keywords: *Additive manufacturing, articulated mechanism, 3D printing, design optimization, mobility solutions*

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I.INTRODUCTION:

The evolution of additive manufacturing has significantly impacted the development of mechanical systems, particularly in the domain of articulated structures. Traditional fabrication methods often limit design complexity and assembly flexibility. However, with 3D printing technologies, engineers can now realize intricate mechanisms that are lightweight, customizable, and cost-effective.

This paper focuses on designing an articulated mechanism using 3D printing technology, exploring its potential applications in enhancing mobility solutions. The objective is to develop a functional prototype demonstrating the efficacy of integrating multiple articulations within a singular, cohesive design.

II.METHODOLOGY

The design process commenced with identifying the essential requirements for mobility-focused articulated mechanisms: flexibility, strength, and user-friendly operation. Parametric design tools facilitated the creation of a modular and adaptable structure, enabling easy iteration and optimization.

Material selection was pivotal, with PLA chosen for its printability and mechanical properties suitable for prototyping. Design considerations included joint clearance, range of motion, and integration of snap-fit connections to allow seamless assembly without external fasteners.

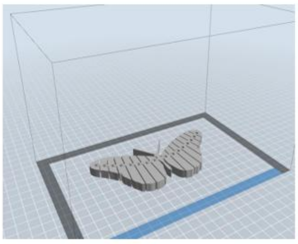
Advanced slicing software was utilized to optimize print orientation and support structures, minimizing post-processing efforts and enhancing mechanical performance. The printing process employed fused deposition modelling (FDM) technology, ensuring layer adhesion and dimensional accuracy.

III.TYPES OF ARTICULATED JOINTS AND DESIGN

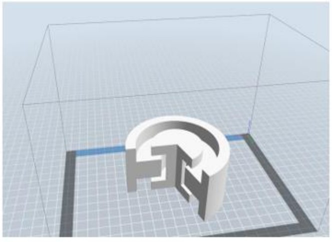
There are several types of articulated joints, each with its own range of motion and application:

Hinge Joint: Allows rotation around a single axis, similar to a door hinge. Hinge joints are commonly used in doors, lids, and robotic arms.

Fidget Joint: Provides limited movement in multiple directions, often used in stress-relief toys. Fidget joints are designed to be flexible and interactive, allowing users to manipulate the joint in various ways.



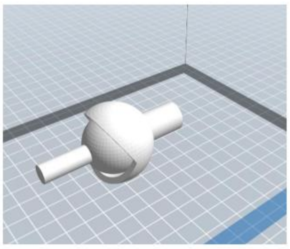
Hinge Joint



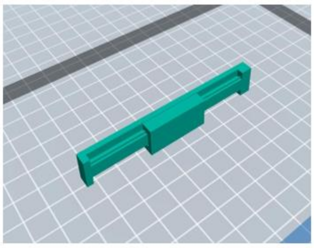
Fidget Joint

Ball and Socket Joint: Offers a wide range of motion in multiple directions, similar to a human shoulder joint. Ball and socket joints are commonly used in robotics, prosthetics, and toys.

Sliding Joint: Enables linear movement along a single axis, often used in drawers and sliding mechanisms. Sliding joints are commonly used in furniture, machinery, and mechanical assemblies.



Ball and Socket Joint



Sliding Joint

Software Tools for Designing Articulated Models: For designing articulated models, especially focusing on 3D printing and mechanical articulation, there are several great software tools from CAD design to simulation and slicing like CAD Software (Designing the Model), solid works, CATIA, Fusion360, Autodesk

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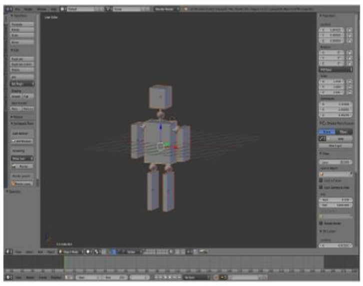
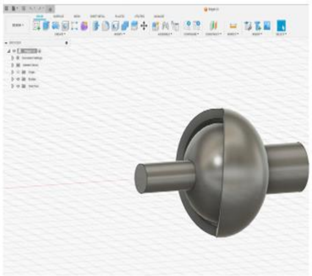
Designing a Toy Using Ball and Socket Joint in Blender:

IV.RESULTS AND DISCUSSION

The fabricated prototype exhibited satisfactory articulation, with smooth joint movement and adequate load-bearing capacity for its intended application. Stress testing revealed that the design could withstand typical operational forces encountered in assistive devices and robotic components.

Challenges encountered during the process included dimensional tolerance variations and support removal in tight joint regions. Iterative design adjustments, such as increasing joint clearances and refining print parameters, effectively mitigated these issues.

The study demonstrated that articulated mechanisms fabricated through 3D printing could achieve a high degree of functional reliability. The design approach employed offers scalability for larger or more complex systems, providing a foundation for further research and application development.

V.CONCLUSION

This research successfully illustrates the potential of 3D printing in producing articulated mechanisms for mobility enhancement. The design and prototyping process validated the feasibility of creating durable, functional structures with integrated joints, paving the way for future innovations in robotics, prosthetics, and consumer mobility solutions.

Future work will focus on material advancements, load optimization, and the integration of smart materials and sensors to further enhance the capabilities of articulated systems.

VI.REFERENCES

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