ME 322 Assignment 4

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Question (1):
The mechanism of Theo Jansen's Strandbeest is a fascinating creation that embodies elegance and efficiency. Its fundamental building block mechanism is a prime example of a one-degree-of-freedom mechanism that is driven by a central "crank" link, which rotates in a circular motion. This motion is generated by a rotary actuator such as an electric motor or can be manually operated.

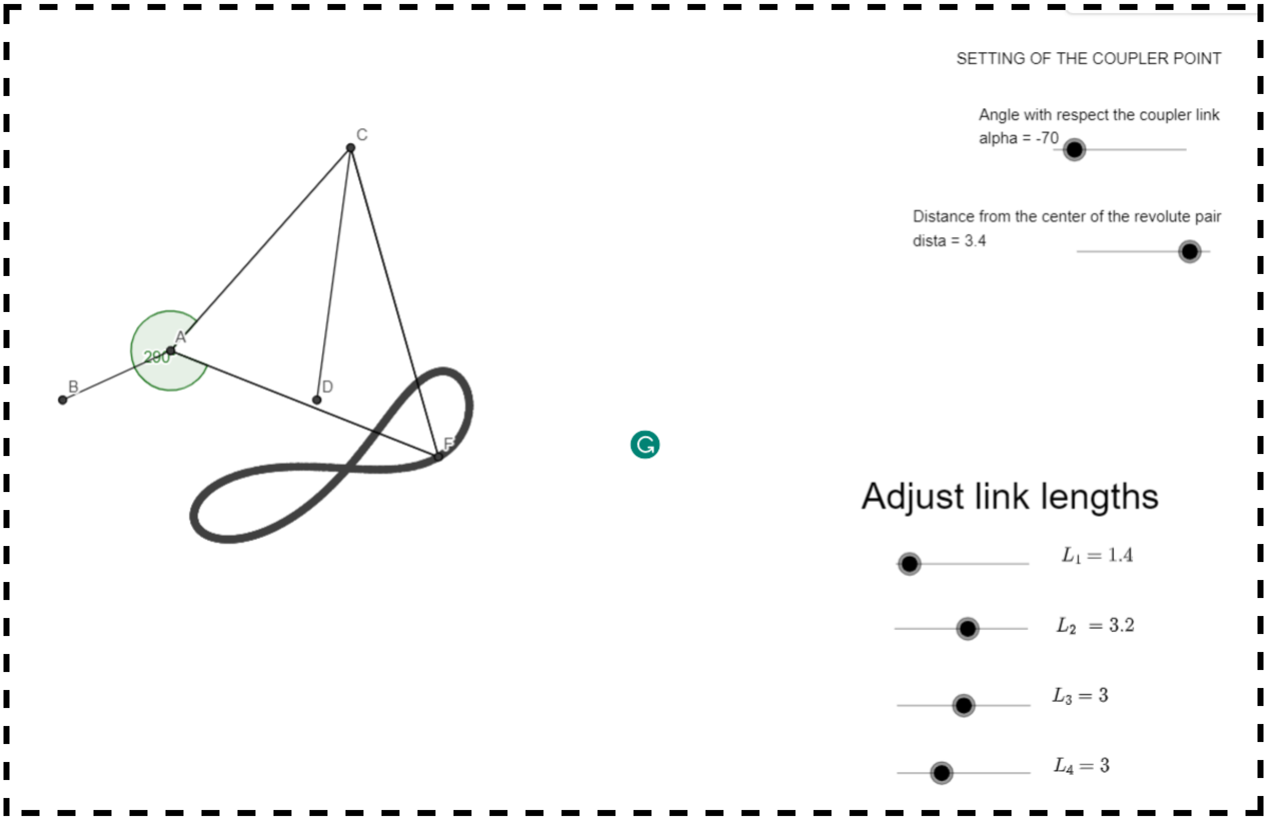
The central crank link is the driving force behind the movement of the other links and pin joints that constitute the mechanism. As the crank rotates, it imparts motion to the other links through the pin joints that connect them, resulting in a coordinated and complex movement that is characteristic of the Theo Jansen mechanism. The positions and orientations of these links and joints are uniquely defined by the angle of the crank, which determines the motion of the entire mechanism.

The Strandbeest mechanism has only one degree of freedom, allowing only one independent input variable to determine its motion. This simplicity of design and control makes it highly versatile and adaptable to different applications. Furthermore, the mechanism comprises eight links and ten revolute joints, including a ground joint at point B. Out of these links, two are ternary and the rest are binary links.

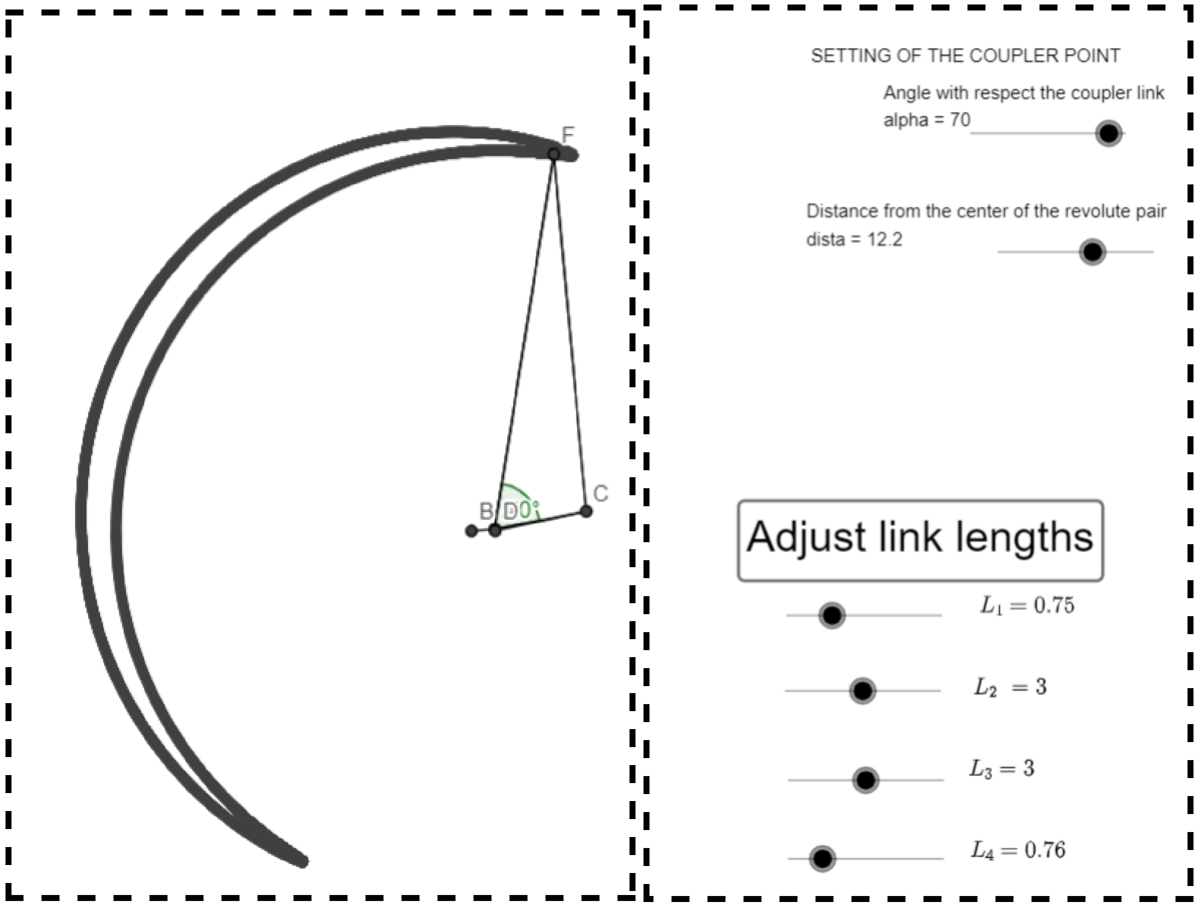
The ingenious design of the Theo Jansen mechanism, with its one-degree-of-freedom nature and a limited number of links and joints, showcases the power of simplicity and efficiency in engineering. The Strandbeest's unique mobility and motion are a testament to the creative genius of its designer and serve as a source of inspiration for aspiring engineers and inventors.

Question (2):

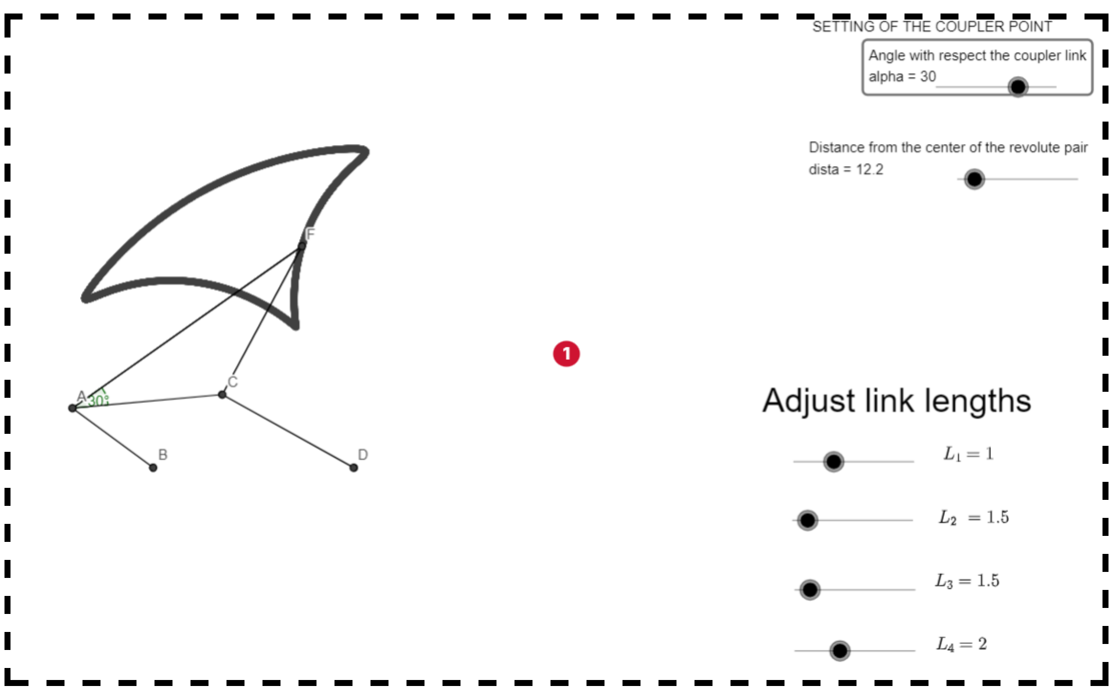
(A)


SETTING OF THE COUPLER POINT
Angle with respect the coupler link
alpha = -70
Distance from the center of the revolute pair
dista = 3.4
C
A
B
D
F
Adjust link lengths
$L_1 = 1.4$
$L_2 = 3.2$
$L_3 = 3$
$L_4 = 3$

(**B**)


F
B
D
C
SETTING OF THE COUPLER POINT
Angle with respect the coupler link
alpha = 70
Distance from the center of the revolute pair
dista = 12.2
Adjust link lengths
$L_1 = 0.75$
$L_2 = 3$
$L_3 = 3$
$L_4 = 0.76$

(**C**)


SETTING OF THE COUPLER POINT
Angle with respect the coupler link
alpha = 30
Distance from the center of the revolute pair
dista = 12.2
F
A
30°
C
B
D
Adjust link lengths
$L_1 = 1$
$L_2 = 1.5$
$L_3 = 1.5$
$L_4 = 2$

Question (3):

The leg mechanisms of Boston Dynamics' SPOT and MIT's Cheetah robots have been meticulously studied, analyzed, and explained by robotic enthusiasts worldwide. These technological marvels boast intricately designed legs that exhibit remarkable stability, mobility, and agility, making them an awe-inspiring sight to behold.

The SPOT robot, equipped with four legs, each with three degrees of freedom, comprises three joints – hip, knee, and ankle. These joints are connected by a ball joint and two universal joints that offer various degrees of flexion-extension and abduction-adduction, enabling the robot to navigate challenging terrain, climb stairs, and execute other intricate movements. Additionally, the ankle joint has a passive compliance mechanism, enhancing the robot's adaptability to uneven surfaces.

On the other hand, the MIT Cheetah robot boasts four legs, each with four degrees of freedom, with the hip and knee joints functioning similarly to the SPOT robot. The ankle joint, however, is more complex, featuring two degrees of flexion-extension and inversion-eversion. The foot joint, connected to the ankle joint via a ball joint, adds more degrees of freedom to the robot's movement.

Both robots employ diverse driving mechanisms to power their leg movements. The SPOT robot uses electric motors, gearboxes, and sensors to generate torque, translate motor torque to joint speed and torque, and provide feedback to the control system. The Cheetah robot, on the other hand, utilizes hydraulic actuators, high-speed motors, and sensors, offering exceptional power, force, speed, and precision for high-speed running and obstacle jumping.

These leg mechanisms are not only marvels of modern engineering but also draw inspiration from nature's intricacies. With a careful and safe study of a stray dog's legs, one can appreciate how closely the design of these robots' legs mimics nature. The complex leg mechanisms in these robots also inspire new designs for prosthetic limbs and other assistive devices.

In summary, the leg mechanisms of the SPOT and Cheetah robots are both technically complex and artistically impressive. With their remarkable stability, mobility, and agility, they are a testament to the wonders of modern robotics and provide boundless opportunities for future advancements in the field.

Question (4):

I found the mechanism atlas to be interesting due to the variety of mechanisms and their wide range of applications. The diagrams were clear, and the explanations provided a lot of detail. Overall, it's a valuable resource for anyone interested in learning about different types of mechanisms and their uses.

Question (5):

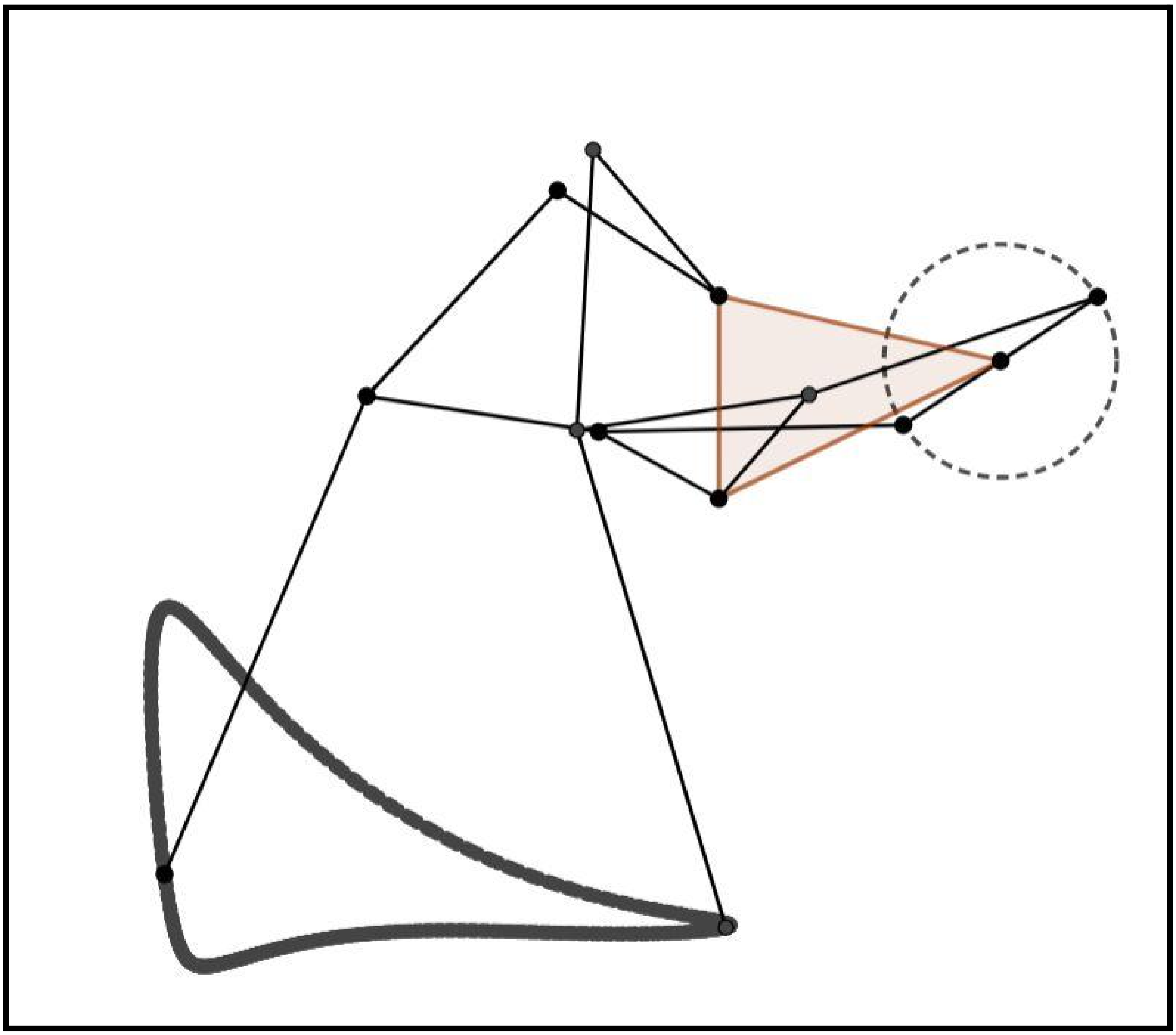


Fig: Klann Mechanism

In our project, we utilized a Klann mechanism to create a 6-legged crab model using MDF and acrylic sheets. To ensure smooth movements and accurate positioning of the legs, we used laser cutting to cut the parts and 3D printing to create joint hooks. This mechanism allowed us to simulate the movements of a real crab, including its distinctive sideways walk.

One of the challenges we faced was accurately depicting the 3D motion of the crab using GeoGebra, which primarily displays 2D motion. However, we were able to successfully incorporate the Klann mechanism into our project and create a realistic and engaging simulation of the crab's movement.

Overall, the use of the Klann mechanism and the combination of various fabrication techniques allowed us to create a complex and dynamic model that accurately captures the unique movements of a crab. By incorporating this model into GeoGebra, we were able to provide a more interactive and visually appealing demonstration of our project.

Question (6):

Some of the key learnings through our Mini-Project 2 were:

Collaboration and communication play a vital role in mechanism design, as it typically involves a team of members with diverse expertise. To ensure that everyone is working towards the same objectives and that the final design meets all requirements, effective communication and collaboration are critical.

Iterative testing is crucial in mechanism design, as it involves multiple rounds of iteration and testing to enhance and refine the design. In the design process, prototyping and testing are significant stages to verify that the mechanism performs as intended and to detect any potential issues or areas that need to be enhanced.

This project has provided me with a deeper understanding of gear geometry and its significance in transmitting motion between various components of a mechanism. As with any project, there may be challenges, such as misalignment or interference of gears. Overcoming these obstacles requires problem-solving skills and the ability to approach problems with creativity and innovation.

The primary objective of mechanism design is to ensure that the mechanism achieves the desired motion as expected. The crucial task is to create a functional design that can perform its intended purpose efficiently.