FINAL PROJECT

DIMENSIONAL SYNTHESIS AND KINEMATIC ANALYSIS OF PLANAR SIX-BAR CRANK-DRIVEN LEG MECHANISM

By:

RIDHO WIDIANTO

NIM. 2210912001

Supervisor:

Dr. Eng. Syamsul Huda

NIP. 197306022000031001

Co-Supervisor:

Prof. Dr.-Ing. Mulyadi Bur

NIP. 195808211986031002

MECHANICAL ENGINEERING DEPARTMENT

FACULTY OF ENGINEERING

UNIVERSITAS ANDALAS

PADANG

2026

ABSTRACT

The planar six-bar crank-driven leg mechanism offers a single-actuator robotic leg solution capable of generating trajectories resembling human strides with relatively low torque requirements. This research aimed to determine the kinematic constants of the mechanism through dimensional synthesis and kinematic analysis to generate a human-like walking trajectory. The study consisted of formulating loop closure equations, conducting position, velocity, and acceleration analyses, determining gait precision points, performing numerical dimensional synthesis using the Modified Newton–Raphson method in Maple 2022, and validating the optimized mechanism through dynamic simulation in Autodesk Inventor 2023. The analytical position equations were validated against CAD simulation with errors below 0.1% for angular position and below 1% for Cartesian coordinates, confirming the accuracy of the kinematic model. The dimensional synthesis producing optimized kinematic constants of r_1 = 341.79 mm, r_2 = 78.26 mm, r_3 = 178.32 mm, $r_4 = r_7$ = 258.61 mm, $r_5 = r_6$ = 452.72 mm, β = 145.90°, and γ = 54.67°. The optimized mechanism successfully passed all seven target precision points, although deviations remained between precision points due to the limited number of optimized points. Overall, the proposed dimensional synthesis method successfully determined the kinematic constants of a planar six-bar crank-driven leg mechanism capable of generating a walking trajectory closely resembling the desired human gait pattern.

Keywords: planar six-bar mechanism, crank-driven leg, dimensional synthesis, kinematic analysis, leg trajectory.