Department of Robotics & Mechatronics Engineering
University of Dhaka

Course code : RME 4111
Course name : Advanced Robotics Lab

Experiment no : 05
Experiment name : Robots manipulability measurement.

Group no : 02
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Objective:

- Robots manipulability measurement.
- Analyze the impact of robot configuration on manipulability

Theory:

The manipulability Jacobian, which is easily acquired for serial manipulators in the form of the common Jacobian matrix, is necessary for the calculation of the manipulability measure and manipulability ellipsoid. The Jacobian matrix provides a mapping from active joint velocities to end-effector velocities for parallel manipulators as well. The manipulability Jacobian cannot be derived using the same method as in the aforementioned situations, making it difficult to determine this measure when working with serial manipulators that integrate limitations inside the kinematic chain.

Due to the additional kinematic restrictions present in serial manipulators with constraints, obtaining the manipulability Jacobian calls for specialised methods. These limitations may result from joint restrictions, collision prevention, or other design factors. The inclusion of these constraints makes it more difficult to calculate the manipulability measure and mandates the use of additional techniques to get the Jacobian.

To meet this challenge, scientists and engineers have created a number of strategies. To take the constraints into account and arrive at the manipulability Jacobian, some methods require the use of optimisation algorithms or numerical techniques. These techniques formulate the manipulability measure while taking into account the unique constraints of the serial manipulator.

It is possible to evaluate the manipulability measure and build the manipulability ellipsoid by solving the challenges posed by limited serial manipulators. In order to build, control, and optimise serial manipulator systems for use in a variety of robotics, automation, and industrial tasks, it is essential to quantify the manipulator's dexterity and maneuverability.

Equipment:

- MATLAB Software

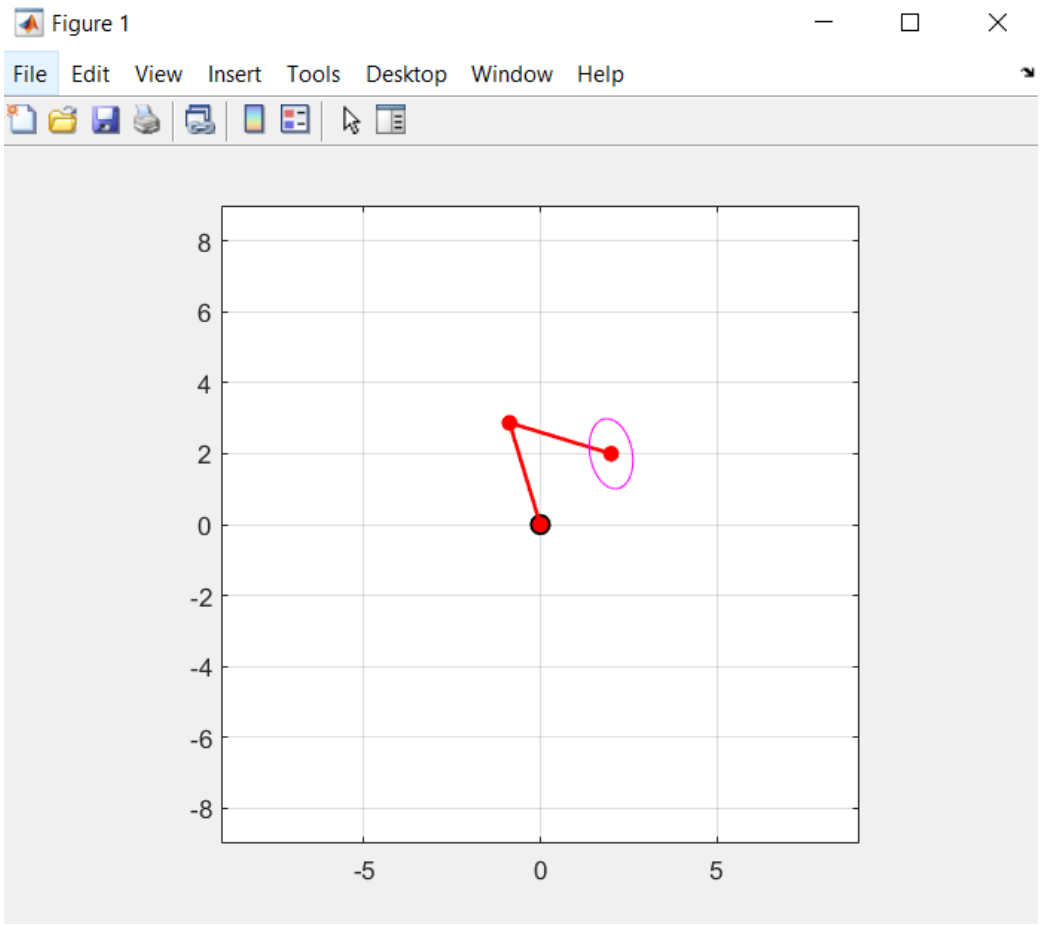
Procedure:

- First, A function to implement Inverse kinematics for the joint which mapped the manipulator co-ordinates and link lengths to joint angles was programmed in MATLAB.
- Then, the Jacobian matrix and eigen values for the corresponding theta values were calculated.
- Finally, The Force Ellipsoid and Velocity Ellipsoid were determined. As the end effector location or length changes, the shape and orientation of the force ellipsoid also changes accordingly.

Result:

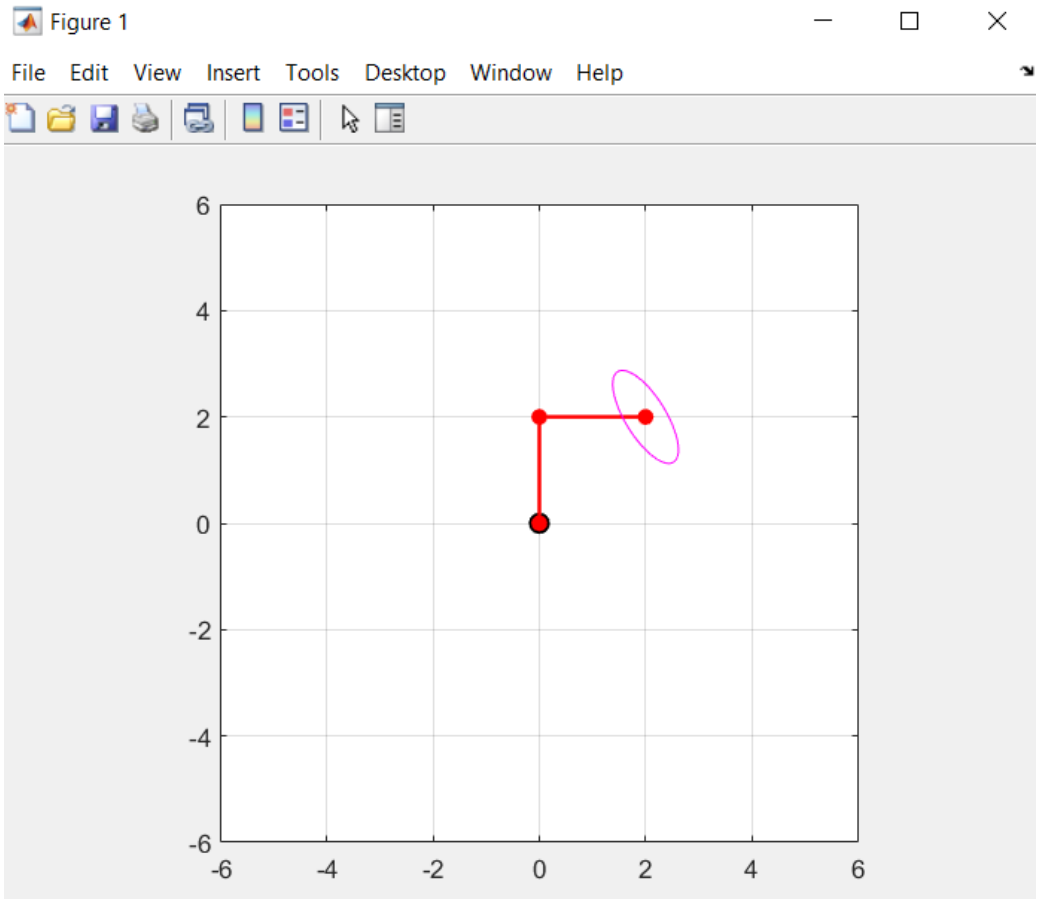
For,

- L1 = 3
- L2 = 3
- X = 2
- Y = 2



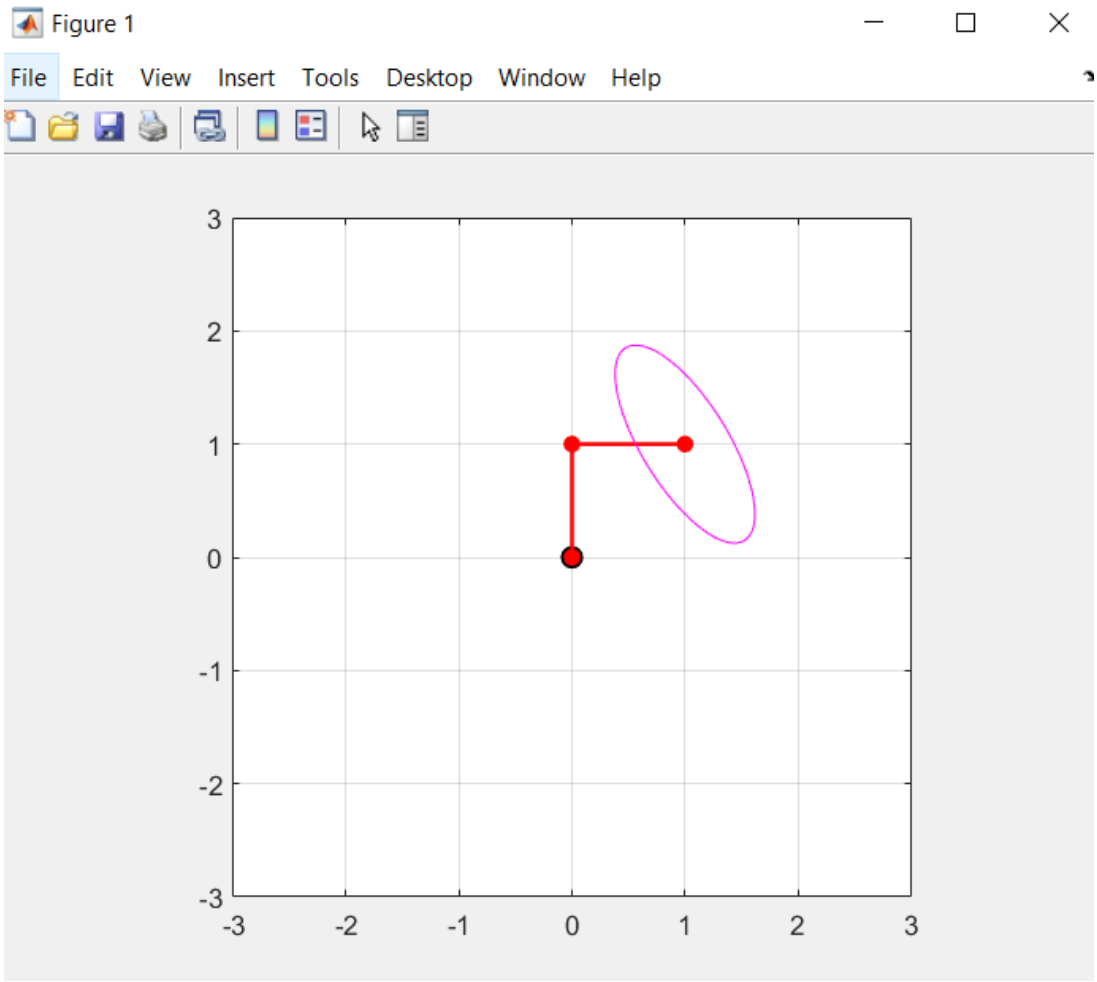
For,

- L1 = 2
- L2 = 2
- X = 2
- Y = 2



For,

- L1 = 1
- L2 = 1
- X = 1
- Y = 1



Discussion:

The force ellipsoid simulations shed important light on the connection between the length and placement of the end-effector and the ensuing orientation, shape, and location of the force ellipsoid. These simulations were examined in order to gain a better understanding of how changes in end-effector settings affect the properties of the force ellipsoid.

It was clear from the simulations how changing the end-effector's length and placement affected how the force ellipsoid behaved. This included modifications to its orientation, which revealed the direction in which forces were applied, as well as modifications to its shape, which revealed the distribution and strength of forces along various axes. The force ellipsoid's location was also impacted, revealing the area of space where the main forces were focused.

The knowledge gained from these simulations is crucial for improving the functionality and design of robotic systems. Engineers and scientists can improve the manipulation capabilities, stability, and general efficacy of robotic systems by taking into account how changes in end-effector parameters affect the force ellipsoid. This information can help in a variety of applications, including as robotic assembly, manipulation, and object interaction, by directing the choice of suitable end-effector configurations and assisting in the achievement of desired force distributions and control.

Date: 27.02.2023

Group no-02

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27.02.2023

Experiment no-05

Experiment name- Robot's manipulability measurement.

For,

$L_1 = 3$

$L_2 = 3$

$x = 2$

$y = 2$

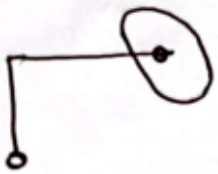
For,

$L_1 = 2$

$L_2 = 2$

$x = 2$

$y = 2$



For,

$L_1 = 1$

$L_2 = 1$

$x = 1$

$Y = 1$