ロボットアームの順運動学: Matlabによるコーディング
Robot Arm Forward Kinematics: Matlab Coding

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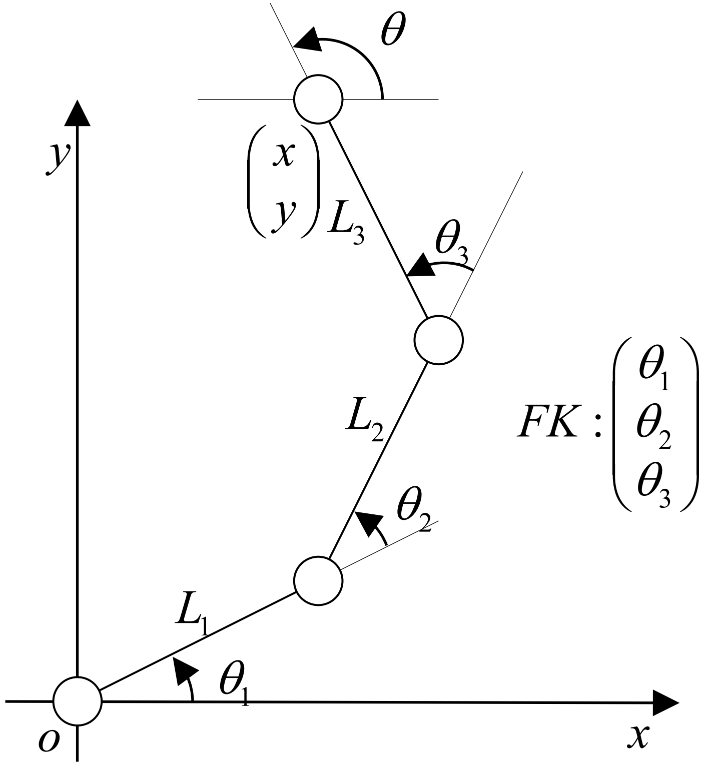


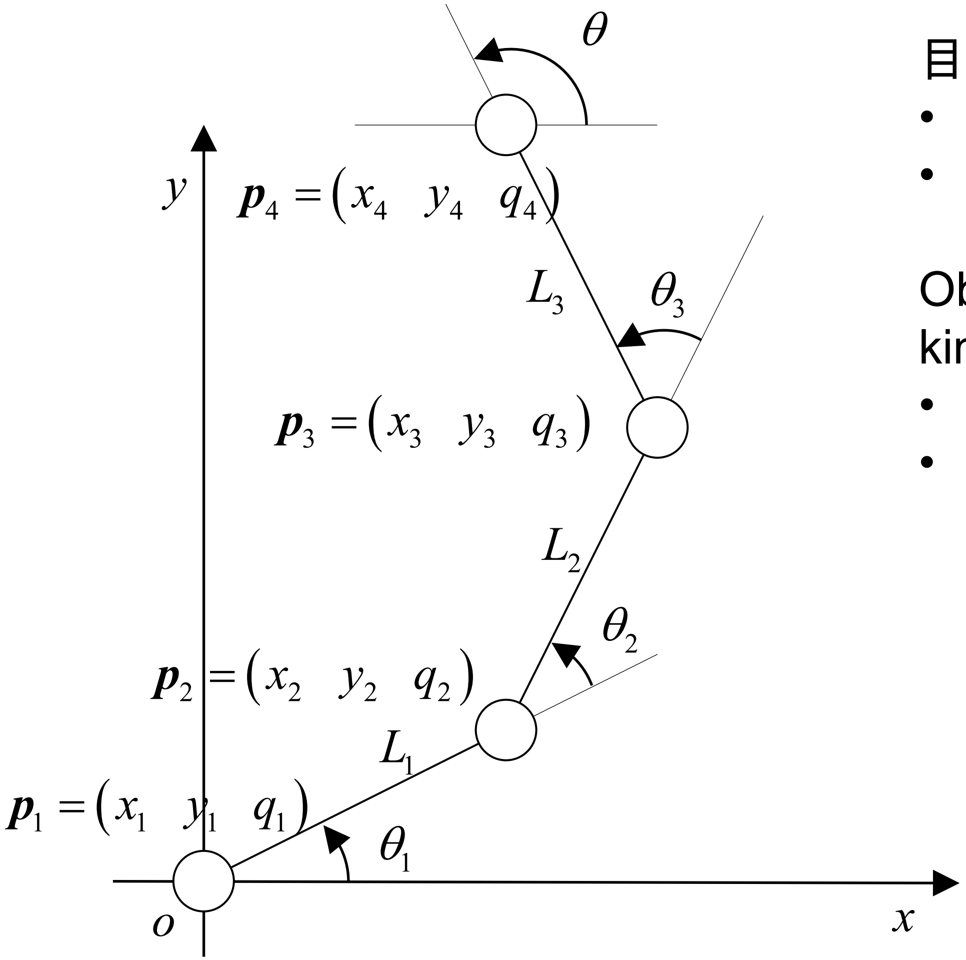
$$FK:\begin{pmatrix}\theta_1\\\theta_2\\\theta_3\end{pmatrix}\rightarrow\begin{pmatrix}x\\y\\\theta\end{pmatrix}$$

まとめ
- Matlabによる順運動学関数のコーディング

Summary
- Matlab coding of a forward kinematics function

ロボットアームの順運動学関数のMatlab コーディング

Matlab Coding of Forward Kinematics Function of Robot Arm



θ
y
$\boldsymbol{p}_4 = (x_4 \quad y_4 \quad q_4)$
L_3
θ_3
$\boldsymbol{p}_3 = (x_3 \quad y_3 \quad q_3)$
L_2
θ_2
$\boldsymbol{p}_2 = (x_2 \quad y_2 \quad q_2)$
L_1
$\boldsymbol{p}_1 = (x_1 \quad y_1 \quad q_1)$
θ_1
o
x

目的：ロボットアームの順運動学をMatlabの関数として実装する

- 引数：関節角度ベクトル
- 戻り値：姿勢行列（行が各関節の姿勢を表す）

Objective: To implement a matlab function to solve forward kinematics of a robot arm

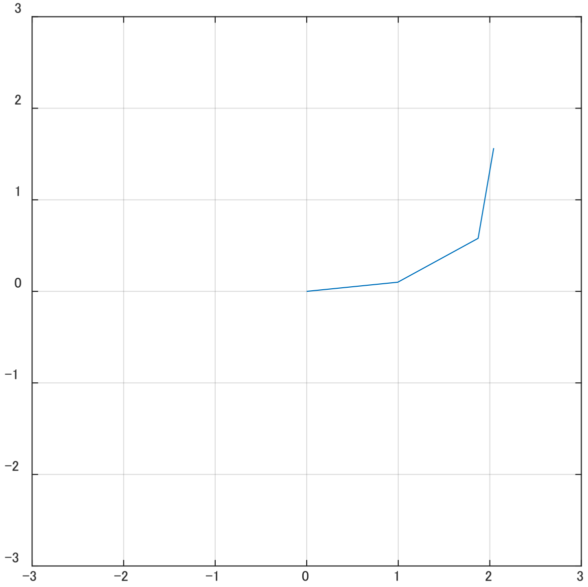
- Argument: A joint angle vector
- Return: A pose matrix, in which a row represents a pose of each of the joints

$$\boldsymbol{q} = (q_1, q_2, q_3) \xrightarrow{\qquad} \boldsymbol{p} = \begin{pmatrix} \boldsymbol{p}_1 \\ \boldsymbol{p}_2 \\ \boldsymbol{p}_3 \\ \boldsymbol{p}_4 \end{pmatrix} = \begin{pmatrix} x_1 & y_1 & q_1 \\ x_2 & y_2 & q_2 \\ x_3 & y_3 & q_3 \\ x_4 & y_4 & q_4 \end{pmatrix}$$

p = fk(q)

Matlabによる順運動学関数の実装：呼び出しとプロット

Matlab Implementation of Forward Kinematics Function: Call and Plot



fk_3Link_planar.m

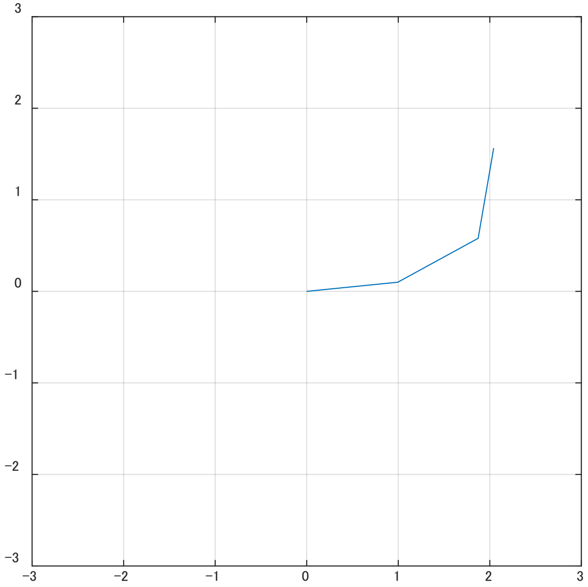
```
% Joint angles
q = [0.1, 0.4, 0.9];

% Forward kinematics calculation
p = fk(q);

% Plot poses
% Open a new plot window named Figure 1
figure(1);
% p(:,1): A vector of X positions
% p(:,2): A vector of Y positions
plot(p(:,1), p(:,2));
% Set plot range
xlim([-3, 3]); ylim([-3, 3]);
% Set aspect ratio between x, y, and z
pbaspect([1, 1, 1]);
% Set grid on plot
grid on;
```

$$\boldsymbol{q} = (q_1, q_2, q_3) \xrightarrow[\text{p = fk(q)}]{} \boldsymbol{p} = \begin{pmatrix} \boldsymbol{p}_1 \\ \boldsymbol{p}_2 \\ \boldsymbol{p}_3 \\ \boldsymbol{p}_4 \end{pmatrix} = \begin{pmatrix} x_1 & y_1 & q_1 \\ \hdashline x_2 & y_2 & q_2 \\ \hdashline x_3 & y_3 & q_3 \\ \hdashline x_4 & y_4 & q_4 \end{pmatrix}$$

Code is available at https://github.com/keitaronaruse/Naruse-robotics-tutorial/blob/main/src/matlab/fk_3Link_planar.m

Matlabによる順運動学関数の実装

Matlab Implementation of Forward Kinematics Function



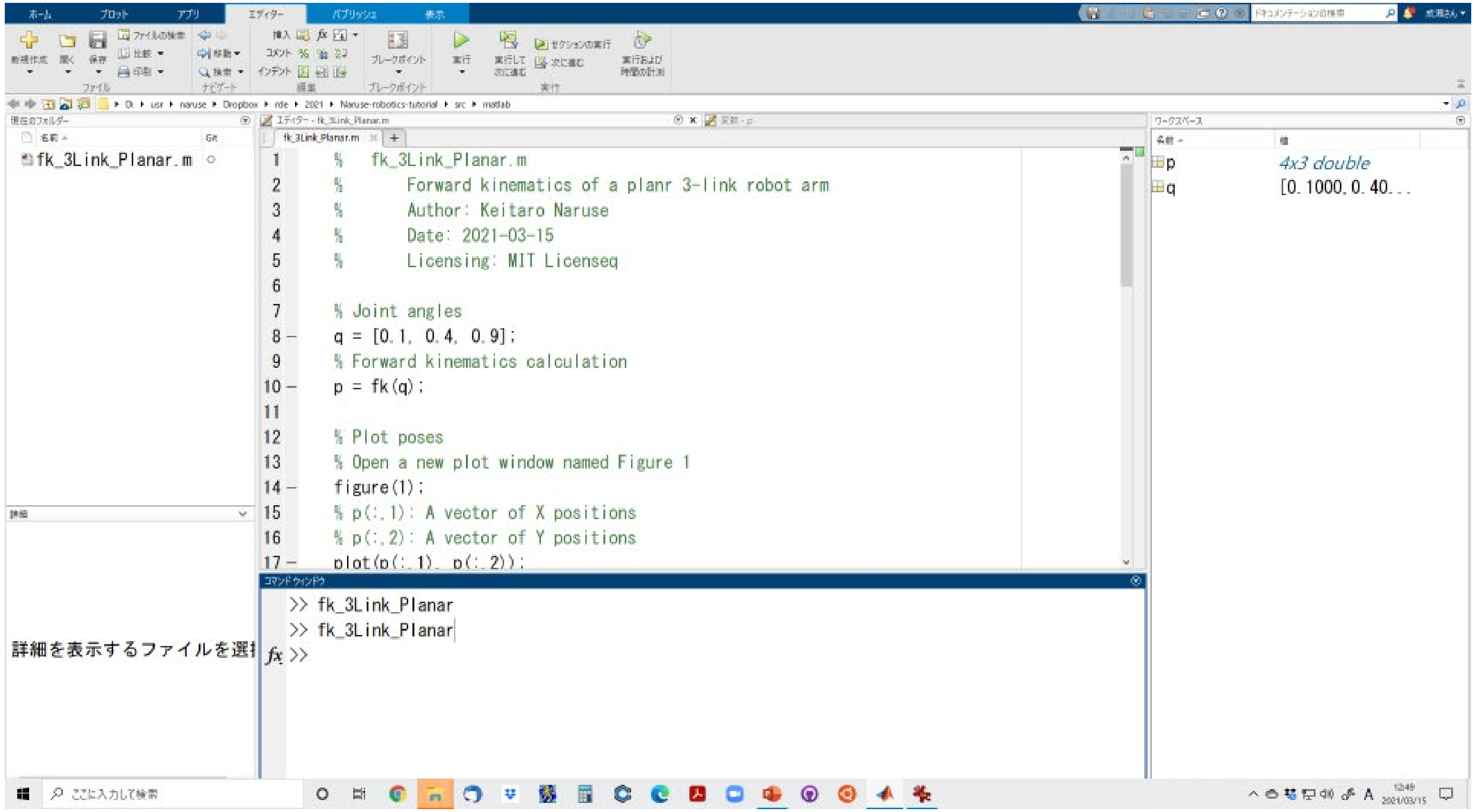
fk_3Link_planar.m

```
function p = fk(q)
% Robot arm parameters
L1 = 1.0; L2 = 1.0; L3 = 1.0;

% Pose calculation
% pi = [xi, yi, qi]
p1 = [0,0,0];
p2 = p1 + [L1 * cos(q(1)), L1* sin(q(1)), q(1)];
p3 = p2 + [L2 * cos(q(1)+q(2)), L2* sin(q(1)+q(2)), q(2)];
p4 = p3 + [L3 * cos(q(1)+q(2)+q(3)), L3* sin(q(1)+q(2)+q(3)), q(3)];

% Set the four poses in a pose vector p
p = [p1; p2; p3; p4];
end
```

$$\boldsymbol{q}=(q_1,q_2,q_3)\xrightarrow[p\ =\ \mathrm{fk}(q)]{}\boldsymbol{p}=\begin{pmatrix}\boldsymbol{p}_1\\ \boldsymbol{p}_2\\ \boldsymbol{p}_3\\ \boldsymbol{p}_4\end{pmatrix}=\left(\begin{array}{ccc} x_1 & y_1 & q_1\\ \hdashline x_2 & y_2 & q_2\\ \hdashline x_3 & y_3 & q_3\\ \hdashline x_4 & y_4 & q_4\end{array}\right)$$

Code is available at https://github.com/keitaronaruse/Naruse-robotics-tutorial/blob/main/src/matlab/fk_3Link_Planar.m

Matlabの順運動学コードのデモンストレーション
Demonstration of Matlab Forward Kinematics Code



fk_3Link_Planar.m

```
%   fk_3Link_Planar.m
%       Forward kinematics of a planr 3-link robot arm
%       Author: Keitaro Naruse
%       Date: 2021-03-15
%       Licensing: MIT Licenseq

% Joint angles
q = [0.1, 0.4, 0.9];
% Forward kinematics calculation
p = fk(q);

% Plot poses
% Open a new plot window named Figure 1
figure(1);
% p(:,1): A vector of X positions
% p(:,2): A vector of Y positions
plot(p(:,1), p(:,2));
```

```
>> fk_3Link_Planar
>> fk_3Link_Planar
fx >>
```

詳細を表示するファイルを選択

名前	値
p	4x3 double
q	[0.1000,0.40...