equationsToMatrix

Convert linear equations to matrix form

Syntax

```
[A,b] = equationsToMatrix(eqns)
[A,b] = equationsToMatrix(eqns,vars)
A = equationsToMatrix( __ )
```

Description

`[A,b] = equationsToMatrix(eqns)` converts equations `eqns` to matrix form. `eqns` must be a linear system of equations in all variables that `symvar` finds in `eqns`.

`[A,b] = equationsToMatrix(eqns,vars)` converts `eqns` to matrix form, where `eqns` must be linear in `vars`.

`A = equationsToMatrix( __ )` returns only the coefficient matrix of the system of equations.

Examples

Convert Linear Equations to Matrix Form

Convert a system of linear equations to matrix form. `equationsToMatrix` automatically detects the variables in the equations by using `symvar`.

```
syms x y z
eqns = [x+y-2*z == 0,
        x+y+z == 1,
        2*y-z == -5];
[A,b] = equationsToMatrix(eqns)
```

```
A =
[ 1, 1, -2]
[ 1, 1,  1]
[ 0, 2, -1]

b =
  0
  1
 -5
```

Matrix Representation of System of Linear Equations

A system of linear equations

$$
\begin{aligned}
&a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = b_1 \\
&a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = b_2 \\
&\ldots \\
&a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n = b_m
\end{aligned}
$$

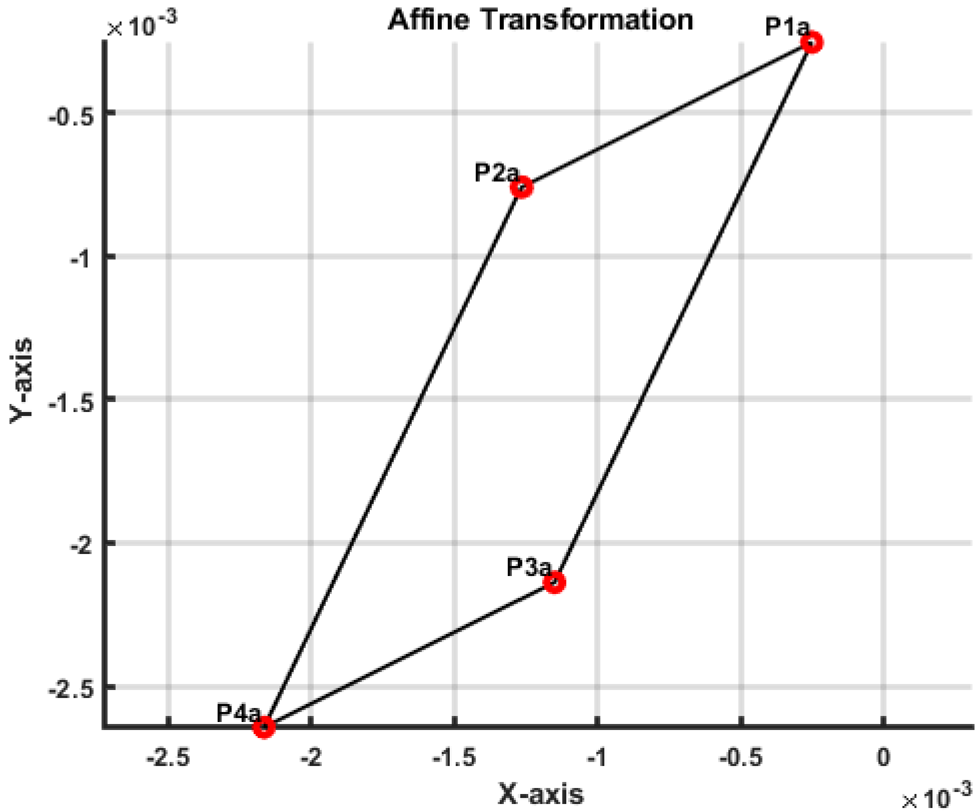
can be represented as the matrix equation $A \cdot \overrightarrow{x} = \overrightarrow{b}$. Here, A is the coefficient matrix.

$$
A = \begin{pmatrix} a_{11} & \ldots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix}
$$

$\overrightarrow{b}$ is the vector containing the right sides of equations.

$$
\overrightarrow{b} = \begin{pmatrix} b_1 \\ \vdots \\ b_m \end{pmatrix}
$$

```
axis equal;grid on; hold off
title('\bf Affine Transformation');
xlabel('\bf X-axis');
ylabel('\bf Y-axis');
set(gca,'fontsize',10,'linewidth',2,'fontweight','bold')
```



Metric Rectification

```
% two-setp method
syms l1 l2 l3 s1 s2 s3 m1 m2 m3
lCm1 = [l1 l2 l3]*[s1 s2 0;s2 s3 0;0 0 0]*[m1;m2;m3]==0
```

lCm1 = $m_1\,(l_1\,s_1 + l_2\,s_2) + m_2\,(l_1\,s_2 + l_2\,s_3) = 0$

```
[A,b] = equationsToMatrix(lCm1, [s1;s2;s3])
```

A = $\begin{pmatrix} l_1\,m_1 & l_1\,m_2 + l_2\,m_1 & l_2\,m_2 \end{pmatrix}$

b = (0)

```
% one-step method
syms l1 l2 l3 a b c d e f m1 m2 m3
Cd = [a b c;b d e;c e f];
lCm2 = [l1 l2 l3]*Cd*[m1;m2;m3]==0
```

lCm2 = $m_1\,(a\,l_1 + b\,l_2 + c\,l_3) + m_2\,(b\,l_1 + d\,l_2 + e\,l_3) + m_3\,(c\,l_1 + e\,l_2 + f\,l_3) = 0$

```
[A,b] = equationsToMatrix(lCm2, [a;b;c;d;e;f])
```

A = $\begin{pmatrix} l_1\,m_1 & l_1\,m_2 + l_2\,m_1 & l_1\,m_3 + l_3\,m_1 & l_2\,m_2 & l_2\,m_3 + l_3\,m_2 & l_3\,m_3 \end{pmatrix}$

b = $\begin{pmatrix} 0 \end{pmatrix}$

Point Correspondance for Estimating a Homography

```
syms h11 h12 h13 h21 h22 h23 h31 h32 h33
syms x y x_p y_p
H = [h11 h12 h13;h21 h22 h23;h31 h32 h33];
x = [x;y;1];
xp = [x_p;y_p;1];

Hx = H*x;
eqn1 = Hx(1)-xp(1)/xp(3)*Hx(3) == 0;
eqn2 = Hx(2)-xp(2)/xp(3)*Hx(3) == 0;

[A1, b1] = equationsToMatrix(eqn1, [h11;h12;h13;h21;h22;h23;h31;h32;h33])
```

A1 = $\begin{pmatrix} x & y & 1 & 0 & 0 & 0 & -x\,x_p & -x_p\,y & -x_p \end{pmatrix}$

b1 = $\begin{pmatrix} 0 \end{pmatrix}$

```
[A2, b2] = equationsToMatrix(eqn2, [h11;h12;h13;h21;h22;h23;h31;h32;h33])
```

A2 = $\begin{pmatrix} 0 & 0 & 0 & x & y & 1 & -x\,y_p & -y\,y_p & -y_p \end{pmatrix}$

b2 = $\begin{pmatrix} 0 \end{pmatrix}$