conv2

2-D convolution

Syntax

```
C = conv2(A,B)
C = conv2(h1,h2,A)
C = conv2(...,shape)
```

Description

`C = conv2(A,B)` computes the two-dimensional convolution of matrices `A` and `B`. If one of these matrices describes a two-dimensional finite impulse response (FIR) filter, the other matrix is filtered in two dimensions. The size of `C` is determined as follows: if `[ma,na] = size(A)`, `[mb,nb] = size(B)`, and `[mc,nc] = size(C)`, then `mc = max([ma+mb-1,ma,mb])` and `nc = max([na+nb-1,na,nb])`.

`C = conv2(h1,h2,A)` first convolves each column of `A` with the vector `h1` and then convolves each row of the result with the vector `h2`. The size of `C` is determined as follows: if `n1 = length(h1)` and `n2 = length(h2)`, then `mc = max([ma+n1-1,ma,n1])` and `nc = max([na+n2-1,na,n2])`.

`C = conv2(...,shape)` returns a subsection of the two-dimensional convolution, as specified by the `shape` parameter:

`'full'`	Returns the full two-dimensional convolution (default).
`'same'`	Returns the central part of the convolution of the same size as `A`.
`'valid'`	Returns only those parts of the convolution that are computed without the zero-padded edges. Using this option, `size(C) = max([ma-max(0,mb-1),na-max(0,nb-1)],0)`.

Note: All numeric inputs to `conv2` must be of type `double` or `single`.

Examples

Shape for Subsection of 2-D Convolution

For the `'same'` case, `conv2` returns the central part of the convolution. If there are an odd number of rows or columns, the "center" leaves one more at the beginning than the end.

This example first computes the convolution of A using the default (`'full'`) shape, then computes the convolution using the `'same'` shape. Note that the array returned using `'same'` corresponds to the red highlighted elements of the array returned using the default shape.

```
A = rand(3);
B = rand(4);
C = conv2(A,B)   % C is 6-by-6

C =
   0.1838   0.2374   0.9727   1.2644   0.7890   0.3750
   0.6929   1.2019   1.5499   2.1733   1.3325   0.3096
   0.5627   1.5150   2.3576   3.1553   2.5373   1.0602
   0.9986   2.3811   3.4302   3.5128   2.4489   0.8462
   0.3089   1.1419   1.8229   2.1561   1.6364   0.6841
   0.3287   0.9347   1.6464   1.7928   1.2422   0.5423

Cs = conv2(A,B,'same')   % Cs is the same size as A: 3-by-3
Cs =
   2.3576   3.1553   2.5373
   3.4302   3.5128   2.4489
   1.8229   2.1561   1.6364
```

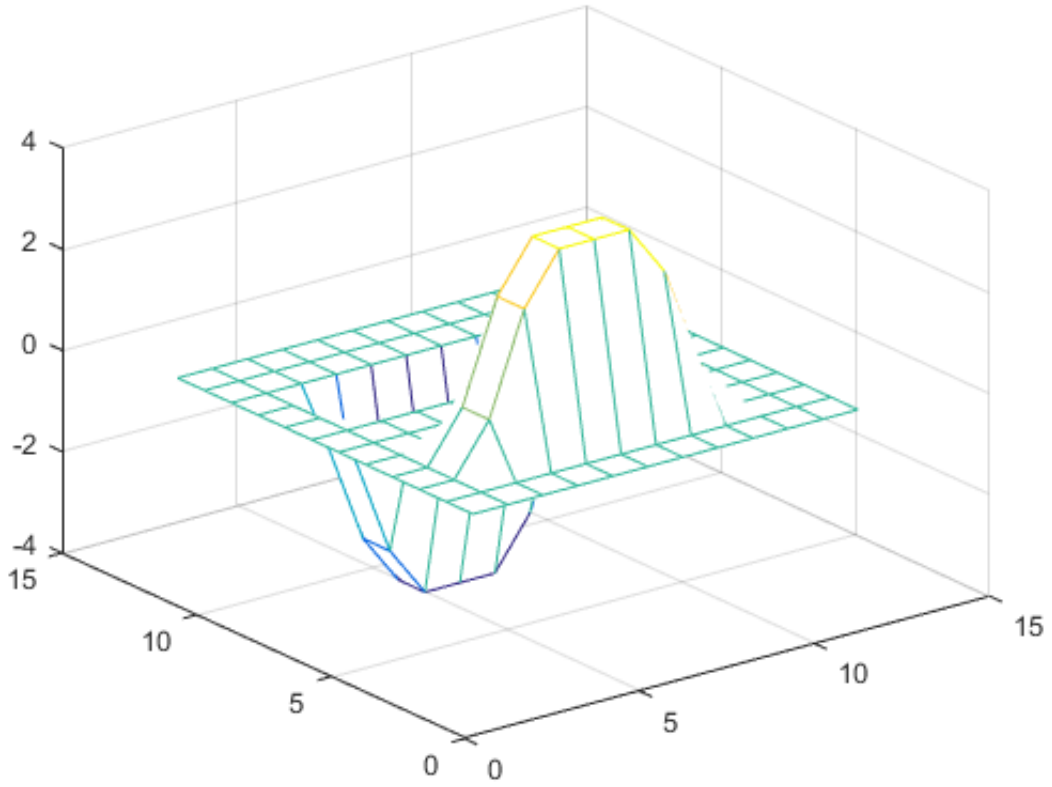
Extract Edges from Raised Pedestal

In image processing, the Sobel edge finding operation is a two-dimensional convolution of an input array with the special matrix:

```
s = [1 2 1; 0 0 0; -1 -2 -1];
```

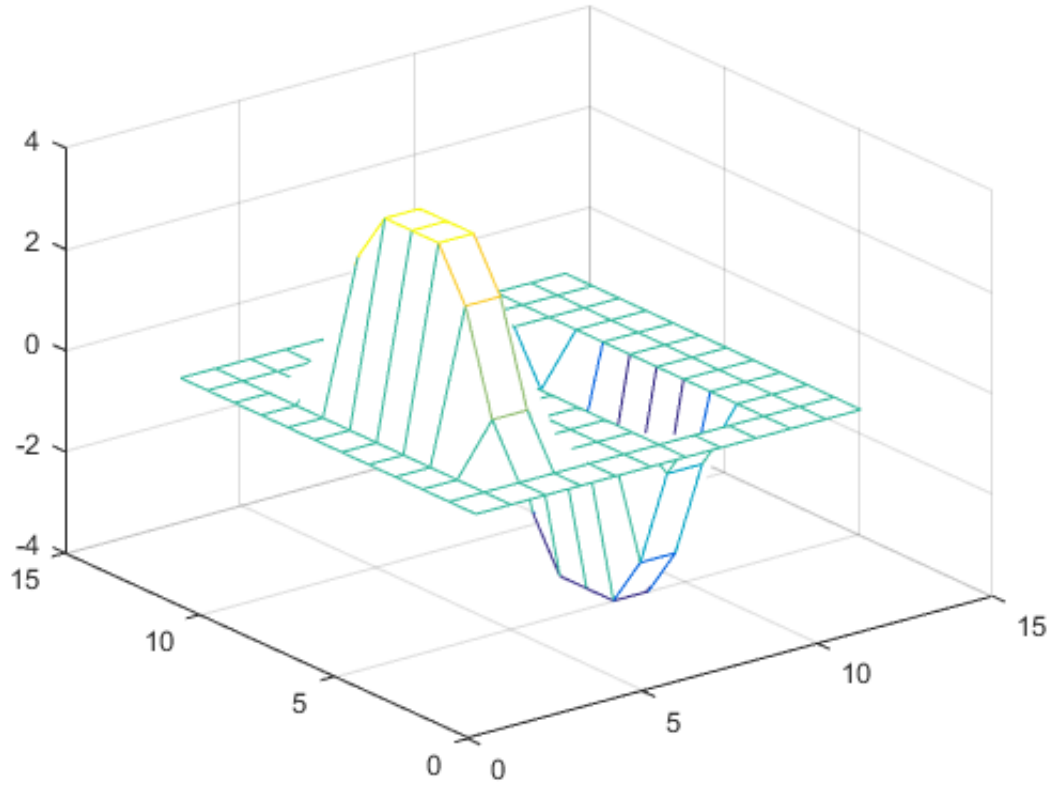
These commands extract the horizontal edges from a raised pedestal.

```
A = zeros(10);
A(3:7,3:7) = ones(5);
H = conv2(A,s);
figure, mesh(H)
```



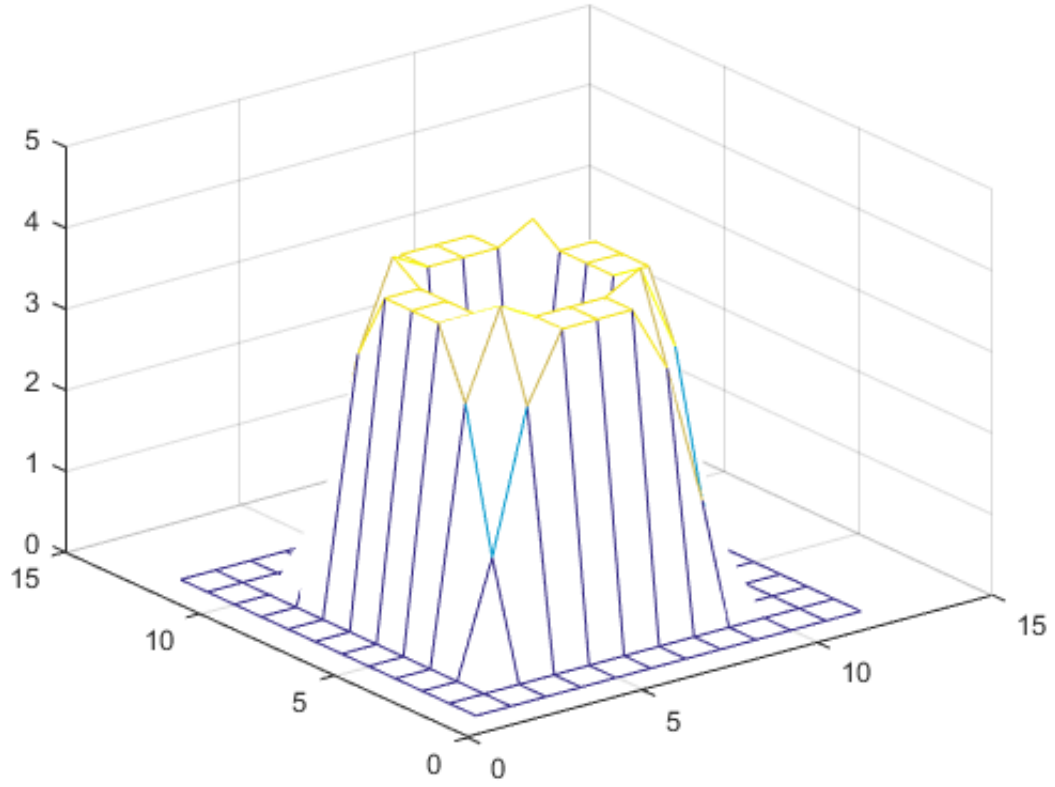
Transposing the filter `s` extracts the vertical edges of `A`.

```
V = conv2(A,s');
figure, mesh(V)
```



This figure combines both horizontal and vertical edges.

```
figure
mesh(sqrt(H.^2 + V.^2))
```



More About

collapse all

Algorithms

`conv2` uses a straightforward formal implementation of the two-dimensional convolution equation in spatial form. If *a* and *b* are functions of two discrete variables, n_1 and n_2, then the formula for the two-dimensional convolution of *a* and *b* is

$$c(n_1, n_2) = \sum_{k_1=-\infty}^{\infty} \sum_{k_2=-\infty}^{\infty} a(k_1, k_2) b(n_1 - k_1, n_2 - k_2)$$

In practice however, `conv2` computes the convolution for finite intervals.

Note that matrix indices in MATLAB® software always start at 1 rather than 0. Therefore, matrix elements `A(1,1)`, `B(1,1)`, and `C(1,1)` correspond to mathematical quantities *a*(0,0), *b*(0,0), and *c*(0,0).

See Also

`conv` | `convn` | `filter2` | `xcorr2`

Introduced before R2006a