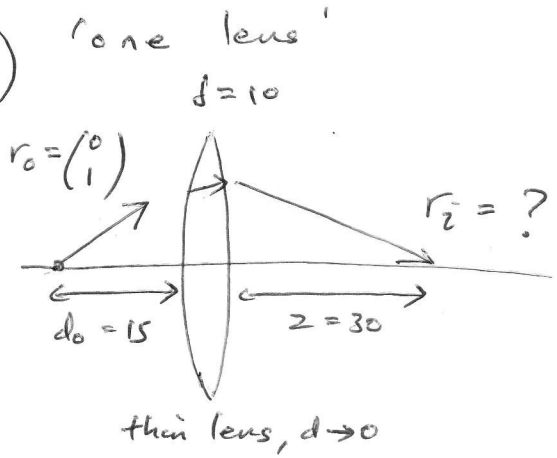
Obtaining output ray coordinates of a single/double lens system.

fn_calc_outray

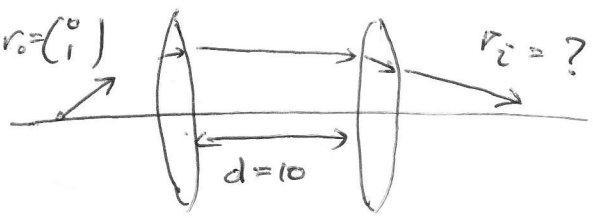
```
%-------------------------
%
% Example codes for ME5405 Machine Vision
%
% File Name: fn_calc_outray.m
%
% Description:
% This function demonstrates the application of ray transfer matrix
% for optics design in machine vision.
% The function determines the output ray coordinates r_i at a distance z
% behind an optical system comprising one or two lens of focus length f
% when the input ray coordinates r_o of a ray starting from an object
% at a distance d_o infront of the lens is specified.
%
% The validity of the system matrix can be checked by finding the
% determinant of the matrix.
%
% Reference:
% Engineering Optics with MATLAB by TC Poon and T Kim
%
% Lecturer: CK Chui, ME, NUS
%
%-------------------------

function fn_calc_outray

clear all;

z = 30;          % 30 cm
f = 10;          % 10 cm
r_o = [0; 1];    % along optical axis, v = 1 rad
d_o = 15;        % 15 cm

%method = 'one lens';
method = 'two-lens';

switch lower(method)
    case 'one lens'
       disp('Single lens')

        T_o = [ 1, d_o; 0, 1 ];
        S_f = [ 1, 0; -(1/f), 1 ];
        T_i = [ 1, z; 0, 1 ];

        S = T_i * S_f * T_o;

    otherwise
        disp('Two-lens')

        d = 10; % 10 cm

        T_o = [ 1, d_o; 0, 1 ];
        S_f1 = [ 1, 0; -(1/f), 1 ];
        T_d = [ 1, d; 0, 1 ];
        S_f2 = [ 1, 0; -(1/f), 1 ];
        T_i = [ 1, z; 0, 1 ];

        S = T_i * S_f2 * T_d * S_f1 * T_o;
end

% checking determinant of system matrix
% detS should be unity
detS = det(S);

% image ray coordinate is r_i
r_i = S * r_o;

disp(r_i);
```

n = 1 for air

'one lens'

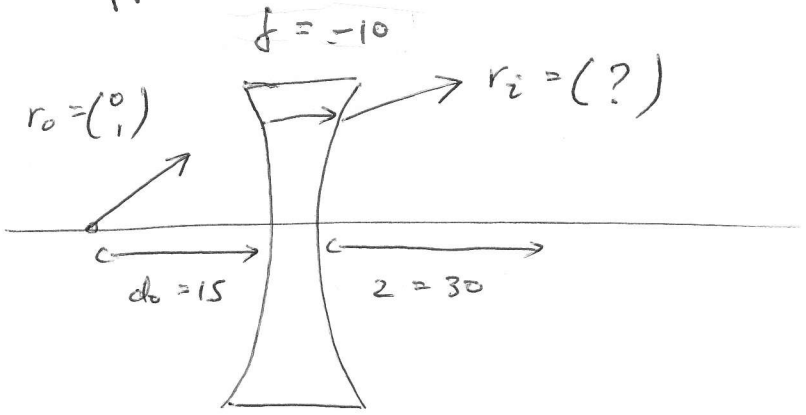


'two lens'

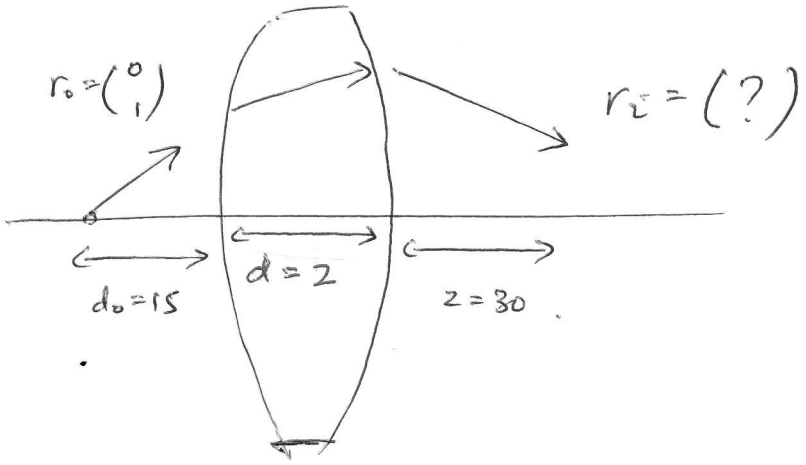


```
end
```

What happened ?



Concave thin lens

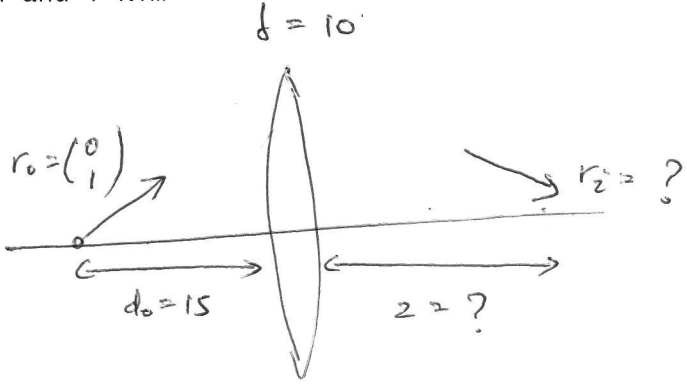


Convex thick lens

Obtaining the image location in a single lens system

fn_calc_imglocatn

```
%-------------------------
%
% Example codes for ME5405 Machine Vision
%
% File Name: fn_calc_imglocatn.m
%
% Description:
% This function demonstrates the application of ray transfer matrix
% for optics design in machine vision.  ,
% Instead of stating the image location and then compute output ray
% coordinates, the program estimates the image location for a given
% location of the single lens system.
% The object is assumed to be an on-axis point,
% If the position of output ray coordinate is sufficiently close to
% the optical axis behind the lens, the corresponding value of z is
% the location of the image.
%
% Reference:
% Engineering Optics with MATLAB by TC Poon and T Kim
%
% Lecturer: CK Chui, ME, NUS
%
%-------------------------

function fn_calc_imglocatn

clear all;
close all;

d_o = 15;
f = 10;
Z_s = 0;
Z_f = 50;
dz = 0.1; % increment of 0.1 cm along z

T_o = [1, d_o; 0, 1];
S_f = [1, 0; -(1/f), 1];

r_o = [0; 1];

n = 0;
for z=Z_s:dz:Z_f
    n = n+1;
    Z1(n) = z;
    T_i = [1, z; 0, 1];
    S = T_i * S_f * T_o;
    % image coordinate is r_i;
    r_i = S * r_o;
    Ri(n)= r_i(1,1);
end
[M, N] = min(abs(Ri));
z_est = Z1(N);

disp('image location (cm)'); disp(z_est);
disp(' distance from optical axis (cm) = '); disp(M);


end
```



thin lens in air