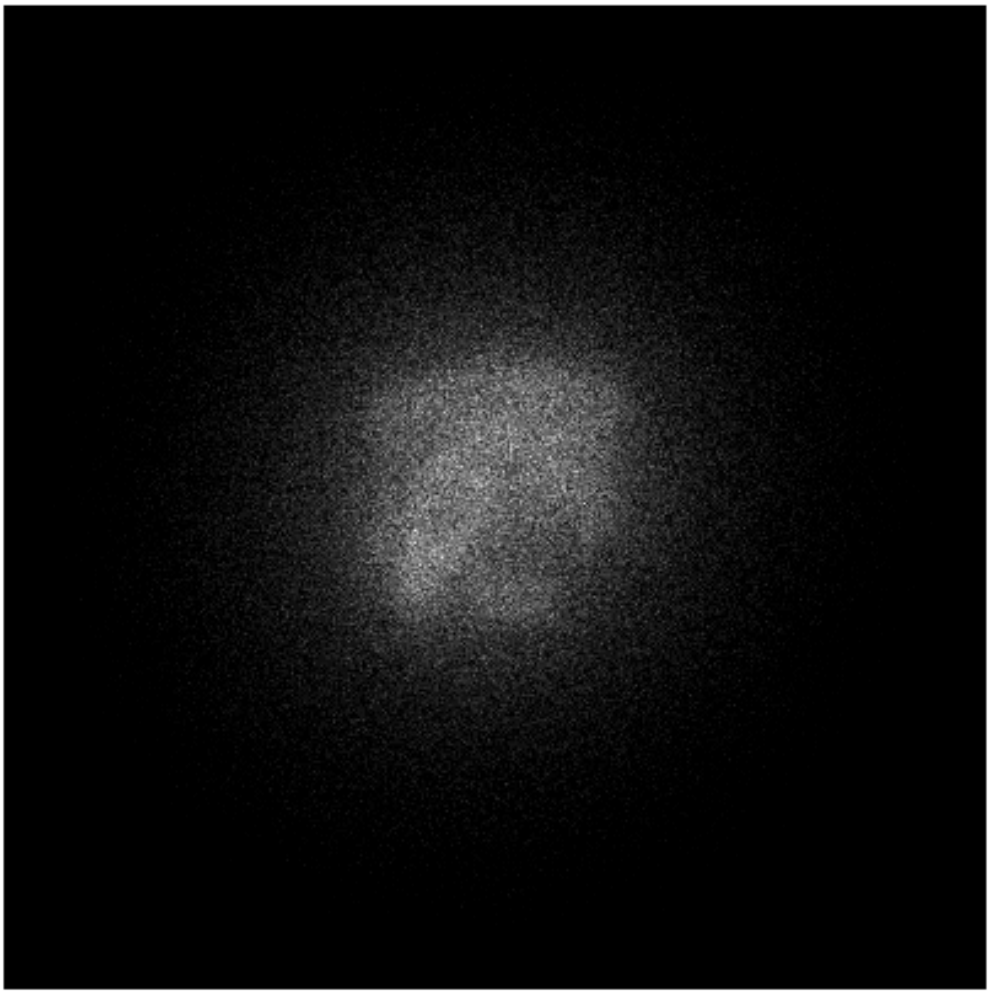
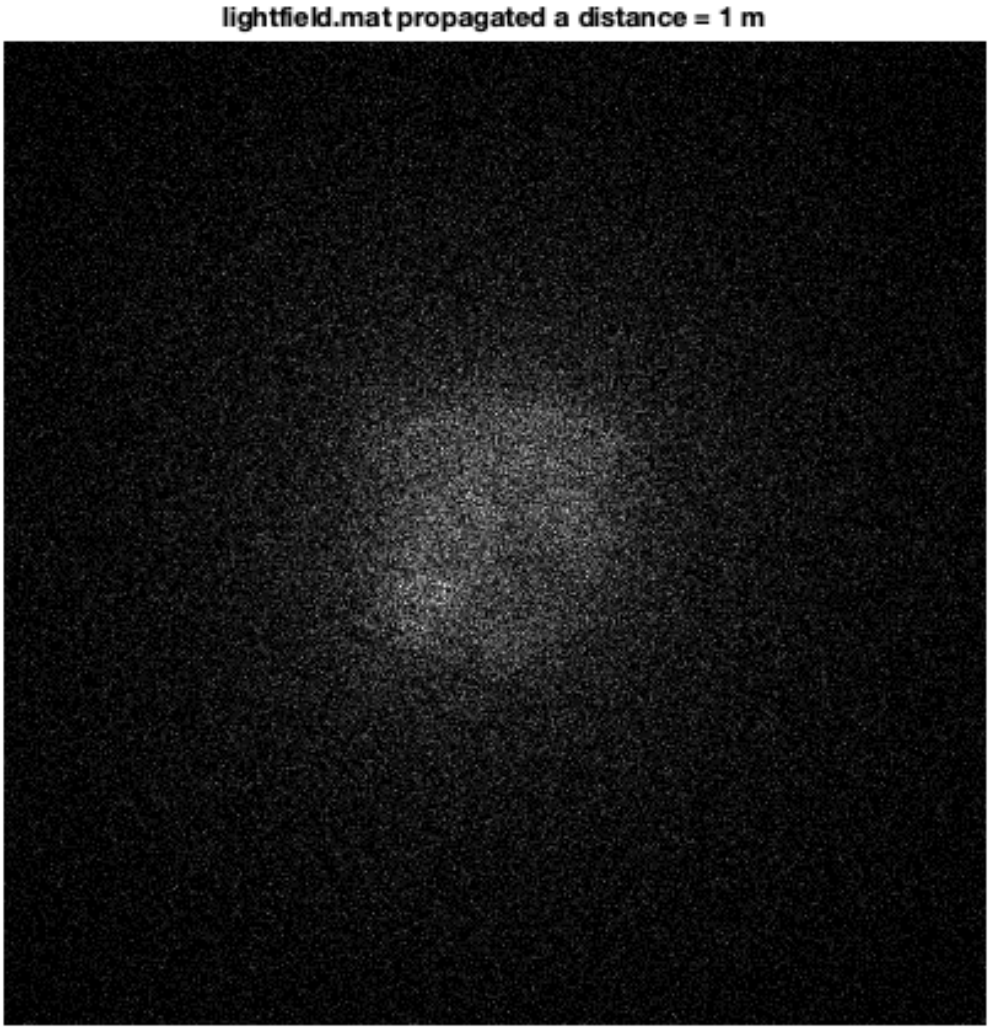
```
% Simulating a Hologram
% Distance = meters; Angle = radians

load('lightField.mat');
width = 0.015; % sensor width parameter for hand-tuning
pixels = 800; % # of pixels parameter for hand-tuning

[img1, x1, y1] = rays2img(rays(1, :), rays(3, :), width, pixels);
figure;
imshow(img1);
title("lightfield.mat with sensor width = " + width + " m");
exportgraphics(gca, 'light_field.png');

% We are unable to discern the object that generated the rays and cannot
% recover a sharp image by increasing/decreasing neither the width of the
% sensor nor the number of pixels, because the rays are traveling freely in
% space and will only continue to disperse without a lense to focus them
% back together in order to create a sharp image.

d = 1; % d > 0

Md = [1,     d,      0,      0;
      0,     1,      0,      0;
      0,     0,      1,      d;
      0,     0,      0,      1];

rays_out = Md * rays;
[img2, x2, y2] = rays2img(rays_out(1, :), rays_out(3, :), width, pixels);
figure;
imshow(img2);
title("lightfield.mat propagated a distance = " + d + " m");
exportgraphics(gca, 'light_field_propagated.png');

% The rays become even more dispersed and unclear after the propagation,
% with a larger value of d leading to a more blurry image. There is no
% positive value of d that will create a sharp image in the absence of a
% lens, because a simple propagation through space with a positive distance
% will not cause the rays to converge back to a single point to create a
% clear image. In other words, the only ways to make the image clear is to
% propagate them back to the starting point with a negative value of d or
% refocus the rays via lenses.
```


lightfield.mat with sensor width = 0.015 m

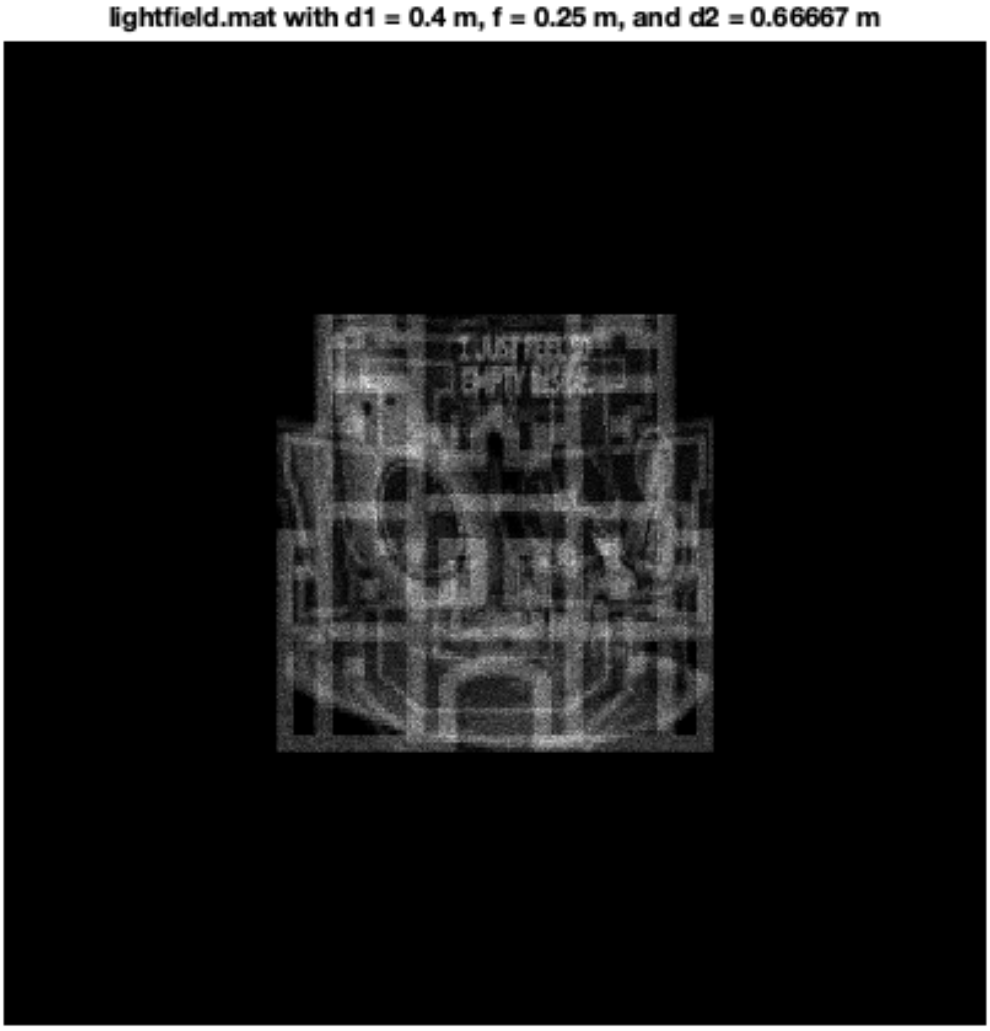


Creating an Image

```
f = 0.25; % constant
d1 = 0.4; % variable
d2 = 1 / (1 / f - 1 / d1);

Md1 = [1,     d1,     0,      0;
       0,     1,      0,      0;
       0,     0,      1,      d1;
       0,     0,      0,      1];

Md2 = [1,     d2,     0,      0;
       0,     1,      0,      0;
       0,     0,      1,      d2;
       0,     0,      0,      1];

Mf = [1,    0,      0,      0;
```

```
      -1/f, 1,      0,      0;
      0,    0,      1,      0;
      0,    0,      -1/f,   1];

rays_out2 = Mf * rays; % passing through the lense
rays_in3 = rays_out2;
rays_out3 = Md2 * rays_in3; % post-lense phase
[img3, x3, y3] = rays2img(rays_out3(1, :), rays_out3(3, :), width, pixels);
figure;
imshow(flip(img3, 2));
title("lightfield.mat with d1 = " + d1 + " m, f = " + f + ...
    " m, and d2 = " + d2 + " m");
exportgraphics(gca, 'light_field_clear.png');

% Final reported values
disp("d2 = " + d2 + " m");
disp("f = " + f + " m");

% Yes, now we can roughly identify the objects that emitted the light rays:
% an avocado, a person (or a humanoid figure), the WashU logo, a building,
% and the text "I just feel so empty inside". This is because the rays are
% properly propagated with the correct value of d1 and a matching
% combination of d2 and f, allowing the 3 million rays to converge to form
% the visible image.
```

```
d2 = 0.66667 m
f = 0.25 m
```



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