Dimension generator for patch antenna

Antenna properties

```
%% Adjust the required frequency and dielectric constant
fv = 6.2e9; % in GHz
er = 2.55;
```

Set the bounds for the antenna

```
% Length (in mm)
lmin = 10;
lmax = 25;

% Height (in mm)
hmin = 0.01;
hmax = 1;

% Width (in mm)
wmin = 1;
wmax = 25;

% Total points to run the algorithm
RefPoints = 100;
```

Generator

```
% Bounds (L, W, H)
L =  [lmin wmin hmin 0];
U =  [lmax wmax hmax 0.9999];

N = 3;
Functions = {@(x)f1(x, fv, er), @f2};
M = length(Functions);

f1_vals = zeros(1, RefPoints);
f2_vals = zeros(1, RefPoints);

rng(42);
X = {};

i = 1;
while i <= RefPoints
    z = [1e-6 0.01]; % Initial decision vector
    w = [10 0.4]; % adjust priority
    w = w / norm(w); % Normalize `w'

    assert (length(z) == M);
    assert (length(w) == M);
```

```
    % Non-Linear Conditions for ASF
    C1 = @(x) ASFCondition(x(1:N), Functions{1}, z(1), w(1));
    C2 = @(x) ASFCondition(x(1:N), Functions{2}, z(2), w(2));

    % Final Objective function
    Objective = @(x) ASF(x, Functions, M, z, w);

    % Make a proper guess which satisfies the constraints
    fprintf("[%2d] Getting feasible solution ...\n", i);
    x0 = rand(1, N+1) .* U;
    while C1(x0) > 0 || C2(x0) > 0
         x0 = rand(1, N+1) .* U;
    end

    fprintf("[%2d] Solving ...\n", i);
    options = optimoptions('fmincon', ...
        'Algorithm', 'sqp', ...
        'TolFun', 1e-9, ...
        'TolX', 1e-9, ...
        'MaxFunctionEvaluations', 1e5, ...
        'Display', 'none');
    [x, fval, exitflag, output] = fmincon(Objective, x0, [], [], [], [], ...
        L, U, ...
        @(x)Constraint(x, C1, C2), options);

    % Don't add the solution if it converges to an infeasible point
    if exitflag < 0
        continue;
    end

    X{i} = x;
    f1_vals(i) = Functions{1}(x);
    f2_vals(i) = Functions{2}(x);
    i = i+1;
end
```

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```

Results

```
fprintf("Optimal results:\n")
```

```
Optimal results:
```

```
[x, idx]= min(f1_vals);
fprintf("Dimensions:");
```

```
Dimensions:
```

```
disp(X{idx}(1:3));
```

```
   15.1521   17.1640    0.0100
```

```
fprintf("Error:");
```

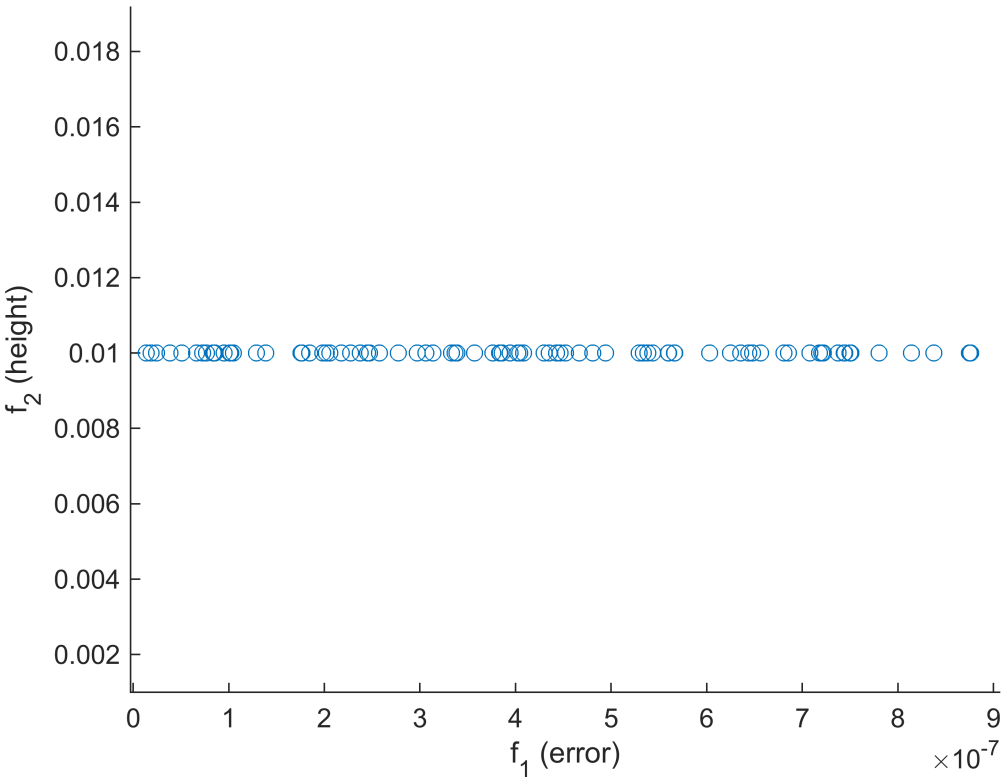
```
Error:
```

```
disp(f1_vals(idx));
```

```
   1.3725e-08
```

Plots

```
scatter(f1_vals, f2_vals);
xlabel("f_1 (error)");
ylabel("f_2 (height)");
ylim([0 0.02]);
xlim([0 1e-6]);
```



Functions

```
function ret = f1(x, fv, er)
```

```
    l = x(1) * 1e-3;
    W = x(2) * 1e-3;
    h = x(3) * 1e-3;

    ep_w = (er+1)/2 + (er-1)/(2 * sqrt(1 + 10*h/W));
    delta_w = 0.412 * h * ((ep_w+0.3)*(W/h+0.264))/((ep_w-0.258)*(W/h+0.813));
    fr = 3e8 ./ (2 * (l + delta_w) * sqrt(ep_w));
    ret = abs(fv-fr) * 1e-9;
end

function ret = f2(x)
    ret = x(3);
end

function ret = ASFCondition(x, Fn, z, w)
    ret = (Fn(x) - z) ./ w - x(end);
end

function [c, ceq] = Constraint(x, C1, C2)
    c = [C1(x); C2(x)];
    ceq = [];
end

function ret = ASF(x, Functions, M, z, w)
    C = zeros([1 M]);

    x = x(1:end-1);
    for i = 1:M
        C(i) = (Functions{i}(x) - z(i)) ./ w(i);
    end
    ret = max(C);
end
```