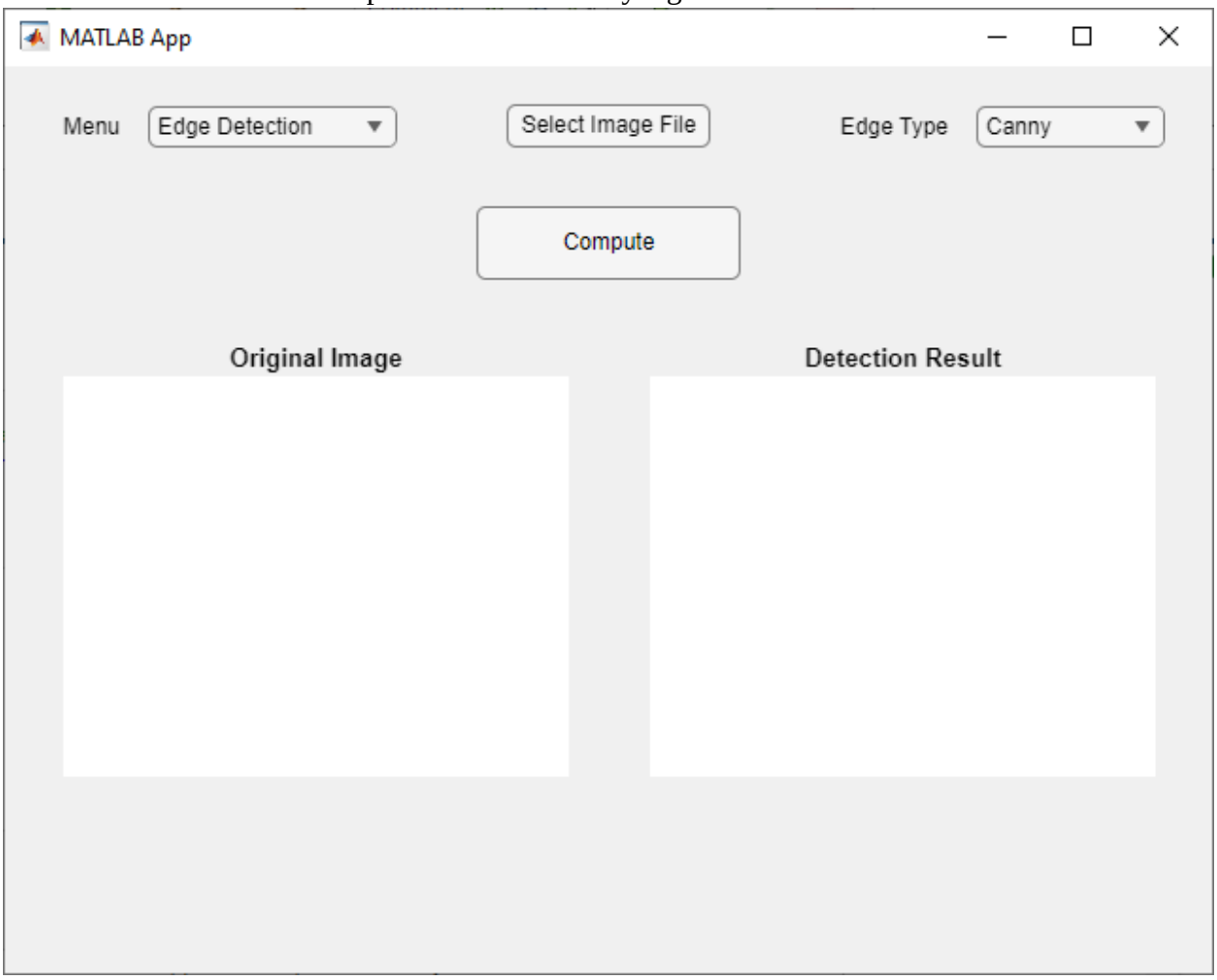
TUGAS 3

IF4073 Pemrosesan Citra Digital

Oleh:

13520052 – Gregorius Moses Marevson

1. Screenshot GUI
   Gambar di bawah adalah tampilan awal dari GUI yang telah dibuat.



2. Untuk setiap program ditampilkan kode, hasil eksekusi, dan analisis sebagai berikut:

2.1. Kode program

a. Edge Detection

detectEdge.m

```
function edgeImage = detectEdge(image, type)
    image = im2gray(image);
    if type == "canny"
        edgeImage = edge(image, 'canny');
        return
    end

    image = double(image);
    switch type
        case 'laplace'
            mask = [0 1 0; 1 -4 1; 0 1 0];
            edgeImage = conv2(image, mask, 'same');
        case 'log'
            mask = fspecial('log');
            edgeImage = conv2(image, mask, 'same');
```

```
        case {'sobel', 'prewitt', 'roberts'}
            edgeImage = doGradientBasedEdgeDetection(image, type);
    end
    edgeImage = uint8(edgeImage);
    edgeImage = im2double(edgeImage) > graythresh(edgeImage);
end

function edgeImage = doGradientBasedEdgeDetection(image, type)
    switch type
        case 'sobel'
            Gx = [-1 0 1; -2 0 2; -1 0 1];
            Gy = [1 2 1; 0 0 0; -1 -2 -1];
        case 'prewitt'
            Gx = [-1 0 1; -1 0 1; -1 0 1];
            Gy = [1 1 1; 0 0 0; -1 -1 -1];
        case 'roberts'
            Gx = [1 0; 0 -1];
            Gy = [0 1; -1 0];
    end
    Jx = conv2(image, Gx, 'same');
    Jy = conv2(image, Gy, 'same');
    edgeImage = sqrt(Jx.^2 + Jy.^2);
end
```

b. Object Detection

detectObject.m

```
function detectedObjects = detectObject(edgeImage, image)
    % Measure properties for each object (connected component) in an image
    % properties: "Area", "Centroid", and "BoundingBox"
    % https://www.mathworks.com/help/images/ref/regionprops.html
    stats = regionprops(edgeImage);

    % Filter out small noise
    validObjects = stats([stats.Area] > 100);

    detectedObjects = zeros(size(edgeImage));
    for i = 2:length(validObjects)
        % BoundingBox: Position and size of the smallest box containing the region
        % bbox: (x, y, width, height)
        bbox = round(validObjects(i).BoundingBox);

        % Create box for object
        detectedObjects(bbox(2):bbox(2)+bbox(4), bbox(1):bbox(1)+bbox(3)) = 1;
    end

    % Display the object in original image
    detectedObjects = uint8(detectedObjects .* double(image));
end
```

c. Line Detection

detectLines.m

```
function detectLines(image, useInBuilt, type, axesHandle)
    % https://www.mathworks.com/help/images/ref/houghlines.html
    % Create Hough transform using edge image
    edgeImage = detectEdge(image, type);
    if useInBuilt
        houghFn = @hough;
    else
```

```
        houghFn = @houghTransform;
    end
    [H, T, R] = houghFn(edgeImage);

    % Find peaks in the Hough transform
    P = houghpeaks(H, 5, 'Threshold', ceil(0.3*max(H(:))));

    % Fine lines and plot them
    lines = houghlines(edgeImage, T, R, P);

    if nargin < 4
        imshow(image), hold on
    else
        imshow(image, 'Parent', axesHandle), hold(axesHandle, "on")
    end

    for k = 1:length(lines)
        % Extract line endpoints
        xy = [lines(k).point1; lines(k).point2];

        % Plot line segments
        if nargin < 4
            plot(xy(:,1), xy(:,2), 'LineWidth', 2, 'Color', 'r');
        else
            plot(axesHandle, xy(:,1), xy(:,2), 'LineWidth', 2, 'Color', 'r');
        end

    end

    if nargin < 4
        hold off
    else
        hold(axesHandle, "off")
    end
end
```

houghTransform.m

```
function [parameter, theta, rho] = houghTransform(edgeImage, p, q)
    % input : edgeImage with size m x n
    % output: parameter with size p x q, theta, rho
    % p : size of theta
    % q : size of r
    [m, n] = size(edgeImage);
    sqrtd = sqrt(m^2 + n^2);

    if nargin < 3
       p = min(180, 2 * ceil(max(m, n) * sqrt(2)));
       q = 2 * floor(sqrtd) - 1;
    end
    parameter = zeros(p, q);

    % -phi/2 <= theta <= phi/2
    theta = linspace(-90, 90, p);
    sin = sind(theta);
    cos = cosd(theta);

    rho = linspace(-sqrtd, sqrtd, q);

    [x, y] = find(edgeImage);
    for t=1:length(x)
```

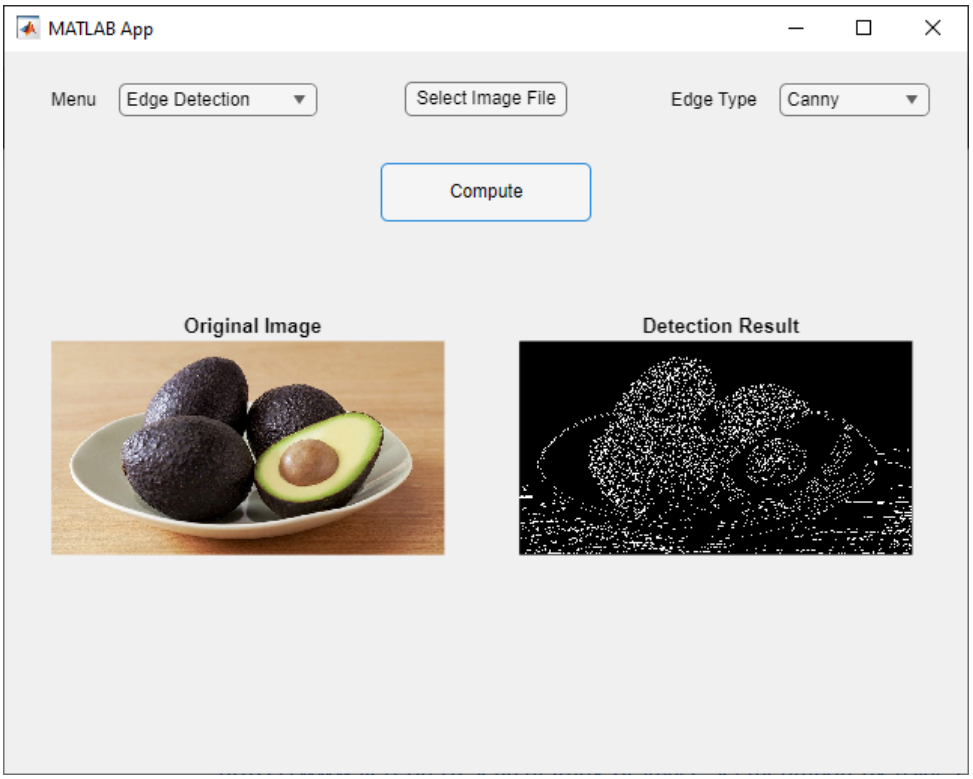
```
        i = x(t) - 1;
        j = y(t) - 1;

        for k=1:p
            r = i*sin(k) + j*cos(k);
            [~, ri] = min(abs(rho - r));
            parameter(k, ri) = parameter(k, ri) + 1;
        end
    end
    parameter = parameter';
end
```

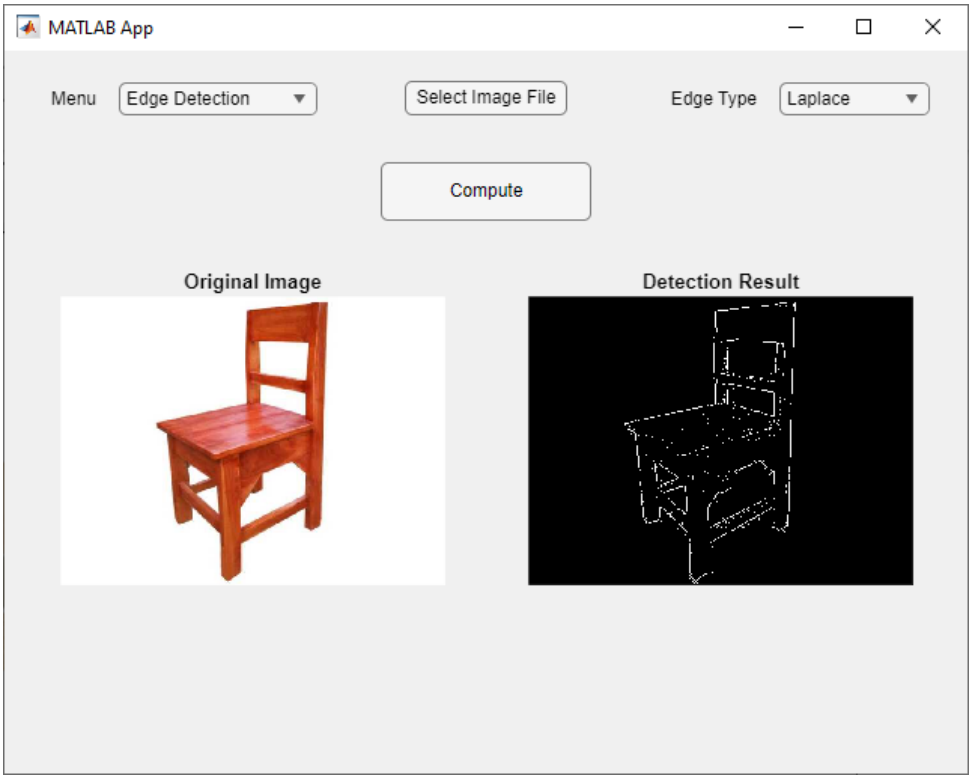
inverseHough.m

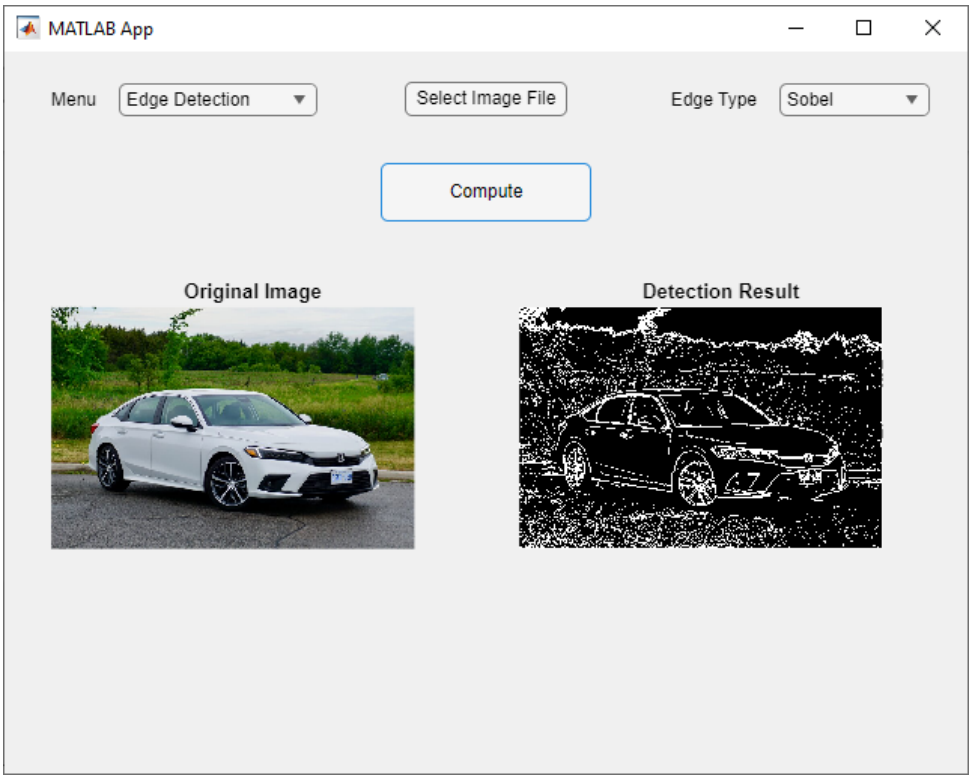
```
function image = inverseHough(edge, parameter)
    % input : edge with size m x n
    %         parameter with size p x q
    % output: image with straight line
    [m, n] = size(edge);
    [p, q] = size(parameter);
    image = zeros(m, n);

    sin = sind(linspace(-90, 90, p));
    cos = cosd(linspace(-90, 90, p));
    sqrtd = sqrt(m^2 + n^2);

    for i=1:p
        for j=1:q
            y = 0;
            if parameter(i, j)
                for k=1:m
                    r = j*(2*sqrtd)/(m-1) - sqrtd;
                    if sin(i) == 0
                        y = y + 1;
                    else
                        y = (r - k * cos(i))/sin(i);
                    end
                    y = y + 1;
                    l = floor(y);
                    if (l >= 1 && l <= n)
                        if edge(k, l)
                            image(k, l) = image(k, l) + 1;
                        end
                    end
                end
            end
        end
    end
end
```

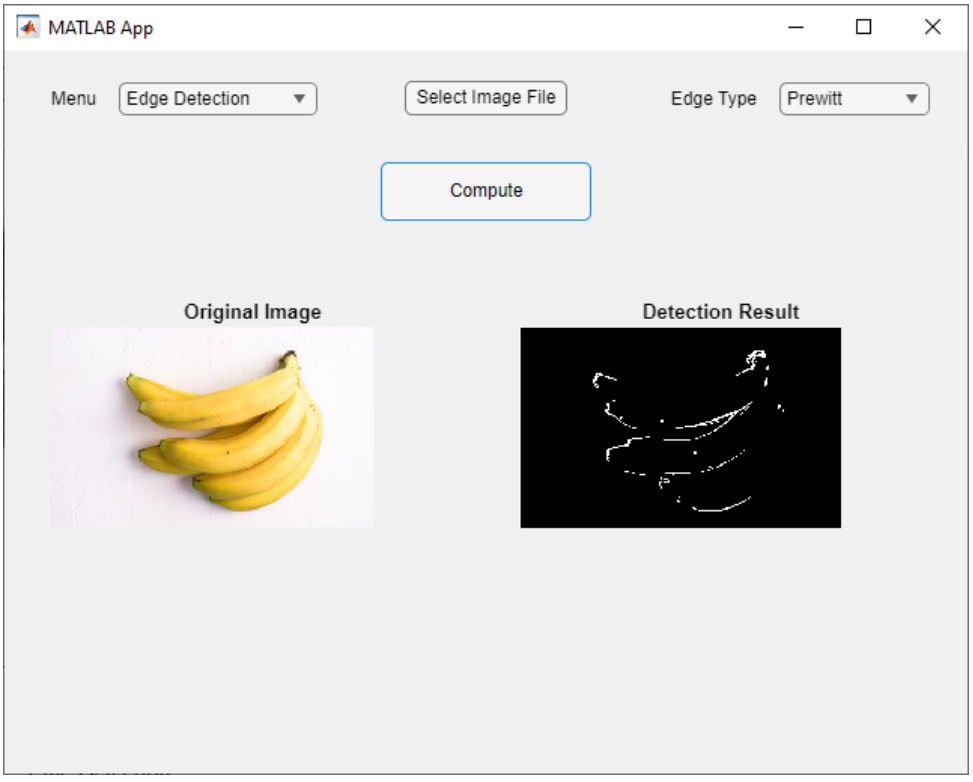
2.2.Hasil eksekusi

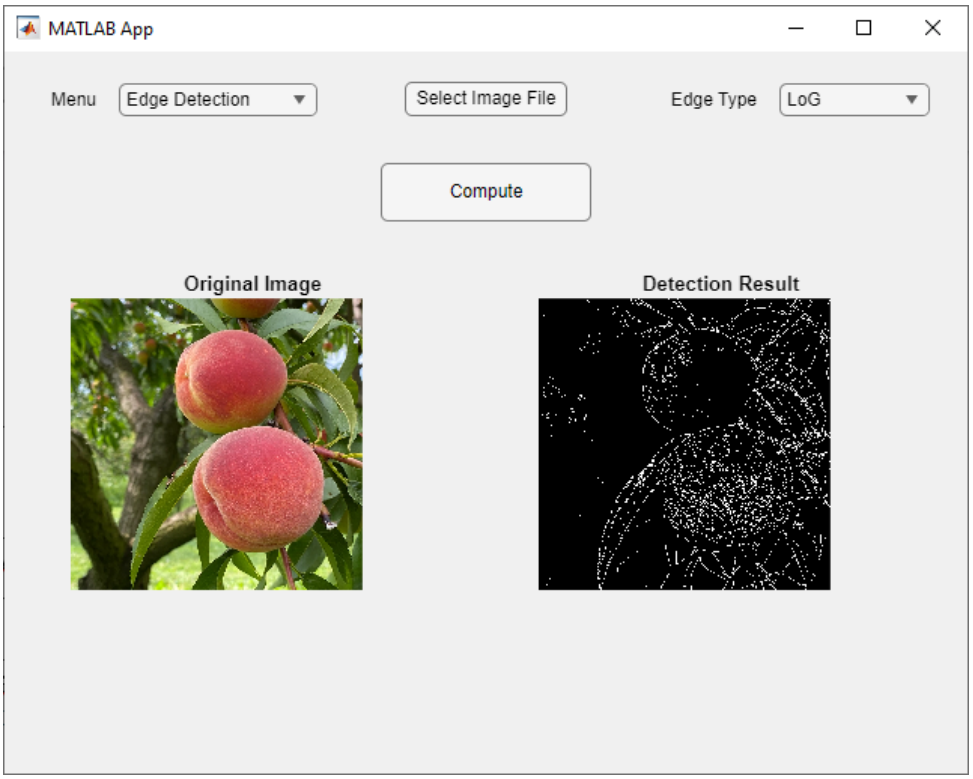
a. Edge Detection

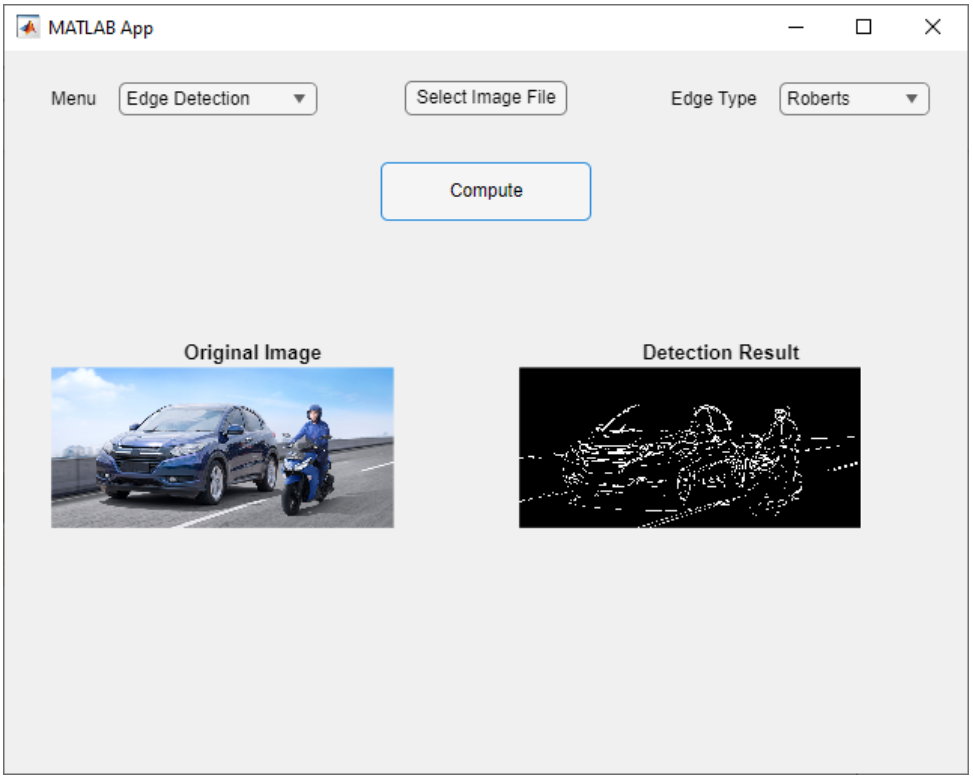

MATLAB App
Menu
Edge Detection
Select Image File
Edge Type
Canny
Compute
Original Image
Detection Result


MATLAB App
Menu
Edge Detection
Select Image File
Edge Type
Laplace
Compute
Original Image
Detection Result

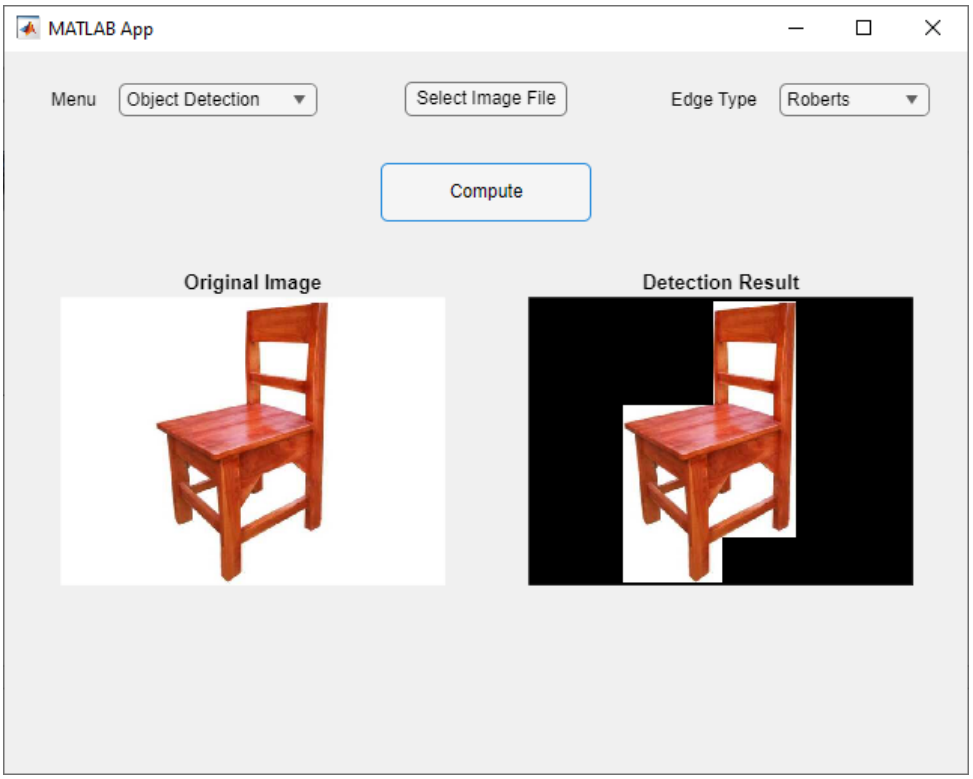

MATLAB App
Menu
Edge Detection
Select Image File
Edge Type
Sobel
Compute
Original Image
Detection Result

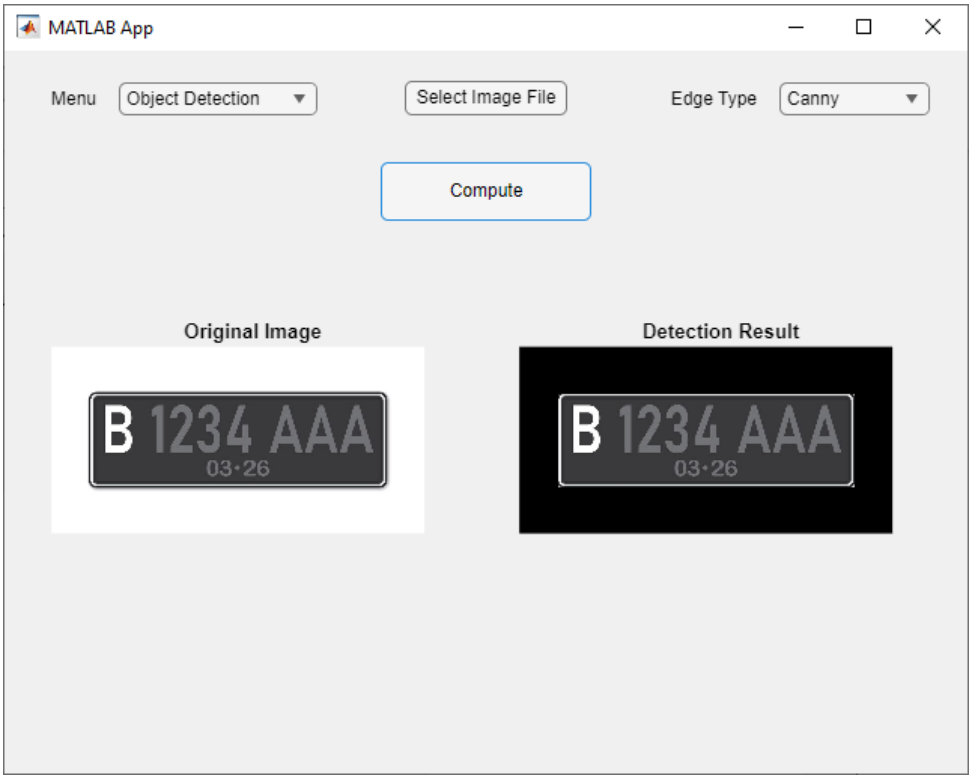

MATLAB App
Menu
Edge Detection
Select Image File
Edge Type
Prewitt
Compute
Original Image
Detection Result

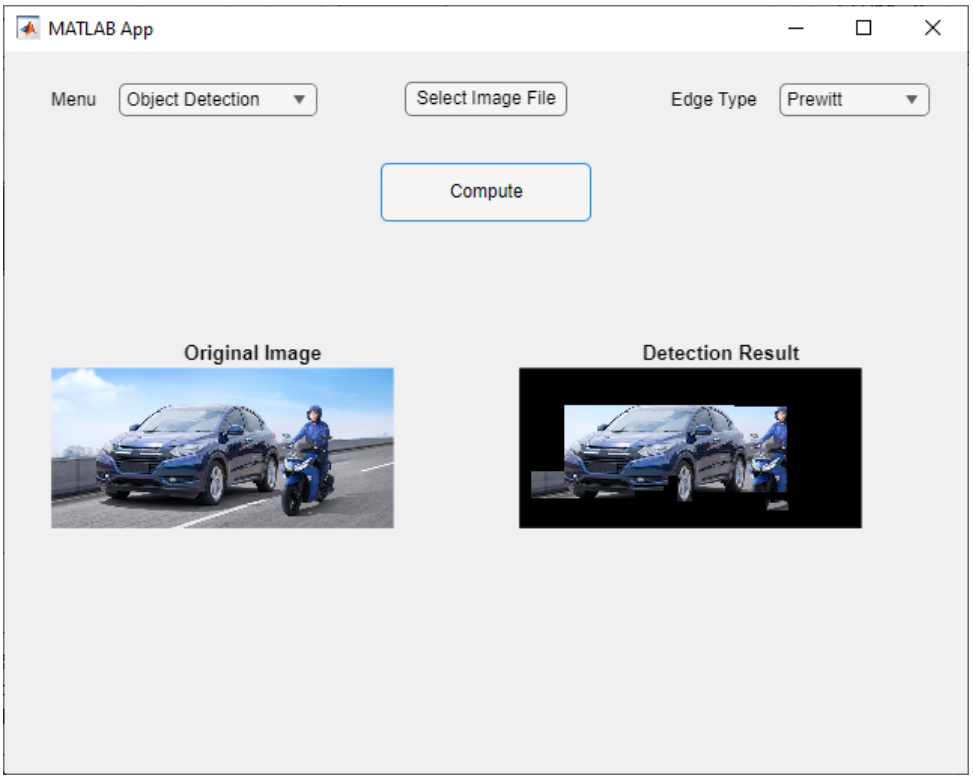


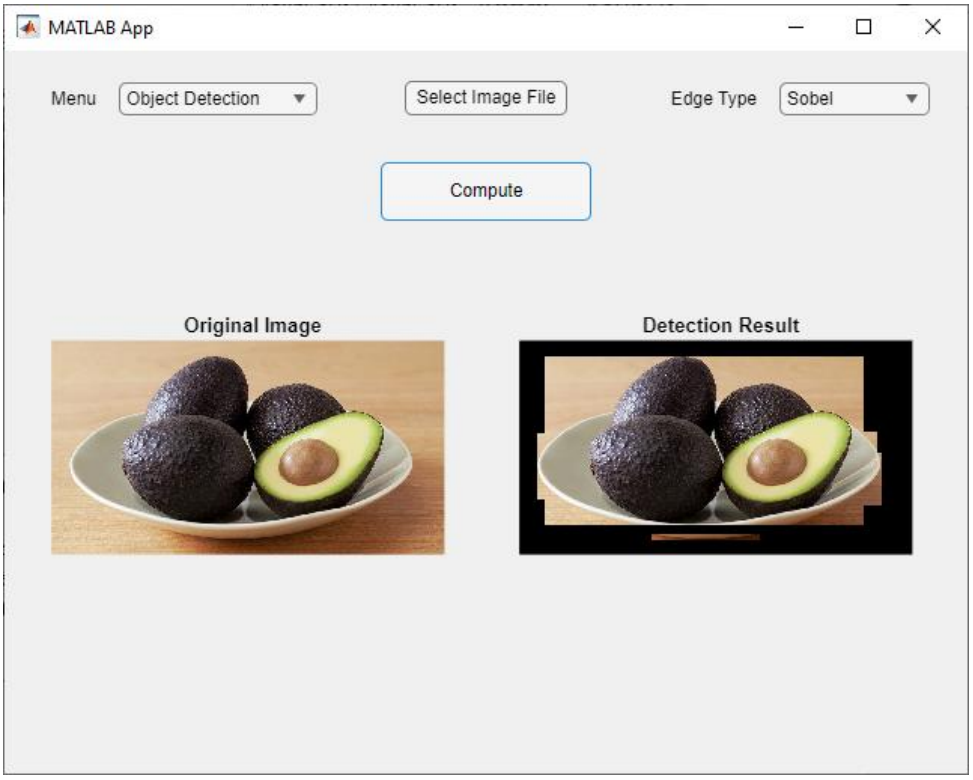


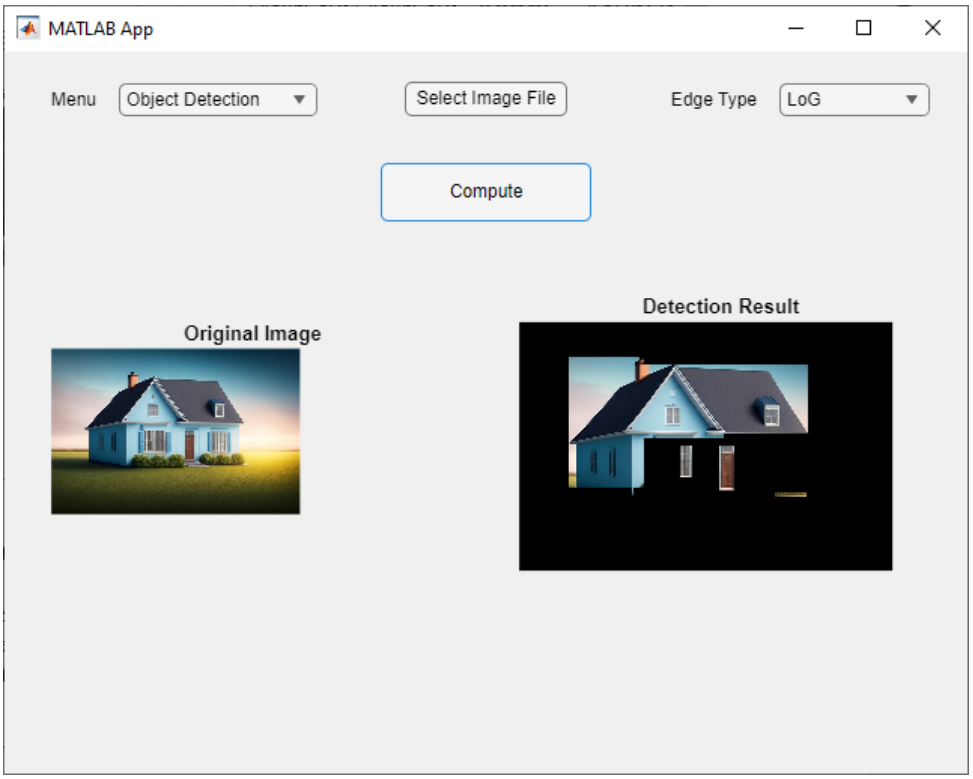
b. Object Detection

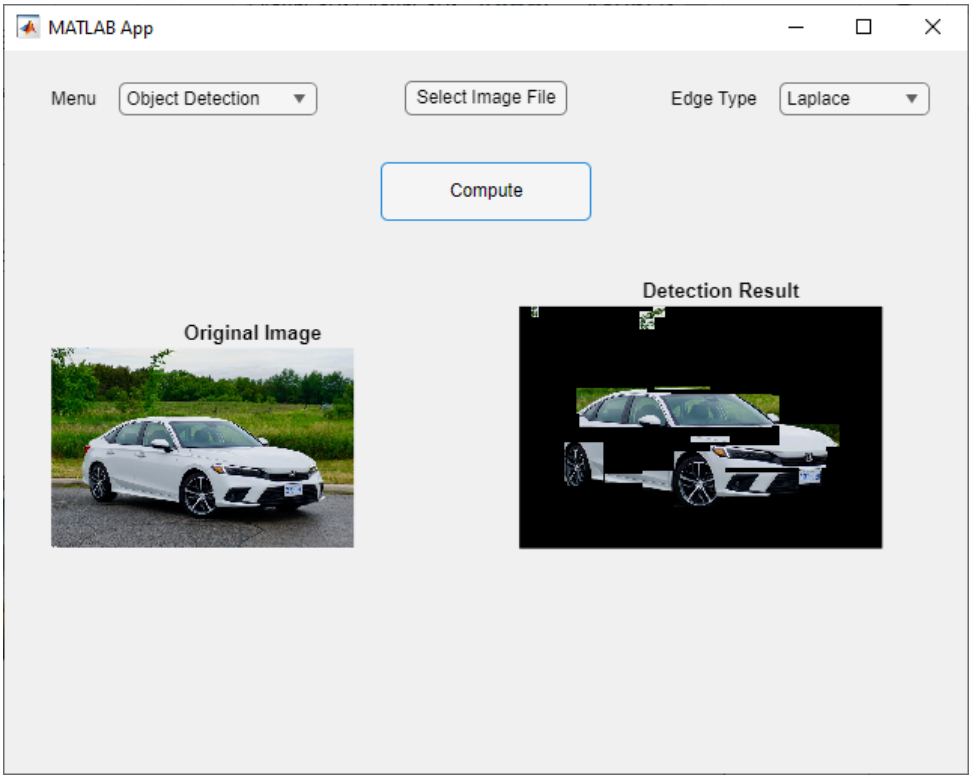

MATLAB App
Menu
Object Detection
Select Image File
Edge Type
Roberts
Compute
Original Image
Detection Result

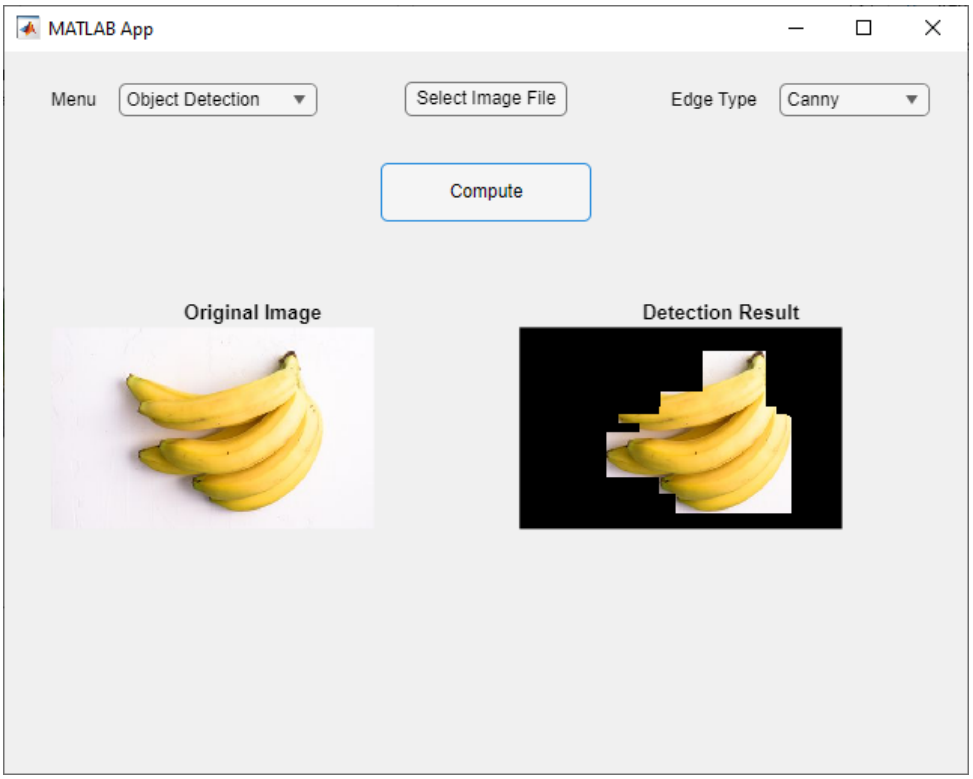

MATLAB App
Menu
Object Detection
Select Image File
Edge Type
Canny
Compute
Original Image
Detection Result
B 1234 AAA
03·26
B 1234 AAA
03·26

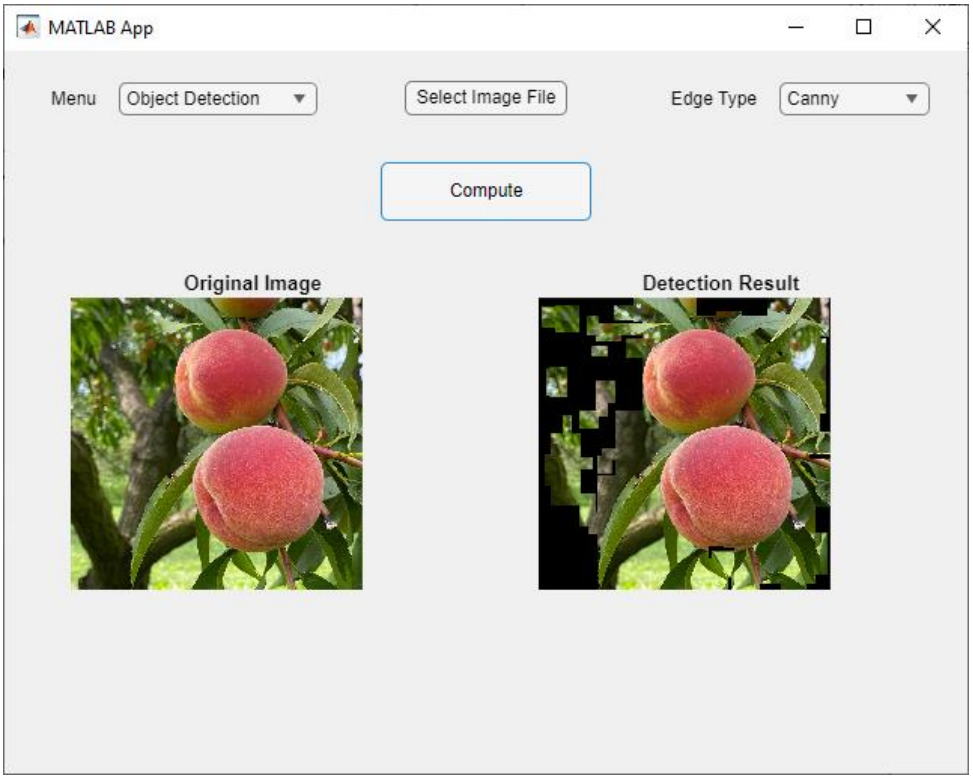

MATLAB App
Menu
Object Detection
Select Image File
Edge Type
Prewitt
Compute
Original Image
Detection Result


MATLAB App
Menu
Object Detection
Select Image File
Edge Type
Sobel
Compute
Original Image
Detection Result

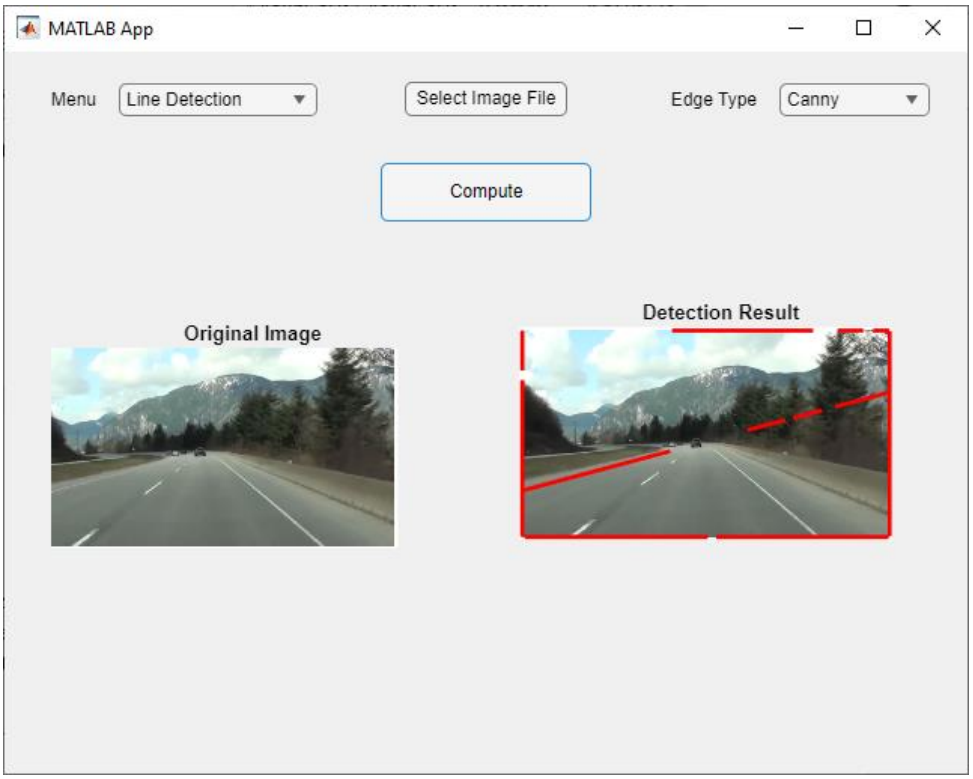

MATLAB App
Menu
Object Detection
Select Image File
Edge Type
LoG
Compute
Original Image
Detection Result

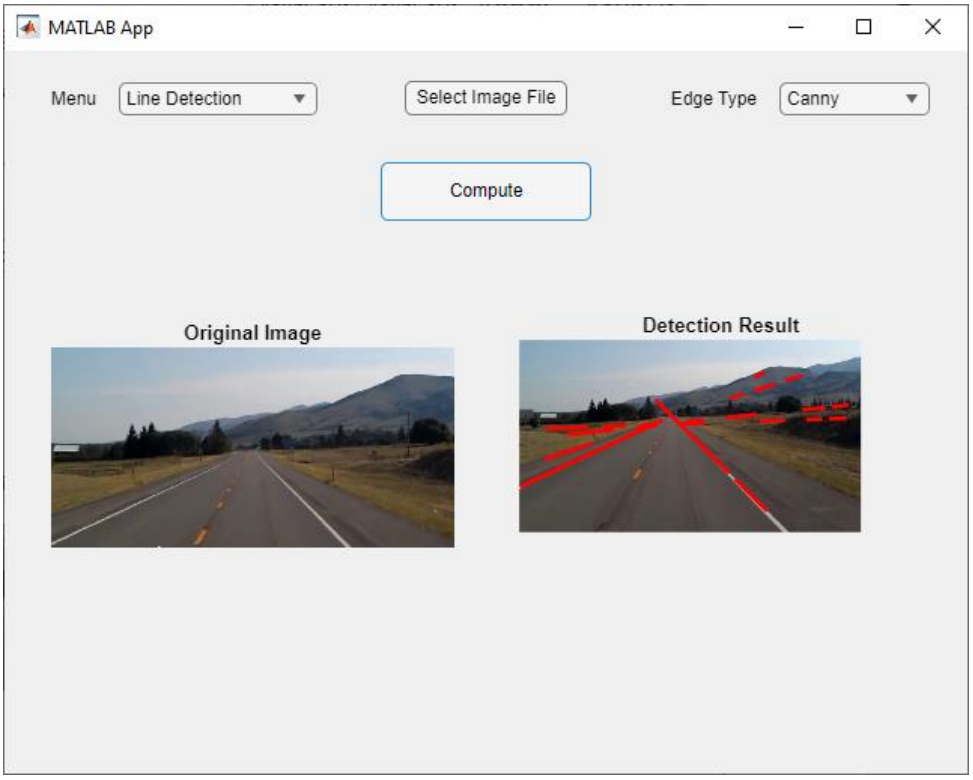

MATLAB App
Menu
Object Detection
Select Image File
Edge Type
Laplace
Compute
Original Image
Detection Result

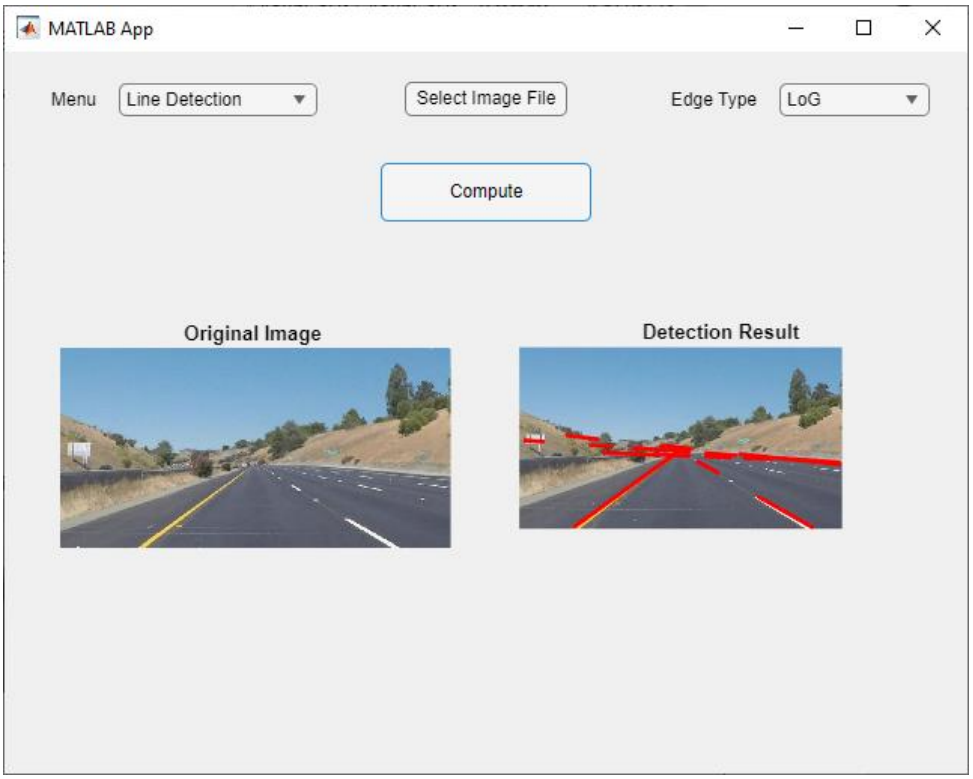


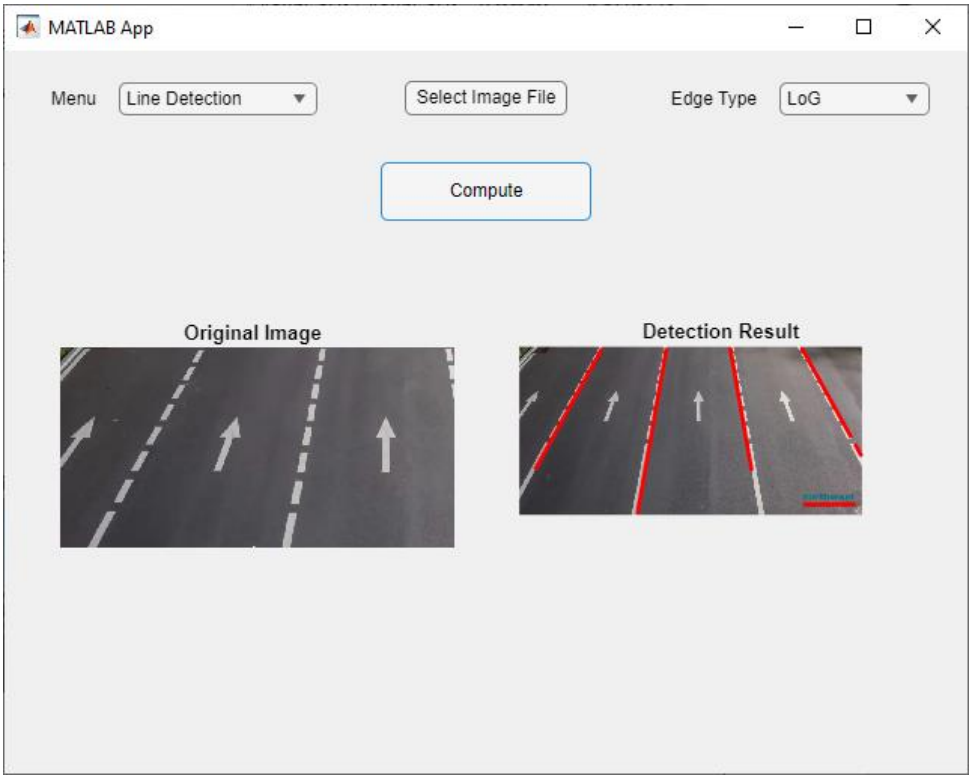


c. Line Detection


MATLAB App
Menu
Line Detection
Select Image File
Edge Type
Canny
Compute
Original Image
Detection Result


MATLAB App
Menu
Line Detection
Select Image File
Edge Type
Canny
Compute
Original Image
Detection Result





2.3.Analisis

a. Edge Detection

Cara kerja program adalah: melakukan konvolusi antara mask dengan gambar pada algoritma laplace dan LoG, atau melakukan konvolusi antara mask pada sumbu x dan y, kemudian menghitung magnitude di gradien yang telah dihitung pada algoritma sobel, roberts, prewitt, dan canny. Implementasi canny menggunakan fungsi edge yang tersedia di matlab. Di akhir program, dilakukan global thresholding dengan algoritma otsu.
Dilihat dari hasil program, algoritma edge detection tidak memiliki masalah (bug).

b. Object Detection
Deteksi objek dengan menerima parameter edge dan gambar original. Pencarian objek dilakukan dengan fungsi regionprops yang tersedia di matlab. Regionprops menghasilkan sejumlah objek yang berhasil dideteksi dari edge, juga memberikan beberapa property seperti “Area”, “Centroid”, dan “BoundingBox”. Kemudian, dilakukan filtering untuk menghilangkan noise yaitu objek dengan area yang kecil. Untuk setiap objek yang dideteksi, dilakukan penghitungan kotak yang akan menunjukkan lokasi objek. Kotak dihasilkan dari BoundingBox (x, y, width, height), dengan mengisi gambar dengan nilai 1 pada range (x:x+width, y+y+height). Box tersebut kemudian dikalikan dengan gambar asli untuk menampilkan objek yang berhasil dideteksi.
Dilihat dari hasil program, algoritma object detection masih bisa diperbaiki, terutama dengan memanfaatkan fungsi imfill untuk mengisi daerah edge tertutup. Selain itu, deteksi objek masih bisa salah di beberapa gambar.

c. Line Detection
Deteksi garis pada gambar dilakukan menggunakan fungsi hough yang tersedia di matlab atau fungsi houghTransform yang dibuat sendiri. Untuk kecepatan algoritma, fungsi hough jauh lebih cepat dibanding houghTransform karena algoritma yang lebih effisien seperti penggunaan accumarray. Hough dan houghTransform menghasilkan parameter hough, theta, dan rho. Parameter hough kemudian digunakan untuk menghitung peaks dengan fungsi houghPeaks. Kemudian dilakukan pencarian garis menggunakan fungsi houghlines. Pencarian garis sudah diimplementasi sendiri pada fungsi inverseHough, tetapi belum menghasilkan hasil yang tepat dan membutuhkan waktu yang lama. Ditampilkan gambar original, kemudian dilakukan plot segmen garis untuk setiap garis pada lines yang dihasilkan houghlines.
Dilihat dari hasil program, algoritma line detection masih bisa dikembangkan lagi. Algoritma inverseHough yang telah dibuat juga dapat di refactor sehingga memiliki hasil yang dapat digunakan untuk melakukan plot.

3. Github
https://github.com/Moses-ui/tugas-3-citra