# CHAPTER II
# LITERATURE STUDY

## 2.1 Data Structure

This program use matrix to storage pixel value from image.

### 2.1.1 Matrix

Matrix is an Array of Array and consist of rows and columns. Matrix usually use two represented value from a table.

This two-dimensional array will have two rows and four columns. This actually allocates 3 objects: a one-dimensional array of 2 elements to hold each of the actual row arrays, and a two one-dimensional arrays of 4 elements to represent the contents of the rows.[2]

```
+-----+     +-----+-----+-----+-----+
|a[0] | ->  | [0] | [1] | [2] | [3] |
|     |     +-----+-----+-----+-----+
+-----+
|     |     +-----+-----+-----+-----+
|a[1] | ->  | [0] | [1] | [2] | [3] |
+-----+     +-----+-----+-----+-----+
```

Figure 2.1 Array 2 Dimensional

In this case the array 2 dimensional used for storage the pixel value to be treated with template from sobel edges detections.

## 2.2 Algorithm

### 2.2.1 Sobel Edge Detection

The sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image.

2 http://www.leepoint.net/notes-java/data/arrays/arrays-2D.html

| | | |
|---|---|---|
| -1 | 0 | +1 |
| -2 | 0 | +2 |
| -1 | 0 | +1 |

Gx

| | | |
|---|---|---|
| +1 | +2 | +1 |
| 0 | 0 | 0 |
| -1 | -2 | -1 |

Gy

Figure 2.2 Template Matrix 3x3

$$S_x = \begin{bmatrix} 1 & 2 & 0 & -2 & -1 \\ 4 & 8 & 0 & -8 & -4 \\ 6 & 12 & 0 & -12 & -6 \\ 4 & 8 & 0 & -8 & -4 \\ 1 & 2 & 0 & -2 & -1 \end{bmatrix} \qquad S_y = \begin{bmatrix} -1 & -4 & -6 & -4 & -1 \\ -2 & -8 & -12 & -8 & -2 \\ 0 & 0 & 0 & 0 & 0 \\ 2 & 8 & 12 & 8 & 2 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix}$$

Figure 2.3 Template Matrix 5x5

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these Gx and Gy). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by: |G|=|GX|+|GY|.[3]

| | | |
|---|---|---|
| P1 | P2 | P3 |
| P4 | P5 | P6 |
| P7 | P8 | P9 |

Figure 2.4 Example from Template 3x3

Using this kernel the approximate magnitude is given by:

|G| = |(P1 + 2xP2 + P3)-(P7 + 2xP8 + P9) + |(P3 + 2xP6 + P9) – (P1 + 2xP4 + P7)|

3 http://ssip2003.info.uvt.ro/projects/teamE/abstract.htm