## 4.1 Algorithms Used

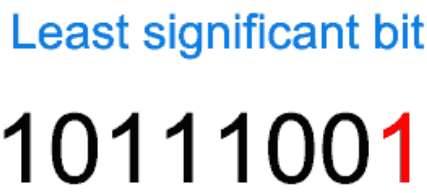
The following is the proper used algorithm upon the project idea. But before discussing the LSB technique, there is a need to know the difference between visible and invisible watermarks.

A visible watermark is a visible semi-transparent text or image overlaid on the original image. It allows the original image to be viewed, but it still provides copyright protection by marking the image as its owner's property. Visible watermarks are more robust against image transformation especially if we use a semi-transparent watermark placed over whole image. Thus they are preferable for strong copyright protection of intellectual property that's in digital format. [26]

An invisible watermark is an embedded image which cannot be perceived with human's eyes. Only electronic devices or specialized software can extract the hidden information to identify the copyright owner. Invisible watermarks are used to mark a specialized digital content like text, images or even audio content to prove its authenticity. [26]

### 4.1.1 LSB algorithm

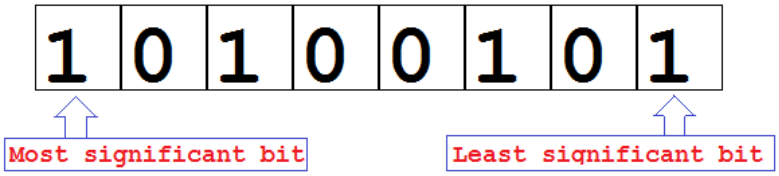
The least significant bit (LSB) is the lowest bit in a series of numbers in binary. It is the byte or octet in that position of a multi byte number which has the least potential value. It is either the leftmost or rightmost bit in a binary number, depending on the computer's architecture. In the current project, we will use the LSB of the right. For example, the rightmost LSB of binary number 00000001 is 1. As shown in the following figure.




The least significant bit (LSB) technique is used for simple operation to embed information in a cover image. The LSB technique is that inside of a cover image pixels are changed by bits of the secret message. Although the number was embedded into the first 8 bytes of the grid, the 1 to 4 least bits needed to be changed according to the embedded message. On the average, only half of the bits in an image will need to be modified to hide a secret message using a cover image. Because the quality of the Watermarked image is low, less than over the 4-bit LSB, changing the LSB of a pixel results in small changes in the intensity of the colors. [28]

In LSB technique, cover image is converted to binary image and the least significant bits of the binary image are changed by bits of watermark image. These changes cannot be perceived by the human visibility system. Least Significant Bit is one of the oldest popular technique. Watermark bits are embedded by substituting the least significant bit of intensity values of the cover image. The watermark can be spread throughout the image or can exist in the selected locations of the cover image. LSB algorithm has higher embedding capacity. Watermark embedding and extraction is less time consuming. It is the simplest method of watermarking. [25]

The MSB (Most Significant Bit) and LSB gives you more resolution when controlling the parameters. MSB stands for most significant bit, while LSB is least significant bit. In binary terms, the MSB is the bit that has the greatest effect on the number, and it is the left-most bit. The following figure is an example. [27]




Peak signal-to-noise ratio (PSNR) is the ratio between the maximum possible power of an image and the power of corrupting noise that affects the quality of its representation. To estimate the PSNR of an image, it is necessary to compare that image to an ideal clean image with the maximum possible power. [27]

PSNR is defined as follows:

$$PSNR = 10log_{10}(\frac{(L-1)^2}{MSE}) = 20log_{10}(\frac{L-1}{RMSE})$$

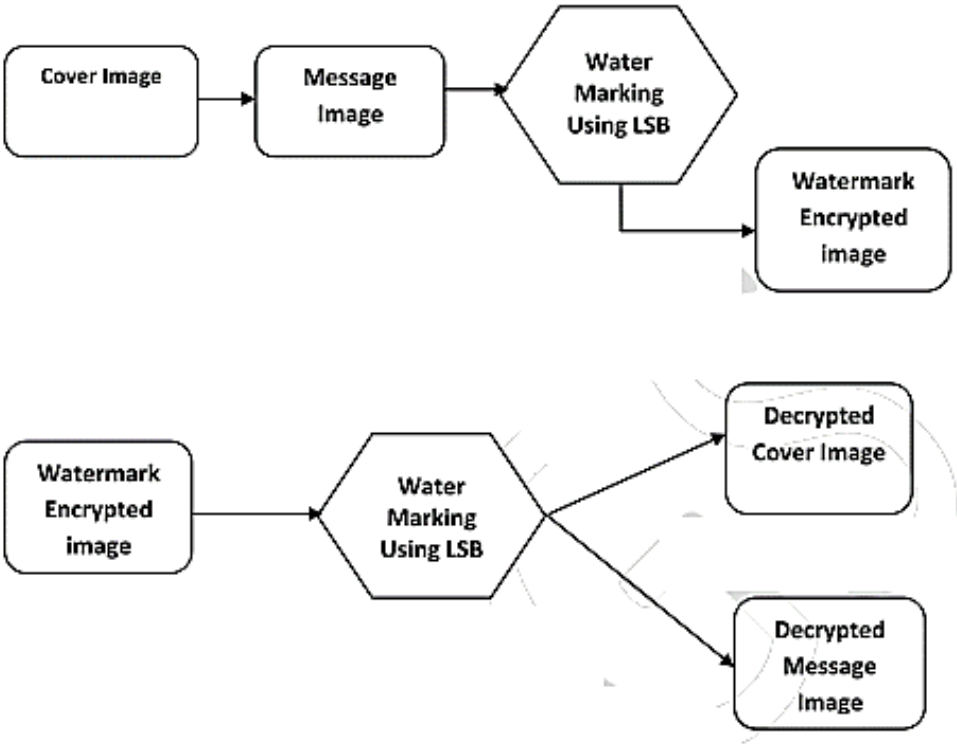
(RMSE) is the root mean squared error. And (L) is the number of maximum possible intensity levels (minimum intensity level supposed to be 0) in an image.

MSE is the mean squared error & it is defined as:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}(O(i,j) - D(i,j))^2$$

Where, (O) represents the matrix data of original image. (D) represents the matrix data of degraded image. (m) represents the numbers of rows of pixels and (i) represents the index of that row of the image. (n) represents the number of columns of pixels and (j) represents the index of that column of the image.

PSNR is most commonly used to estimate the efficiency of compressors, filters, etc. The larger the value of PSNR, the more efficient is a corresponding compression or filter method. The following figure shows a general view of the used algorithm


Cover Image
Message Image
Water Marking Using LSB
Watermark Encrypted image
Watermark Encrypted image
Water Marking Using LSB
Decrypted Cover Image
Decrypted Message Image