* 1. **PROPOSED SYSTEM:**

**2.2.1 OVERVIEW**

Proposed method introduces a new method of embedding secret data within skin as it is not that much sensitive to HVS (Human Visual System).This takes advantage of Biometrics features such as skin tone, instead of embedding data anywhere in image, data will be embedded in selected regions. Overview of method is briefly introduced as follows. At first skin tone detection is performed on input image using HSV (Hue, saturation, value) colour space. Secondly cover image is transformed in frequency domain. This is performed by applying Haar-DWT, the simplest DWT on image leading to four sub subbands. Then payload (number of bits in which we can hide data) is calculated. Finally secret data embedding is performed in one of the high frequency sub-band by tracing skin pixels in that band.

Before performing all steps cropping on input image is performed and then in only cropped region embedding is done, not in whole image. Cropping results into more security than without cropping. Since cropped region works as a key at decoding side. Here embedding process affects only certain *Regions of Interest* (ROI) rather than the entire image. So utilizing objects within images can be more advantageous. This is also called as Object Oriented steganography. Next sub-sections briefly introduce skin tone detection and DWT.

* 1. **Skin Colour Tone Detection:**

A skin detector typically transforms a given pixel into an appropriate colour space and then uses a skin classifier to label the pixel whether it is a skin or a non-skin pixel. A skin classifier defines a decision boundary of the skin colour class in the colour space. Although this is a straightforward process has proven quite challenging. Therefore, important challenges in skin detection are to represent the colour in a way that is invariant or at least insensitive to changes in illumination and another challenge comes from the fact that many objects in the real world might have skin-tone colours.

This causes any skin detector to have much false detection in the background if the environment is not controlled.

The simplest way to decide whether a pixel is skin colour or not is to explicitly define a boundary. RGB matrix of the given colour image can be converted into different colour spaces to yield distinguishable regions of skin or near skin tone. There exists several colour spaces. Mainly two kinds of colour spaces are exploited in the literature of biometrics which are HSV (Hue, Saturation and Value) and YCbCr (Yellow, Chromatic Blue, Chromatic red) spaces.

It is experimentally found and theoretically proven that the distribution of human skin colour constantly resides in a certain range within those two colour spaces. Colour space used for skin detection in this work is HSV. Any colour image of RGB colour space can be easily converted into HSV Colour space. Sobottaka and Pitas defined a face localization based on HSV. They found that human flesh can be an approximation from a sector out of a hexagon with the constraints:

Smin= 0.23, Smax =0.68, Hmin =00 and Hmax=500

* 1. **Discrete Wavelet Transform (DWT):**

This is another frequency domain in which steganography can be implemented. DCT is calculated on blocks of independent pixels, a coding error causes discontinuity between blocks resulting in annoying blocking artifact. This drawback of DCT is eliminated using DWT. DWT applies on entire image. DWT offers better energy compaction than DCT without any blocking artifact. DWT splits component into numerous frequency bands called sub bands known as

LL – Horizontally and vertically low pass

LH – Horizontally low pass and vertically high pass

HL - Horizontally high pass and vertically low pass

HH - Horizontally and vertically high pass

Since Human eyes are much more sensitive to the low frequency part (LL subband) we can hide secret message in other three parts without making any alteration in LL subband. As other three sub-bands are high frequency sub-band they contain insignificant data. Hiding secret data in these sub-bands doesn’t degrade image quality that much. DWT used in this work is Haar-DWT, the simplest DWT.

* 1. **Embedding Process:**

Suppose C is original 24-bit colour cover image of M×N Size.

It is denoted as:

C= {xij, yij, zij |1 ≤ i ≤ M, 1 ≤ j ≤ N, xij, yij, zij Є {0, 1...255}}

Let size of cropped image is Mc×Nc where Mc≤M and Nc≤N and Mc=Nc. i.e. Cropped region must be exact square as we have to apply DWT later on this region. Let S is secret data. Here secret data considered is binary image of size a×b. Fig. 1 represents flowchart of embedding process. Different steps of flowchart are given in detail below.

Stego

Image

(M×N)

P

Load Image

(M×N)

Perform Skin Detection

Merging with

original image

Crop an Image (Mc×Nc)

Cropped

Stego

image

(Mc×Nc)

Perform DWT

Perform IDWT

Embedding in

B-plane

Secret

Data (a×b)

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**Figure 3.1**: **Flowchart of Embedding Process**

**Step 1:**

Once image is loaded, apply skin tone detection on cover image. This will produce mask image that contains skin and non skin pixels.

**Step 2:**

Ask user to perform cropping interactively on mask image (Mc×Nc). After this original image is also cropped of same area. Cropped area must be in an exact square form as we have to perform DWT later and cropped area should contain skin region such as face, hand etc since we will hide data in skin pixels of one of the sub-band of DWT. Here cropping is performed for security reasons. Cropped rectangle will act as key at receiving side. If it knows then only data retrieval is possible. Eavesdropper may try to perform DWT on whole image; in such a case attack will fail as we are applying DWT on specific cropped region only

**Step 3:**

Apply DWT to only cropped area (Mc×Nc) not whole image (M×N). This yields 4 sub-bands denoted as HLL, HHL, HLH, and HHH. (All 4 sub-bands are of same size of

Mc/2, NC/2). Payload of image to hold secret data is determined based on no. of skin pixels present in one of high frequency sub-band in which data will be hidden.

**Step 4:**

Perform embedding of secret data in one of sub-band that we obtained earlier by tracing skin pixels in that sub-band. Other than the LL, low frequency sub-band any high frequency sub-band can be selected for embedding as LL sub-band contains significant information. Embedding in LL sub-band affects image quality greatly. We have chosen high frequency HH sub-band. While embedding, secret data will not be embedded in all pixels of DWT subband but to only those pixels that are skin pixels. So here skin pixels are traced using skin mask detected earlier and secret data is embedded. Embedding is performed in G-plane and B-plane but strictly not in R-plane as contribution of R plane in skin colour is more than G or B plane. So if we are modifying R plane pixel values, decoder side doesn’t retrieve data at all as skin detection at decoder side gives different mask than encoder side.

**Step 5:**

Perform IDWT to combine 4 sub-bands.

**Step 6***:*

A cropped stego image of size Mc×Nc is obtained in above step (step 5). This should be similar to original image after visual inspection but at this stage it is of size Mc× Nc, So we need to merge the cropped stego image with original image to get the stego image of size M×N. To perform merging we require coefficients of first and last pixels of cropped area in original image so that r calculated. Thus a stego image is ready for quality evaluation.

* 1. **Extraction Process:**

Secret data extraction is explained as follows:

24 bit colour stego image of size M×N is input to extraction process. We must need value of cropped area to retrieve data. Suppose cropped area value is stored in ‘rect’ variable that is same as in encoder. So this ‘rect’ will act as a key at decoder side. All steps of Decoder are opposite to Encoder. Care must be taken to crop same size of square as per Encoder. By tracing skin pixels in HHH sub-band of DWT secret data is retrieved. Extraction procedure is represented using Flowchart

Load Image

(M×N)

Perform Skin Detection

Rect (key)

Crop an Image (Mc×Nc)

Perform DWT

Secret

data

Retrieval

**Figure 3.2:** **Flowchart of Extraction Process**