Biometrics are actively being used for authentication on various systems. The use of human physiological characteristics is distinct for each human being like fingerprints, iris scans, voice, face. Some human physiological characteristics like face are highly prone to spoofing attacks. Availability of high resolution and cheap cameras makes it easy to spoof faces using videos or photos. Numerous highly accurate face recognition approaches are available. This implementation in combination with face matching can be used for better face recognition with greater security.

We can compute a value known as the eye liveness score is calculated as the hamming distance between two binarized images of eyes. If average liveness score is less than threshold then its face fake. An eyeblink activity can be represented by an image sequence $S$ consisting of $T$ images, where $S_i (i = 1,...,T)$, the image is the open frequency image of the original image, $F_i$ is the Gaussian Kernel. The typical eye states in the images are open, close and ambiguous. This can be modeled as a linear chain CRF (conditional random field) [2].

**EYE NORMALIZATION**

Image Normalization [3]
- The eye images can have different orientations and sizes.
- To compare images normalization is necessary.
- Image is reduced to fixed dimension and then Self Quotient Image (SQI) is applied for normalization.
- SQI can be thought of as a high pass filter.

\[
Q = \frac{1}{2 \sigma^2} \int \frac{df}{dI}
\]

[Ref 2]

Where, $f$ is low frequency image of the original image, $I$ is the Gaussian kernel, and $w_i (j)$ is the weight in $(i, j)$. The various parameters are calculated in the training phase.

**METHOD – LIVENESS DETECTION USING CRF**

Detection using eye blinking and CRF [From Ref 1]
- Conditional modeling of blinking behaviors can be used for liveness detection.
- An eyeblink activity can be represented by an image sequence $S$ consisting of $T$ images, where $S_i (i = 1,...,T)$, the image is the open frequency image of the original image, $F_i$ is the Gaussian Kernel. The typical eye states in the images are open, close and ambiguous. This can be modeled as a linear chain CRF (conditional random field) [2].

HMM features
- Observations: All the images are modeled as observations.
- States: Resulting state is the given state.
- In this graphical model, a parameter of observation window size $W$ is introduced to describe the conditional relationship between the current state and $(2W+1)$ temporal observations around the current one.

\[
\begin{align*}
\text{Model of linear chain CRF, Window size is 1 here}\n\end{align*}
\]

**REFERENCES**

1. Liveness Detection for Face Recognition : Gang Pan, Zhaohui Wu and Lin Sun, Department of Computer Science, Zhejiang University
2. Liveness Detection for Embedded Face Recognition System : Hyung-Keun Lee, Sung-Uk Jung, and Jang-Hee You
5. OpenCV docs for face detection http://docs.opencv.org/3.1.0/d7/dbb/tutorial_py_face_detection.html
6. Motion-Based Counter-Measures to Photo Attacks in Face Recognition : Andre Anjos, Murali Mohan Chakka and Sebastien Marcel