# Visvesvaraya Technological University
## Belgavi, Karnataka-590 014

## A Project Report on

# "DETECTION OF DISEASES USING ELECTROPHOTONIC IMAGING"

**Project Report submitted in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Medical Electronics**
**2020-2021**


**Submitted by**

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**Department of Medical Electronics**
**2020-2021**

# Department of Medical Electronics Engineering

## CERTIFICATE

Certified that the project work entitled "**DETECTION OF DISEASES USING ELECTROPHOTONIC IMAGING**" carried out by Nikitha S USN 1MS17ML030, Srusti B Sain USN 1MS17ML051, Sumathi G.A USN 1MS17ML052, Vishesh Agarwal USN 1MS17ML060, bonafide students of Ramaiah Institute of Technology, in partial fulfillment for the award of **Bachelor of Engineering** in Medical Electronics department of the Visvesvaraya Technological University, Belgaum during the year 2020-2021. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

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**2)**

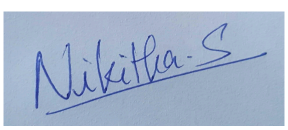
# DECLARATION

We, the students of Eighth semester of Medical Electronics, Ramaiah Institute of Technology, Bangalore 560054 declare that the work entitled "**DETECTION OF DISEASES USING ELECTROPHOTONIC IMAGING**" has been successfully completed under the guidance of Dr.Basavaraj Hiremath, Dr. C K Narayanappa, Medical Electronics Department, Ramaiah Institute of Technology, Bangalore. This dissertation work is submitted to Visvesvaraya Technological University in partial fulfillment of the requirements for the award of Degree of Bachelor of Engineering in Medical Electronics during the academic year 2020 - 2021. Further the matter embodied in the project report has not been submitted previously by anybody for the award of any degree or diploma to any university.

Place:

Date:

Team Members:



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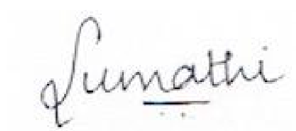

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We are also grateful to all the authors and writers for their books, e-resources, and scientific papers references for our project.

# ABSTRACT

**The pancreas and liver are the organs which produce insulin and regulate blood sugar respectively, which is one of the main hormones that helps to regulate diabetes. Electrophotonic imaging is a process that measures the energy fields of humans. The Electrophotonic Imaging (EPI) instrument is used to capture coronal discharges at the fingertips induced by a pulsed electrical signal (10-15kV, 1024Hz, 10- microsecond) on the glass plate of the camera. The EPI instrument is based on the stimulation of photon and electron emissions from the surface of the object. In this process, the images are captured by a highly specialized camera referred to as a GDV (gas discharge visualization), EPC or EPI camera. The camera must be placed at certain angles in order to perform the imaging of the desired organ i.e pancreas and liver. From the EPI dataset collected from SVYASA Institute which consisted of 53 diabetic patients and 58 healthy individuals, parameters such as mean, entropy, intensity, fractality, and root mean square were found. Further, classification is performed to predict the onset of diabetes. The parameters found are used for training the network. For Support-Vector Machine classification, inputs are the parameters found and the expected output is diabetic or non-diabetic.**

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# CHAPTER 1
# INTRODUCTION

## 1.1 INTRODUCTION

The aim of the work described in the report was to provide a software tool using which people can know if they are diabetic or healthy using the electrophotonic images of their fingertips. Electrophotonic imaging is a process that measures the energy fields of humans as well as plants, crystals, essential oils and water. These images are captured by a highly-specialized camera referred to as a GDV (gas discharge visualization), EPC or EPI camera. Gas Discharge Visualisation Technique (GDV) is computer registration and analysis of gas discharge glow (GDV/EPI-images, Korotkov's Images) of any biological objects placed in a high intensity electromagnetic field.

**Fig 1.1 GDV Camera Pro**

## 1.2 WORKING OF GAS DISCHARGE VISUALIZATION

The GDV method is based on the stimulation of photon and electron emissions from the surface of the object whilst transmitting short electrical pulses. In other words, when the object is placed in an electromagnetic field, it is primarily electrons, and to a certain degree photons, which are 'extracted' from the surface of the object. This process is called 'photo-electron emissions' and it has been quite well studied with physical electronic methods[10]. The emitted particles accelerate in the electromagnetic field, generating electronic avalanches on the surface of the dielectric (glass). This process is called 'sliding gas discharge'. The discharge causes glow due to the excitement of molecules in the surrounding gas, and this glow is what is being measured by the GDV method[5]. Therefore, voltage pulses stimulate optoelectronic emission whilst intensifying this emission in the gas discharge, owing to the electric field created.

**Fig 1.2 GDV Camera**

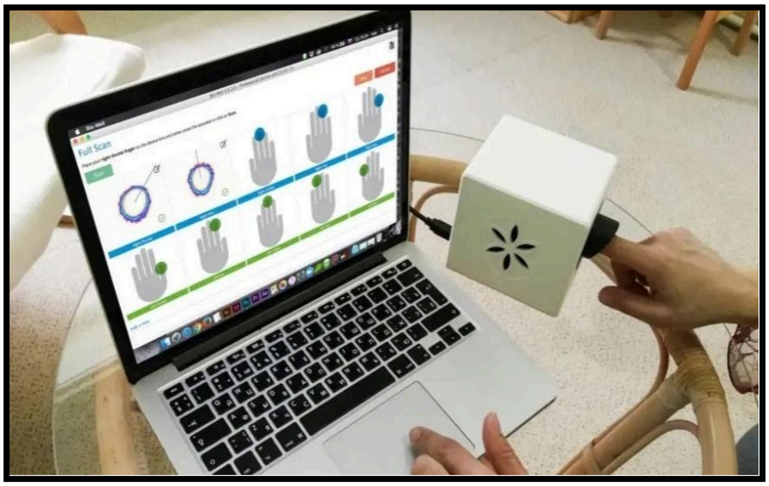


**Fig 1.3 Obtaining EPI Images**

The electric field characteristics are high voltage upto 10kV where the frequency is approximately 124 Hz and a low current of milli amperes is applied. Here, the fingertips of a person are made to be placed on a dielectric glass plate of the impulse analyzer and the voltage characteristics are applied under the glass plate to produce high electric files.[5] Electrons collide around the fingertips. These excited electrons ionize the molecules of air and produce a glow around the fingertip[7]. This process is captured by a couple devices that are charged, placed below the glass plate and then registered as an electrophotonic or EPI image.

## 1.3 ABOUT ELECTROPHOTONIC IMAGING

Electrophotonic imaging is a process that measures the energy fields of humans as well as plants, crystals, essential oils and water. These images are captured by a highly-specialized camera referred to as a GDV (gas discharge visualization), EPC or EPI camera.[6]

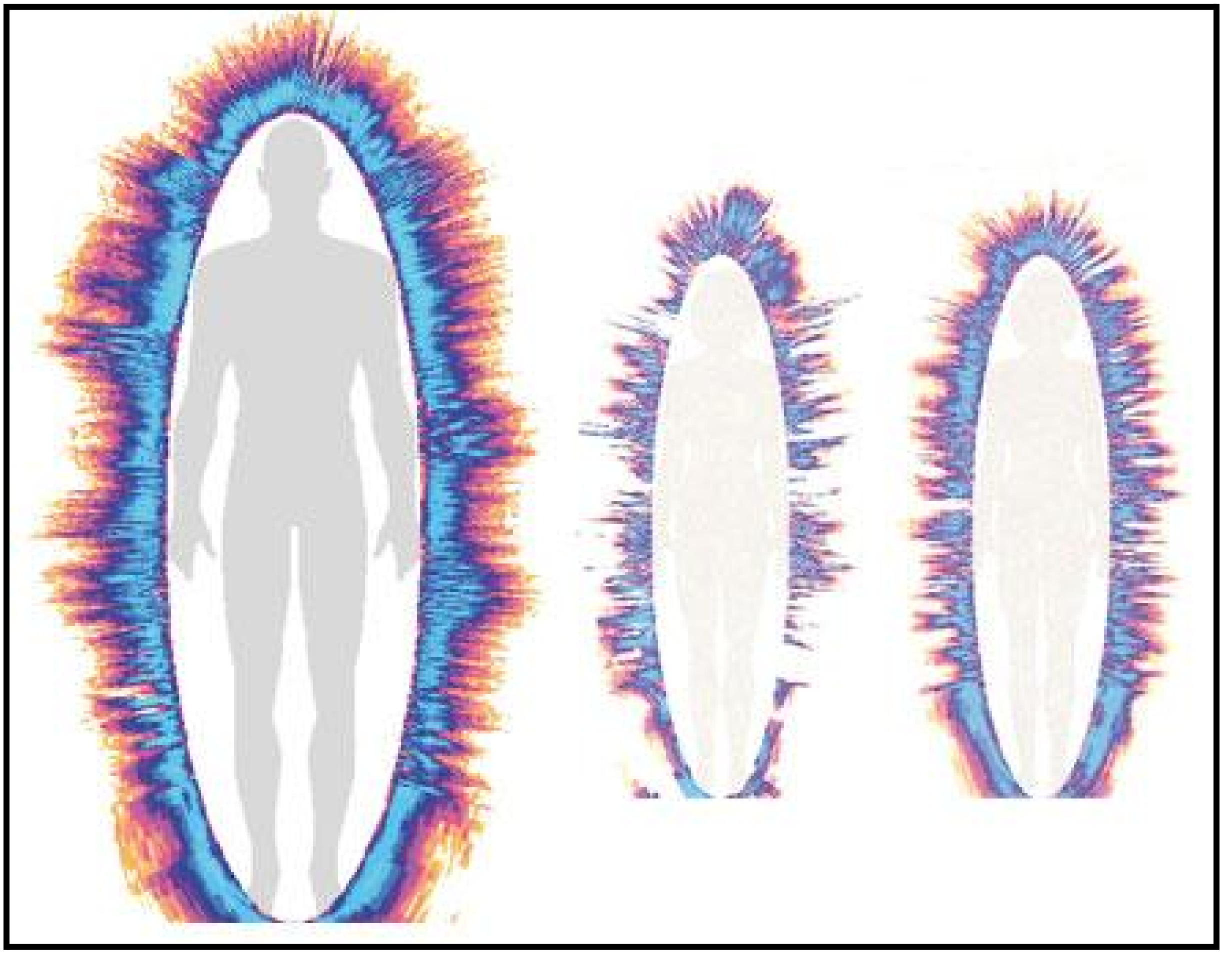


**Fig 1.4 Energy field around an individual**

All metabolic processes involve electron transfer mechanisms. Electrophotonic Imaging (EPI) captures the coronal discharge around the finger as a result of electron capture from the ten fingers. The coronal discharge around each fingertip supposedly represents the energy state of the corresponding organs and organ systems.

Different structures of water generate specific patterns of gas discharge bursts or imaging[8]. Structured, energy-rich water provides essential health benefits, such as better hydration, increased energy and the release of toxins from the body.

The discharge causes glow from the excitement of molecules in the surrounding gas, and this glow is what is being measured by the EPI instrument . Voltage pulses stimulate optoelectronic emission, while intensifying this emission in the gas discharge, amplified by the electric field created. Electrophotonic Image represents spatially distributed glow areas having varying brightness characteristics, it reveals general, local and sector based details. The electron capture from each of the fingers has a definite relationship with the health of the organ/organ system. This electron captured from the finger has to come from the lowest resistance meridian which would be the corresponding organ. This is similar to Kirlian photography.[9]

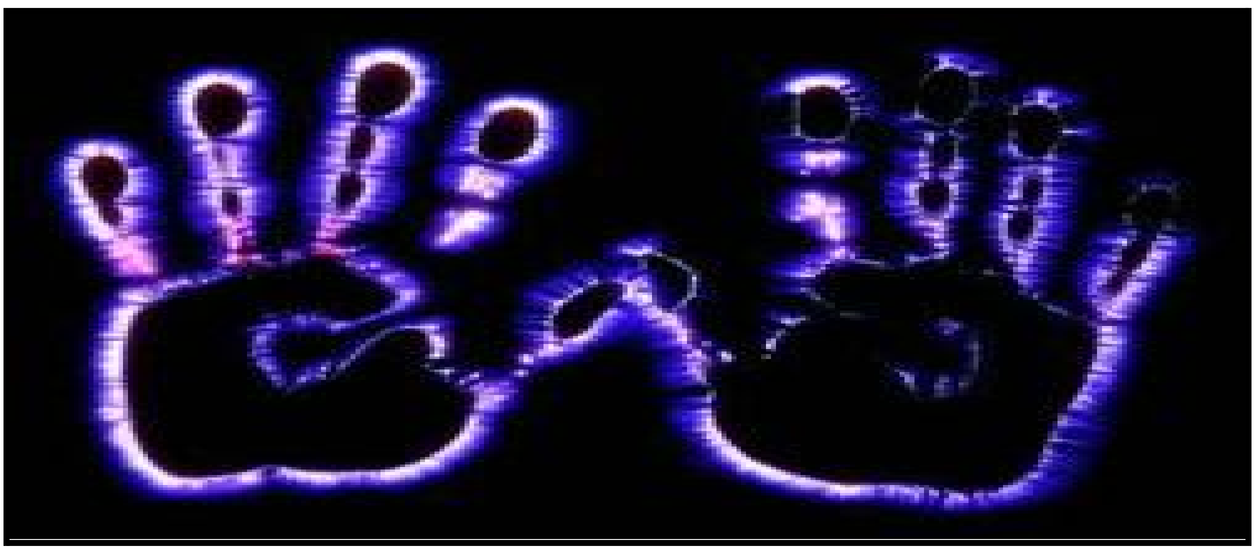


**Fig 1.5 Coronal discharge**

Electrophotonic imaging is a novel method that is used in increased applications in medical science to evaluate the status of health based on bio-energy. EPI technique is an efficient, noninvasive, inexpensive technique and is highly reliable. Hence, EPI technique is being applied worldwide and is used in various fields like sports, alternative medicine, material testing, and psychology.

Our project makes use of this potential and application of the GDV camera to generate the EPI images. Electrophotonic parameters or EPI parameters like the mean, entropy, intensity, energy and fractality which are based on pixel count are extracted corresponding to divisions of the EPI image that indicates an organ or organ of the body as shown in the figure.

Among the various existing methods of disease prediction, most of them are not accurate. Our study helps in improving the disease prediction accuracy. This not only helps in early stage detection of diseases but also helps in taking steps to prevent it from spreading or moving to a higher stage. Electrophotonic imaging has many uses and advantages. It is one of the leading methods of imaging in the present day.

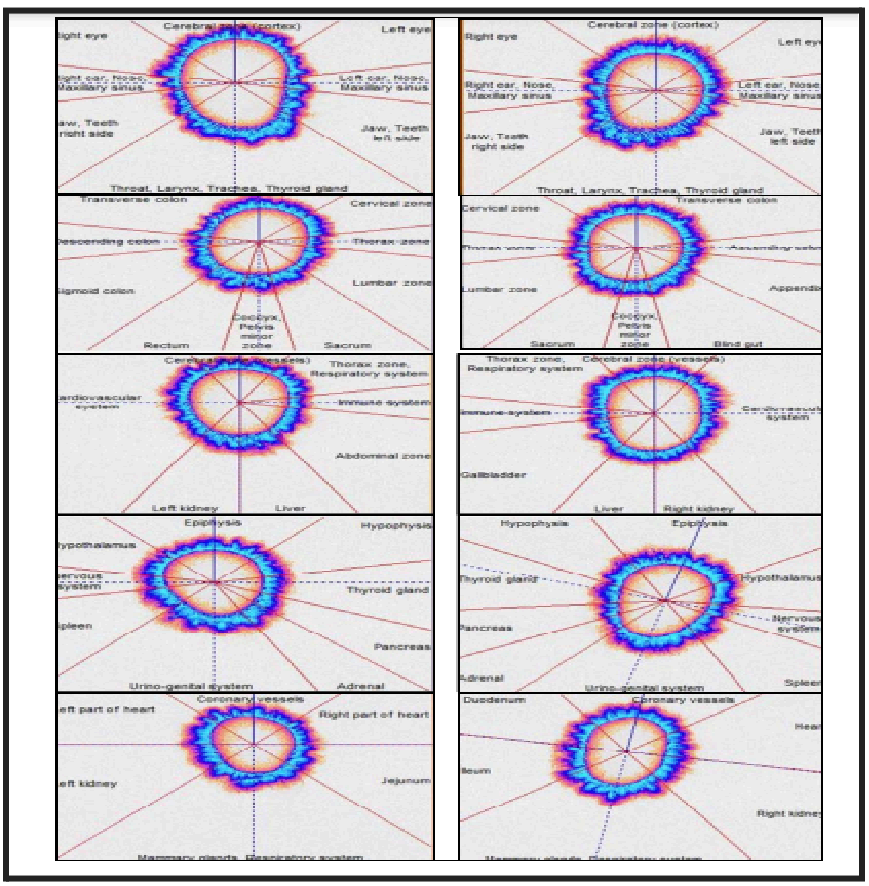



**Fig 1.6 Sector of the images**

## 1.4 OBTAINING EPI IMAGES

- Information must be taken from the 10 fingers.
- The fingers must not be washed before the EPI images are taken. If there is dirt, moisture or sweat, wipe with a soft cloth. In the case of heavy perspiration, wipe every finger just before the EPI images are taken.
- Any strong drug, medications (in particular hormones and antidepressants), and alcohol change the energy of the body. Ask the patient before measuring.
- Different EPI programs provide different information about the energy because they use different principles for processing the information, therefore a full analysis requires processing in all programs. It allows for several types of analysis.
- The health status and energy status diagrams are very convenient, practical and reliable methods for analysing the person's conditions.
- Assessing the stress level, energy level and left-right balance, both of the energy field as a whole, and of different organs and systems of the body.
- Compare the conditions when taking EPI images in different moments; after carrying out a procedure, exercise, or intervention and so forth.
- Accomplish a detailed analysis of the energy condition of the organs and systems by assessing the various sectors of individual fingers.

## 1.5 NEED FOR STUDY

- There is a need for an automated identification as it is prevalent for a large scale prevention and treatment by diagnosing the early stages of the symptoms based on the empirical data obtained.
- The EPI technique based on the gas discharge visualization process is well characterized in the physical processes by which it captures and analyzes data.
- An increasing number of clinical studies show that particular details of the EPI data correlate with conditions that can be characterized using the standard medical diagnostics as well as correlate with assessment methods used in a wide range of complementary medicine.
- GDV is a non-invasive method that analyzes the psychological and physiological state of a person. It can also be used to assess the functioning state of different organs and organ systems through the electrophotonic emissions of the fingertips when placed on the surface of the impulse analyzer.

## 1.6 OBJECTIVES

The main objectives of our project are-

- To develop specific electrophotonic parameters for higher diagnostic precision.
- To evaluate the sensitivity of new features,
- To evaluate the specificity of new features in healthy and ailing groups.
- To diagnose health conditions earlier in order to prevent further deterioration of the organ and organ system.
- To reveal general, local and sector based details.

# CHAPTER 2
# LITERATURE SURVEY

**2.1 Title of Publication:** ELECTROPHOTONIC IMAGING BASED ANALYSIS OF DIABETES [1]

**Year of Publication:** December 9, 2016

**Authors:** Shiva Kumar Kotikalapudi, T.M Srinivasan, H.R Nagendra, P Marimuthu

**Introduction and Datasets / Techniques used:** Electron transport pathways are present in all metabolic processes. The coronal discharge around the finger is captured using electrophotonic imaging (EPI) as a result of electron capture from the ten fingers. The energy condition of the respective organs and organ systems is said to be represented by the coronal discharge around each fingertip. When a person has diabetes, the blood sugar levels must be assessed repeatedly in regular intervals of time. A measurement method based on electrophotonic imaging could be an alternative. The EPI data was obtained from 200 participants in a diabetes facility in Bangalore, including males and females between the ages of 40 and 60. The patients who came in for a routine blood test had their EPI data taken from all ten fingers. The EPI data corresponding to the meridians of the ring finger, chakras, organs and organ systems related to diabetes were analyzed using a general linear model in IBM SPSS version 20.0. The diabetic and non-diabetic patients were classified using an IBM SPSS built-in neural network classifier.

**Results:** The data captured from each finger corresponds to the same variable, but the values are significantly different because each of these corresponds to different hemispheres in the head region, with left hand data corresponding to the right hemisphere and right hand data corresponding to the left hemisphere. The IBM SPSS tool's neural network function was used to predict whether a given individual was diabetes or non-diabetic based on repeated neural network runs, and the predicted values were kept in the input file. The electron capture from each of the fingers has a  direct correlation with the organ and organ system's health. The results of the study revealed that variables in the endocrine system had a logical relationship to diabetes. It also indicated a link to the fourth finger on both the right and left hand.

**2.2 Title of Publication:** DIGITAL HIGH VOLTAGE ELECTROPHOTONIC

## MEASURES OF THE FINGERTIPS OF SUBJECTS PRE AND POST QIGONG [2]

**Year of Publication:** December 2005

**Authors:** Beverly Rubik, Audrey J Brooks

**Introduction and Datasets / Techniques used:** The goal of this research was to see how qigong affects some measurable features of the human biofield, such as various computed parameters of finger corona discharge patterns created by high-voltage electrophotography. Qigong, which began in China in the 26th century B.C., refers to the cultivation or mastery of qi via constant practice. The goal of this study was to compare measurements taken before and after a qigong session using a Gas Discharge Visualization (GDV) camera. The following is what was predicted:

1.Because qigong improves the flow of qi through the body, post-qigong emission patterns would be larger in area.

2.Prior qigong experience would be linked to more significant alterations in emission patterns.

3.Larger alterations in emission patterns would be related to the presence of a chronic health issue.

The researchers looked at sixteen adults aged 48 to 80, seven of whom had been diagnosed with a chronic illness. The participants ranged from qigong beginners to those who had been practicing for eight years. Pre- and post-qigong, measurements were taken on all 10 fingertips of 16 subjects. The light patterns emitted by the subjects' fingertips were digitally recorded and analyzed by a computer. Normalized area, brightness, density, fractality form coefficient, fractality dimension, and right- and left-hand integrals were all calculated and compared statistically.

**Results:** Following qigong, the homogeneity of the density of the circles of light emitted from the fingertips improved. The variability in the fractal form coefficient was found to be decreasing post-qigong. Post-qigong, subjects with chronic health issues exhibited an increase in fractal dimension, while those without health issues showed a decrease.

**2.3 Title of Publication:** CLASSIFICATION OF ELECTROPHOTONIC

IMAGES OF YOGIC PRACTICE OF MUDRA THROUGH NEURAL NETWORKS [3]

**Year of Publication:** August 2018.

**Authors:** Kotikalapudi Shiva Kumar, T M Srinivasan, Judu Ilavarasu, Biplob Mondal,
H R Nagendra

**Introduction and Datasets / Techniques used:** Mudras are gestures made with the hands, eyes, and body. Mudras are different configurations of the fingertips merging together and are used by yoga practitioners for energy manipulation and therapeutic purposes. The coronal discharge surrounding the fingers is captured using electrophotonic imaging (EPI) as a result of electron capture from the ten fingers. To better understand the effect of mudra on EPI parameters, the coronal discharge around each fingertip was analyzed. The participants were from Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA) and Sushrutha Ayurvedic Medical College, in Bengaluru, India. The mudra group had 29 volunteers, whereas the control group had 32. There were two designs: one was a pre-post with control, and the other was a pre-post with repeated measures, with 18 people practicing mudra for three days. For the pre-post design, the intervention lasted 10 minutes on the first day, 15 minutes on the second day, and 20 minutes on the third day. Mudra and control samples were classified using a neural network classifier.

**Result:** Normalized area and average intensity, both EPI metrics, passed the Shapiro-Wilk normality test. The mudra and control groups had Cohen's d effect sizes of 0.988 and 0.974, respectively. The classification accuracy of the post-intervention samples for mudra and control ranged from 85 percent to 100 percent, while the classification accuracy of the pre-intervention samples ranged from 55 percent to 70 percent, according to neural network-based analysis. The mudra intervention resulted in statistically significant changes in mean values on the third day when compared to the first. The effect size of the mudra changes was larger than the control groups. In comparison to the first day's practice, a lengthier Mudra practice resulted in a statistically significant shift in the EPI parameter, average intensity.

**2.4 Title of Publication:** PRELIMINARY STUDY OF KIRLIAN IMAGE IN DIGITAL ELECTROPHOTONIC IMAGING AND APPLICATIONS [4]

**Year of Publication:** May 2016

**Authors:** Janifal Alipal, Razak Mohd Ali Lee, Ali Farzamnia

**Introduction and Datasets / Techniques used:** Almost all current medical imaging procedures deal with captured non-invasive radiation spectrum (NIR) in digital image form to enable visualization probes for illness diagnosis and therapy. One of them is Electrophotonic Imaging.

In this paper, a preliminary analysis of the Kirlian picture and its current applications is carried out in this research, and the Kirlian effects are proposed to be processed numerically using blob extraction and segmentation techniques employing mathematical morphology in digital image processing. The goal of this pilot study was to examine an insight conclusion of digital analysis on the Kirlian spectrum by introducing a pre-processing procedure to extract the effects texture as the radiation energy signature based on its most significant glow (digitally imaged isolines) for medical biometric and disease interpretations. This paper achieved in digitally simplifying the blob extraction technique for the Kirlian effect by defining four parameters as the picture feature, and then introducing it as a Kirlian ‘digital signature.' Kirlian images are collected and then analyzed under a data learning machine for separating processes between diabetic and non-diabetic subjects on multilayer perceptron and radial basis function of Artificial Neural Network (ANN) in IBM SPSS toolbox. A pre-processing framework is introduced to extract four significant features in the kirlian image. The features are the size of the blob, number of the closed isolines, Form Coefficient, Form Deviation.

**Result:** The goal of the study was to develop significant parameters connected to the Kirlian effects in an image form using simulation, which technically does not relate the image to a specific sickness or health status of the subject. It also aims to evaluate and verify the parameters put into picture feature characterization in the machine learning process in order to investigate the pattern of human health conditions.

**2.5 Title of Publication:** RECENT ADVANCES IN ELECTROPHOTONIC IMAGE PROCESSING [5]

**Year of Publication:** May 2016

**Authors:** Korotkov Konstantin

**Introduction and Datasets / Techniques used:** In this publication, the physical concepts of Electrophotonic Imaging (Gas Discharge Visualization) are discussed, as well as current improvements in the method. Special attention is given to the outline of the newest patents. This approach is utilized all over the world to assess people's psycho-emotional states, particularly in sports, as well as to analyze plants, minerals, water, and hair. The methodology is as follows :

On the bottom surface of the glass plate, the transparent conductive layer is evaporated. This grid is subjected to a train. An electromagnetic field is created around the topic on the glass surface as a result of this. The subject emits a burst of electron-ion emission while under the influence of the field. A sliding gas discharge occurs along the dielectric surface as a result of these particles and photons. The optical system with charge coupled device TV camera, analog-digital processor, and digitized records the spatial distribution of discharge channels via the glass plate.

**Results:** The following parameters were found: Luminescence Area, normalized luminescence area, internal noise, isoline radius, intensity, inner circle radius, isoline length, isoline fractality, isoline entropy, form coefficient.

Alternative/complementary medicine and integrative healthcare can benefit from electrophotonic imaging. The Bio-Well instrument is designed in accordance with the most recent advancements in technology. All picture processing is done on the server, which protects against viruses and hacker attacks and allows clients to receive free upgrades on a regular basis.

# CHAPTER 3
# METHODOLOGY

## 3.1 FLOWCHART

**Software Used-** MATLAB
MATLAB is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks.

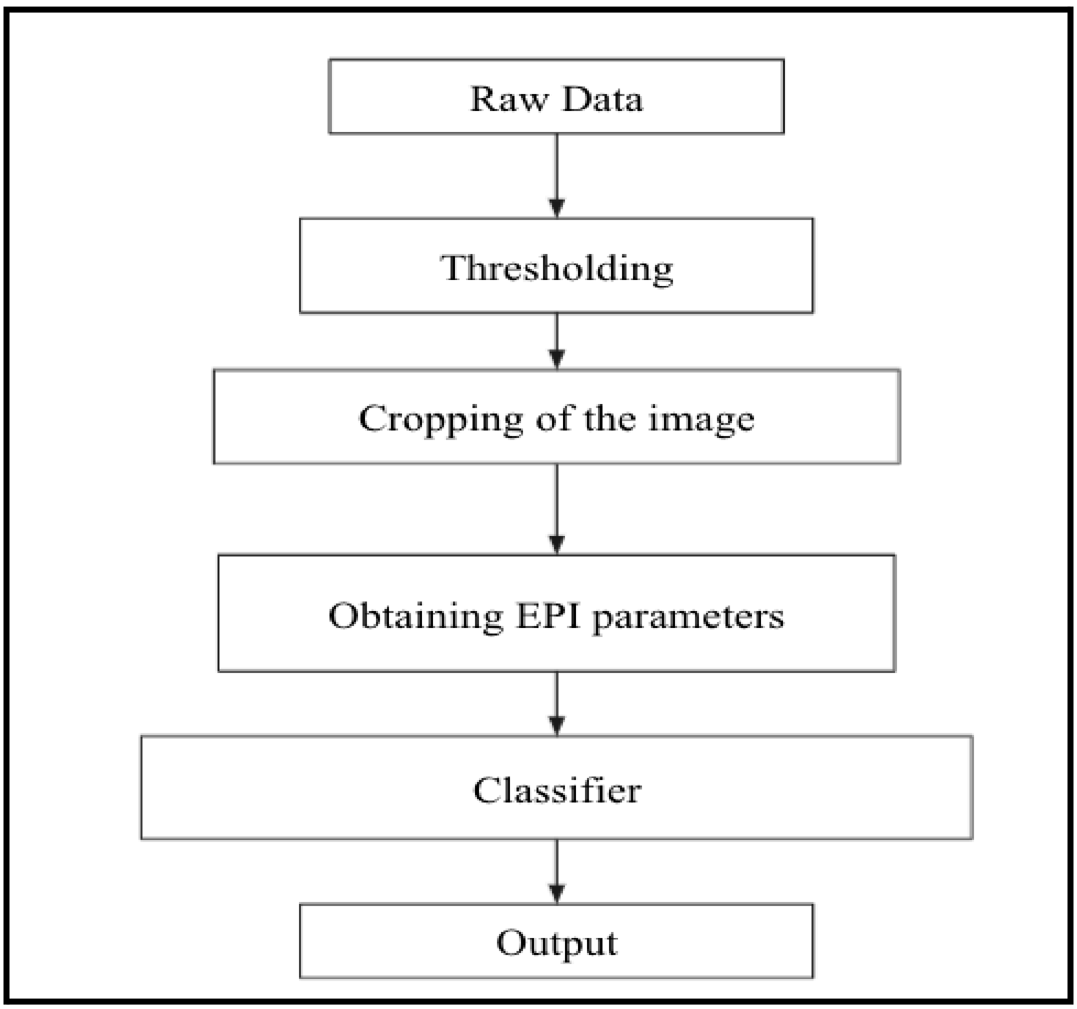



**Fig 3.1 Flowchart**

1) **Raw Data-** The GDV raw image data is collected from SVYASA Institute. Around 58 healthy and 53 diabetic images are collected. Our major focus is ring finger as from our research study we have found that middle finger and ring finger are associated with liver and pancreas respectively. Pancreas is the organ which produces insulin and liver regulates blood sugar, and therefore plays an important part in diabetes. The healthy and diabetic images obtained are divided into 3L, 3R, 4L and 4R, where 3L and 3R belong to the liver and 4L and 4R belong to pancreas represent left and right respectively.

The diagnostic map obtained from our research study-

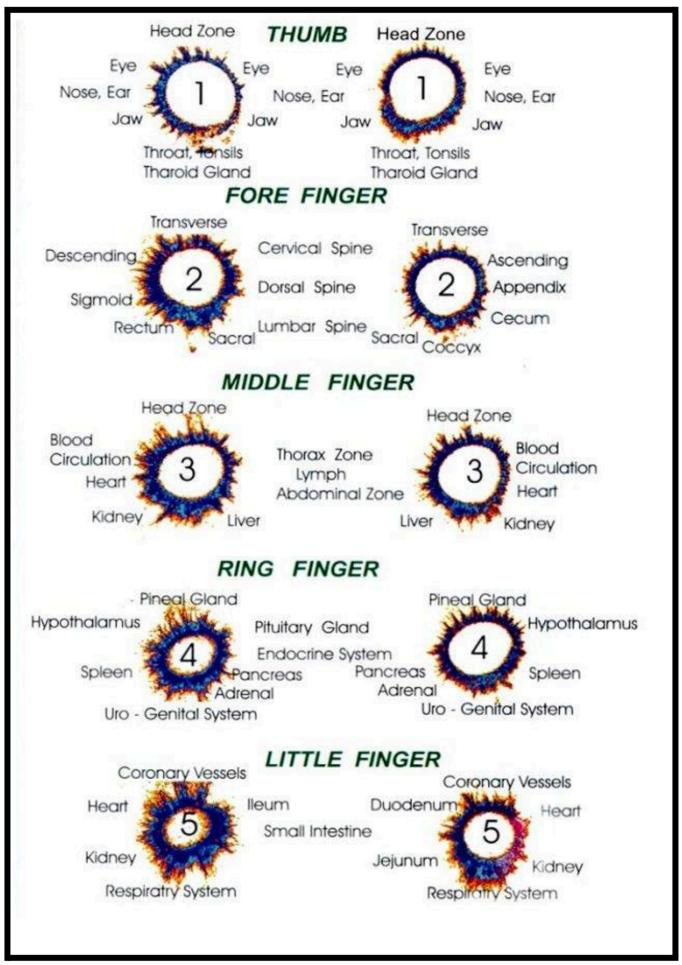



**Fig 3.2 Diagnostic map**

Mapping of the organs-

- 1L: Eyes, ear, nose, jaw, throat, tonsils, thyroid (Head zone)
- 1R: Ear, jaw, throat, tonsils, thyroid, jaw, eye (Head zone)
- 2L: cervical, dorsal, lumbar spines, sigmoid, rectum (Descending)
- 2R: Appendix, cecum, coccyx, sacral (Ascending)
- 3L: Blood circulation, heart, kidney, liver
- 3R: Blood circulation, heart, liver
- 4L: Pineal gland, spleen, uro-genital system, pancreas
- 4R: Pineal gland, spleen, uro-genital system, pancreas
- 5L: coronary vessels, heart, kidney, respiratory system, small intestine
- 5R: coronary vessels, heart, kidney, respiratory system, duodenum, jejunum

The sample images are demonstrated as-

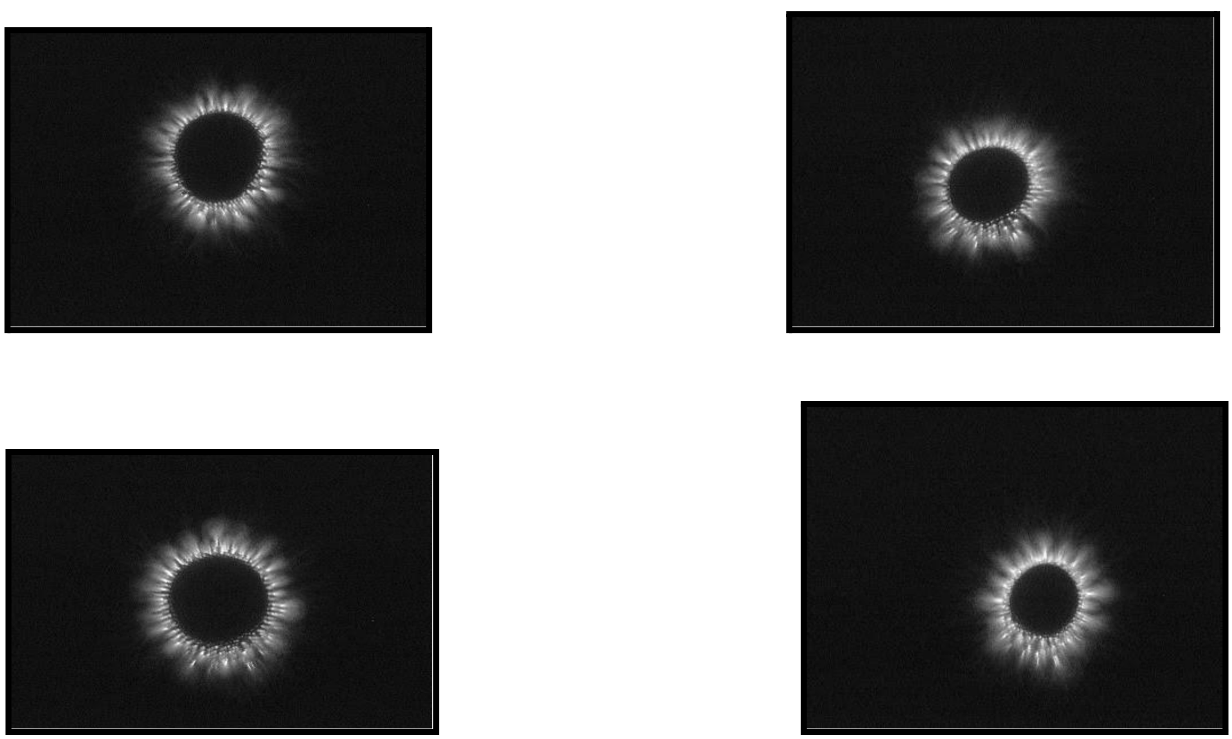


**Fig 3.3 Sample images 3L,3R,4L,4R (Clockwise)**

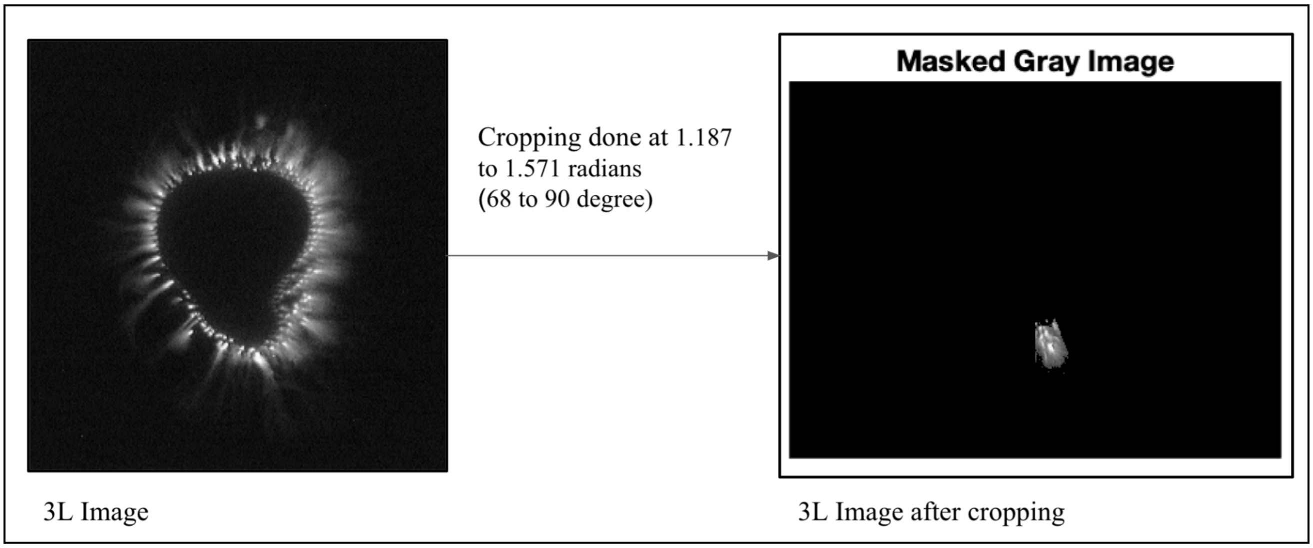
2) **Thresholding-** Thresholding is done to change the pixels of the image to make the image easier to analyze using MATLAB. Also, it is done to reduce the background noise by extracting useful information encoded into pixels.

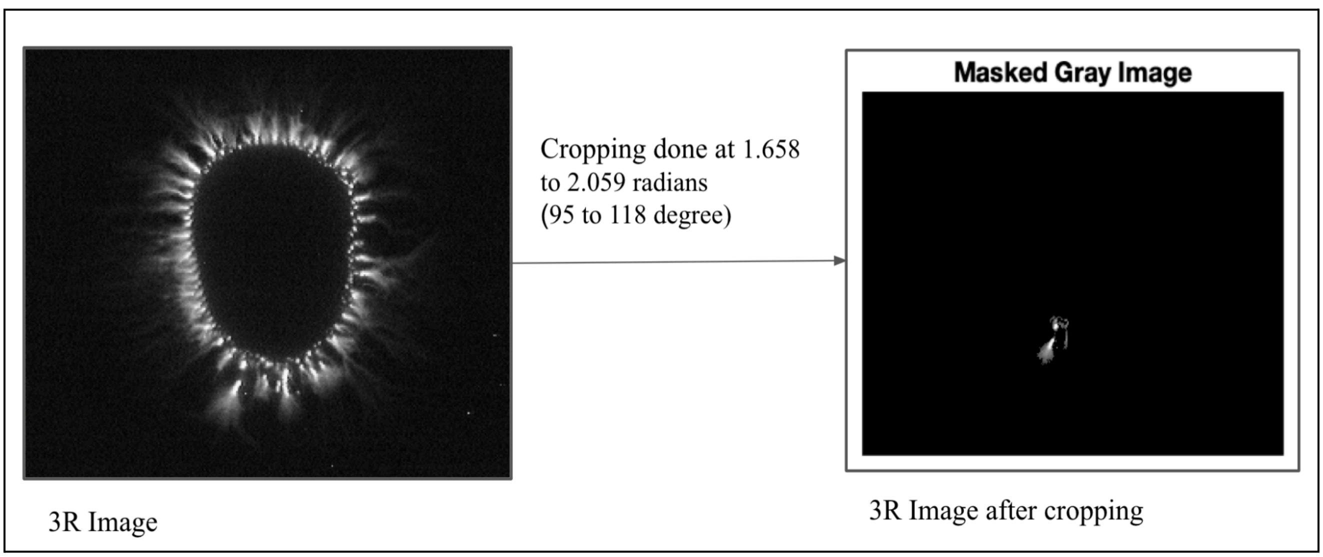
3) **Cropping of the image-** To identify the region associated with pancreas and liver, the images need to be cropped in a desired angle using MATLAB, the desired angle varies for 3L, 3R, 4L and 4R. Therefore, they are cropped accordingly.

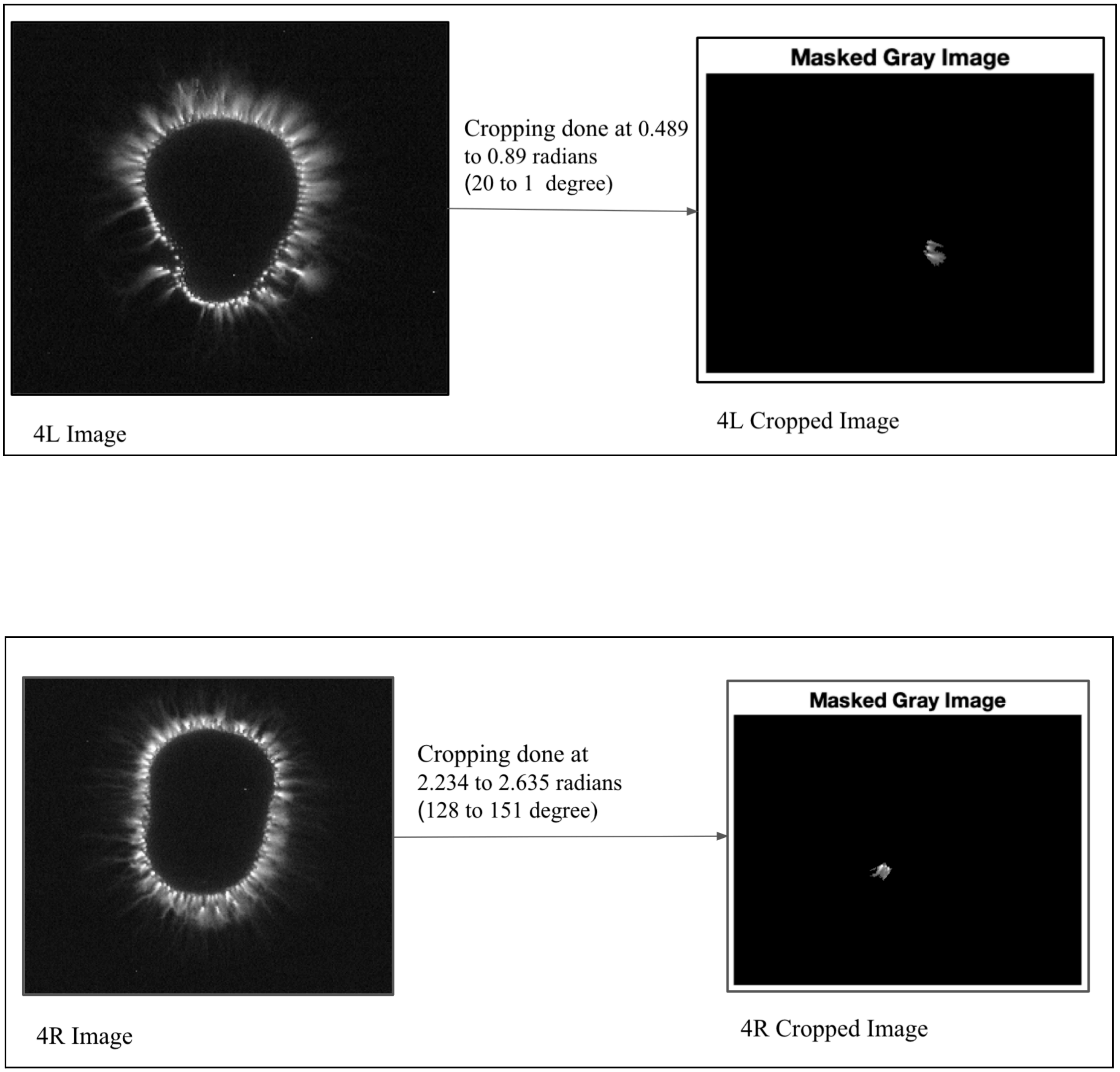
Angles for cropping-

| Finger | Degree | Radians |
|---|---|---|
| Middle finger right hand (3R)- Liver | 95 to 118 | 1.658 to 2.059 |
| Middle finger left hand (3L)- Liver | 68 to 90 | 1.187 to 1.571 |
| Ring finger right hand(4R)- Pancreas | 128 to 151 | 2.234 to 2.635 |
| Ring finger left hand(4L)- Pancreas | 28 to 1 | 0.489 to 0.89 |

The demonstration of cropping of the image-


Masked Gray Image
Cropping done at 1.187
to 1.571 radians
(68 to 90 degree)
3L Image
3L Image after cropping


Masked Gray Image
Cropping done at 1.658
to 2.059 radians
(95 to 118 degree)
3R Image
3R Image after cropping




## Fig 3.4 Cropped Images

4) **Obtaining EPI Parameters-** Features like Mean, Energy, Entropy Intensity, Form Coefficient and Root Mean Square will be obtained from cropped images using MATLAB.

   Formulae-

| | |
|---|---|
| Mean | b=mean(mean(a1)); |
| Entropy | sum(p.*log2(p))<br>P- contains normalized histogram count |
| Intensity | Intensity- Mean of the intensity values |
| Form Coefficient | FC=L*2/S<br>L- length, S- GDI Background Area |
| Energy | S*I*0.00002<br>I- Averaged Intensity<br>S- GDI Background Area |
| Root Mean Square | c=rms(a1); |

5) **Classifier-** From the parameters obtained, we classify the image as healthy or diabetic via SVM classification using MATLAB. SVM stands for Support-Vector Machine and is a supervised learning model. The EPI parameters found for the images is the training data used to train the SVM model. Holdout validation is used where 25 percent of the entire training data set is used as the validation set and the remaining 75 percent of the data is the training set. The model is fit on the training set and the fitted model is used to predict the responses of the validation set.

# CHAPTER 4
# IMPLEMENTATION AND TESTING

## 4.1 IMPLEMENTATION AND TESTING

For classifying we have used a machine learning model namely, Support Vector Machine (SVM) that uses classification algorithms for dual group classification problems. Purpose of using this model is because of two main advantages: higher speed and better performance with a finite number of samples(around thousands). This makes the algorithm very suitable for dual classification problems, where it’s common to have access to a dataset of at most a couple of thousands of tagged samples. Support vector machine creates a decision boundary that separates the n-dimensional space into classes or categories. This best decision boundary is called a hyperplane. SVM choses particular extreme vectors also known as support vectors in forming the hyperplane. SVM is mainly of two types: linear and non-linear SVM. Linear SVM is used when two classes or categories can be separated linearly by a straight line. Non Linear SVM is used when the two classes cannot be separated linearly. Here, we have used linear SVM classification. In order to know about the performance of the SVM model, we use the confusion matrix. Confusion matrix is a N X N matrix, where N is the number of target categories. The matrix compares the actual target values with the values predicted by the machine learning model. A binary classification uses a 2 X 2 confusion matrix.

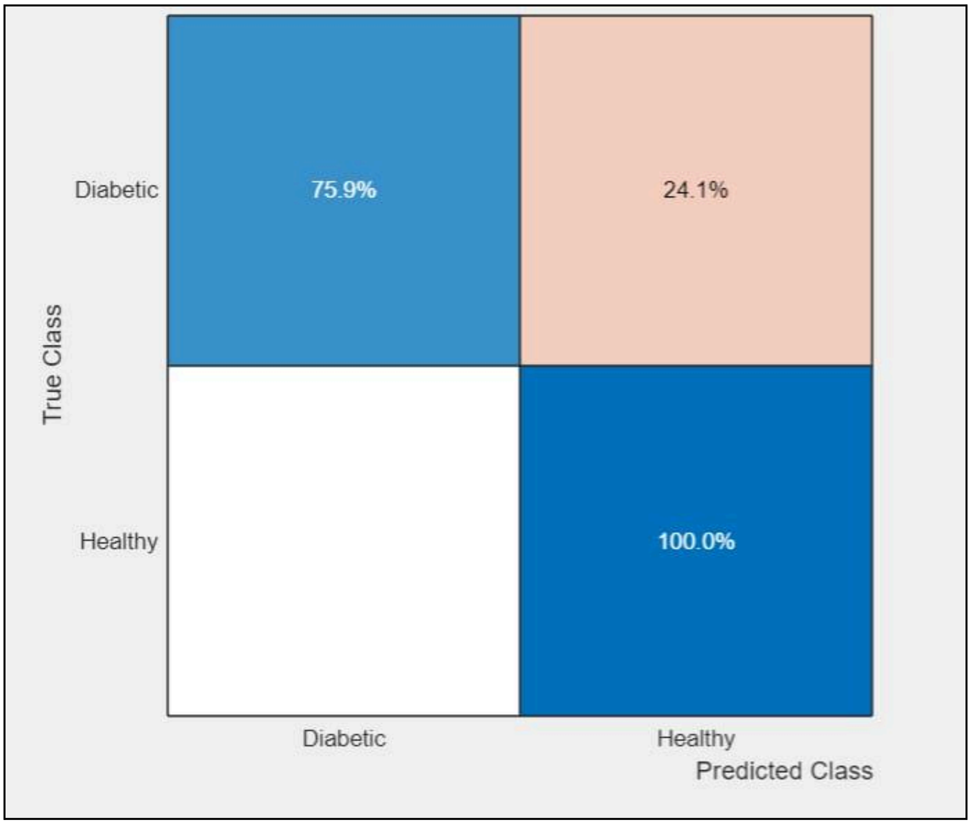



**Fig: 4.1 Confusion Matrix**

Formula:

$$\frac{(TP+TN)}{(TP+FP+TN+FN)}$$

$$\frac{(75.9+100)}{(75.9+100+0+24.1)} = 88.01\%$$

Here, the columns represent the actual values and the rows represent the predicted values.

TP- True Positive. It means the actual value matches the predicted value. Both the actual and predicted values are positive.

TN- True Negative. It means the actual value matches the predicted value. Bothe the actual and predicted values are negative.
FP- False Positive. It is also known as Type 1 error. Here the predicted value is predicted incorrectly. The actual value is negative but the model predicts a positive value.
FN- False Negative. It is also known as Type 2 error. Here the predicted value is predicted incorrectly. The actual value is positive but the model predicts a negative value.
Support Vector Classification algorithm is used for binary classification of the EPI data into healthy and diabetic.
MATLAB is a user-friendly platform that helped us to perform the SVM classification.

## 4.2 ALGORITHM

**Step 1:** The EPI parameters obtained are imported on an excel sheet.

**Step 2:** The excel data is given as an input training data to the model. The predictors are defined as mean, entropy, intensity and fractality.

**Step 3:** The SVM classifion is an inbuilt function on matlab.

**Step 4:** Holdout validation is set in order to assess the performance of the model. It is done by splitting the entire training data into two sets, the training and the validation set.

**Step 5:** Here, 25 percent of the input training data is set as the training set and the rest of the 75 percent of the data is set as the validation set.

**Step 6:** Initially, the model is trained on the training set. This trained SVM model is then tested again by training it using the validation set.

**Step 7:** The validation accuracy is obtained by the correct responses predicted by the SVM model on the validation set.

**Step 8:** This trained model is now ready to make new predictions.

In order to test on a new EPI data, a predict function is used. The new test image is cropped for the desired angle for which EPI parameters are found. These parameters in the form of a table are given as an input to the predict function. The trained model makes a new prediction based on the EPI data it has been trained with and gives an output as healthy or diabetic.

# CHAPTER 5
# RESULTS

## 5.1 RESULTS

- The thresholding and cropping of images for any desired angle is achieved.

- Different parameters like Mean, Entropy, Energy and Intensity, Fractality and RMS values are obtained.

### 5.1.1 Mean

| Images | Minimum Value | Maximum Value |
|---|---|---|
| 3L Diabetic | 142.4009 | 142.8506 |
| 3L Healthy | 142.3777 | 142.8506 |
| 3R Diabetic | 142.3935 | 142.7028 |
| 3R Healthy | 142.3763 | 142.7197 |
| 4L Diabetic | 142.3278 | 142.7173 |
| 4L Healthy | 142.3579 | 142.8588 |
| 4R Diabetic | 142.3798 | 142.6777 |
| 4R Healthy | 142.3290 | 142.6692 |

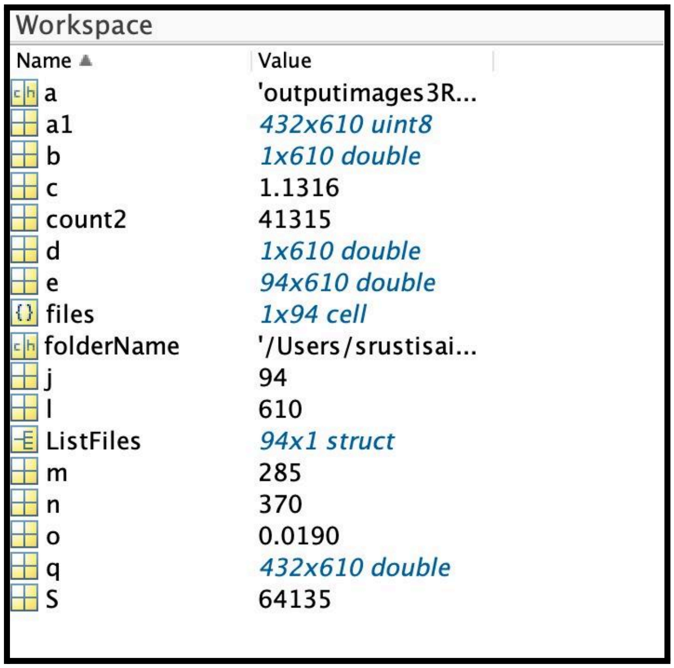
### 5.1.2 Entropy

| Images | Lowest Value | Highest Value |
|---|---|---|
| 3L Diabetic | 1.1124 | 1.1522 |
| 3L Healthy | 1.1098 | 1.1522 |
| 3R Diabetic | 1.1127 | 1.1445 |
| 3R Healthy | 1.1109 | 1.1366 |
| 4L Diabetic | 1.1055 | 1.1443 |
| 4L Healthy | 1.1084 | 1.1448 |
| 4R Diabetic | 1.1110 | 1.1430 |
| 4R Healthy | 1.1130 | 1.1439 |

### 5.1.3 Intensity

| Images | Lowest Value | Highest Value |
|---|---|---|
| 3L Diabetic | 325.0281 | 329.1285 |
| 3L Healthy | 325.0281 | 329.1286 |
| 3R Diabetic | 325.8390 | 328.5216 |
| 3R Healthy | 325.4055 | 329.0418 |
| 4L Diabetic | 326.0940 | 328.9398 |
| 4L Healthy | 326.0889 | 329.2764 |
| 4R Diabetic | 325.9359 | 329.0265 |
| 4R Healthy | 325.8747 | 329.5263 |

### 5.1.4 Form Coefficient and Root Mean Square



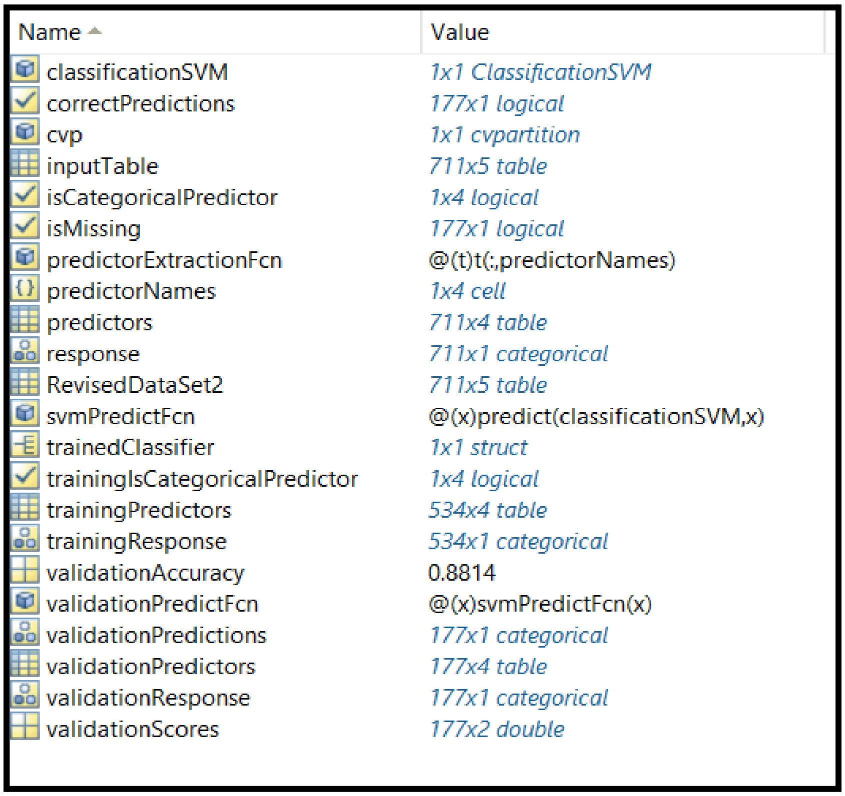
Workspace

| Name ▲ | Value |
|---|---|
| a | 'outputimages3R... |
| a1 | 432x610 uint8 |
| b | 1x610 double |
| c | 1.1316 |
| count2 | 41315 |
| d | 1x610 double |
| e | 94x610 double |
| files | 1x94 cell |
| folderName | '/Users/srustisai... |
| j | 94 |
| l | 610 |
| ListFiles | 94x1 struct |
| m | 285 |
| n | 370 |
| o | 0.0190 |
| q | 432x610 double |
| S | 64135 |

**Fig 5.1 Form coefficient and root mean square values**

| Parameters | Minimum Value | Maximum Value |
|---|---|---|
| Form Coefficient | 0.0189 | 0.0191 |
| Root Mean Square | 1 | 1 |

Using a Support-Vector Machine, classification of healthy and diabetic images was performed. An accuracy of 88% was obtained via SVM classification.



| Name | Value |
|---|---|
| classificationSVM | 1x1 ClassificationSVM |
| correctPredictions | 177x1 logical |
| cvp | 1x1 cvpartition |
| inputTable | 711x5 table |
| isCategoricalPredictor | 1x4 logical |
| isMissing | 177x1 logical |
| predictorExtractionFcn | @(t)t(:,predictorNames) |
| predictorNames | 1x4 cell |
| predictors | 711x4 table |
| response | 711x1 categorical |
| RevisedDataSet2 | 711x5 table |
| svmPredictFcn | @(x)predict(classificationSVM,x) |
| trainedClassifier | 1x1 struct |
| trainingIsCategoricalPredictor | 1x4 logical |
| trainingPredictors | 534x4 table |
| trainingResponse | 534x1 categorical |
| validationAccuracy | 0.8814 |
| validationPredictFcn | @(x)svmPredictFcn(x) |
| validationPredictions | 177x1 categorical |
| validationPredictors | 177x4 table |
| validationResponse | 177x1 categorical |
| validationScores | 177x2 double |

**Fig 5.2 SVM Accuracy**

# CHAPTER 6
# DISCUSSIONS

## 6.1 ACHIEVEMENTS AND LIMITATIONS

Below mentioned are the achievements and the limitations from our project-

**It is an indigenous attempt** to classify diabetic and healthy individuals based on ElectroPhotonic Imaging (EPI) which makes the process of early diagnosis of diabetes less cumbersome and easy.

**Successfully able to implement the Support Vector Machine (SVM),** which tested the parameters obtained from the analysis of the processed data and thus helped us in classifying the individual as healthy or diabetic.

**Accuracy from the Support Vector Machine (SVM),** has been around 88% in classifying the person as healthy or diabetic which has been the highest considering all the research papers (included in reference) we have conducted a comprehensive study have provided the accuracy in the range of 50-70%.

**Degree of seriousness** regarding the disease cannot be determined; only the diagnosis of the disease can be done. After the diagnosis it is important to know the level of seriousness of the disease that has infected the person, so that the doctor can provide suitable medications or surgeries(if required).

# CHAPTER 7
# FUTURE WORK

## 7.1 FUTURE WORK

- We intend to procure additional pictures from the SVYASA institute and increase accuracy with other effective techniques such as Deep Learning and Convolutional Neural Networks. Deep learning is an artificial intelligence (AI) function that mimics the human brain's processing of data and pattern creation in order to make decisions. Deep learning is an artificial intelligence subset of machine learning that uses neural networks to learn unsupervised from unstructured or unlabeled data. Deep learning has progressed in lockstep with the digital era, which has resulted in an avalanche of data in all formats and from all corners of the globe. A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other.

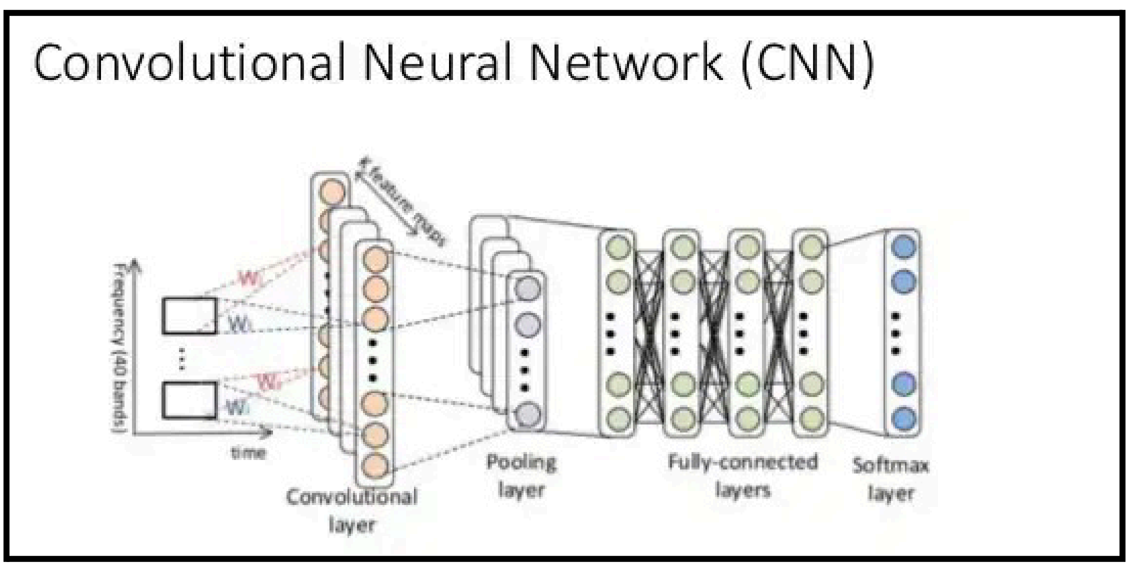



**Fig 7.1 Convolution Neural Network**

- The classification of healthy and diabetic based on SVM will now be integrated into a cloud to perform cloud based analysis wherein when an EPI image is uploaded, the result of either being a healthy individual or a diabetic can be obtained.
- Using HTML and CSS we intend to create a website with respect to cloud analysis.

# CHAPTER 8
# CONCLUSION

## 8.1 CONCLUSION

Our project was focused on automated identification for a large-scale prevention and treatment by diagnosing the early stages of the symptoms based on the empirical data obtained. We were able to develop an algorithm wherein a subject's data is obtained with the help of GDV Camera. The output of the camera is an Electrophotonic image which is later processed with the tools like gray level thresholding and cropping. Different and relevant parameters are obtained and these parameters are used to classify the images captured from individuals into diabetic or healthy. Being a non-invasive method and totally automated, we were able to obtain the results much faster than any other traditional methods that exist in medical sciences. Also, from this technique, we obtained an accuracy of 88%.

# CHAPTER 9
# REFERENCES

## 9.1 REFERENCES

[1] Shiva Kumar Kotikalapudi, T.M Srinivasan, H.R Nagendra, P Marimuthu , Electrophotonic Imaging based Analysis of Diabetes, December 9 2016

[2] Beverly Rubik, Audrey J Brooks, Digital High voltage electrophotographic measures of the fingertips of subjects pre and post Qigong, December 2005

[3] Kotikalapudi Shiva Kumar, T M Srinivasan, Judu Ilavarasu, Biplob Mondal, H R Nagendra, Classification of Electrophotonic Images of Yogic Practice of Mudra through Neural Networks, August 2018

[4] Janifal Alipal, Razak Mohd Ali Lee, Ali Farzamnia, Preliminary Study of Kirlian Image in Digital Electrophotonic Imaging and its Applications, May 2016

[5] Korotkov Konstantin, Recent Advances in Electrophotonic Image Processing, May 2016

[6] Dr. Konstantin Korotkov, Energy fields Electrophotonic analysis in humans and nature

[7] Dr. Konstantin Korotkov, Human Energy Field: Study with GDV bioelectrography

[8] Dr. Ekaterina Yakovleva, Dr. Konstantin Korotkov, Electrophotonic Analysis in Medicine

[9] https://en.wikipedia.org/wiki/Kirlian_photography

[10] https://www.bioriposo.net/la-tecnologia-gdv/?lang=en