Paper ID: 79

Noninvasive Blood Glucose Measurement Using Live Video By Smartphone

Authors:
Jannatun Sumaiya
Md. Rakibul Hasan
Eklas Hossain

Presented By:
Md. Rakibul Hasan

IEEE Region 10 Humanitarian Technology Conference (R10 HTC) 2020

Presentation Outlines

- Introduction
- Techniques Used for Measurement
- Objectives
- Data Collection
- Data Preprocessing
- Models
- Results
- Conclusion

Introduction

❖ **Glucose**

➢ A simple sugar getting from foods we eat.

➢ An important energy source in living organisms and a component of many carbohydrates.

➢ In our body, insulin is needed to maintain glucose level, but those who cannot produce insulin suffers from Diabetes mellitus

➢ **Diabetes**

- **Type 1:** Juvenile that is found in teenagers.
- **Type 2:** Mature that is most common form of diabetes.

➢ **Hypoglycemia** (low blood sugar): < 70 mg/dL

➢ **Hyperglycemia** (high blood sugar): > 140 mg/dL

Techniques Used for Measurement

- **Three Techniques used so far:**
  - (1) Invasive
  - (2) Minimally Invasive
  - (3) Non Invasive

- **Non-Invasive techniques can be further classified into:**
  - (1) Optical Analysis.
  - (2) Non-Optical Analysis

Objectives

- To find the best method for Non-Invasive Glucose Determination.
- Gathering large amount of dataset.
- Determination and prediction with more accuracy than others.
- Make it less expensive.

Data Collection
Step1: Clean and Check the Finger

Clean and dry the hand

No nail polish is allowed on the video recording finger nail

No infection in the video recording site

Step 2: Put Finger on the LED-Board (LB- 0850nm)

Finger is put touches the LED when LEDs OFF

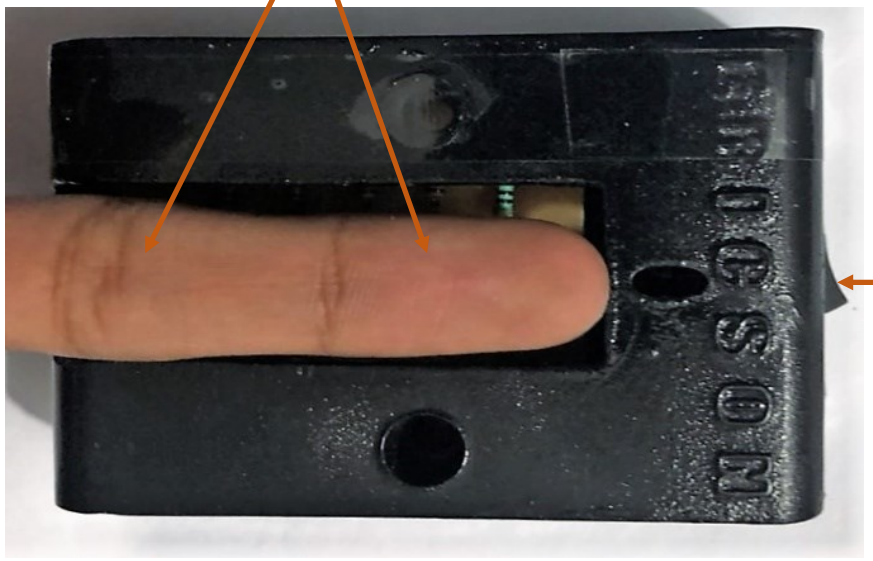
2(A)

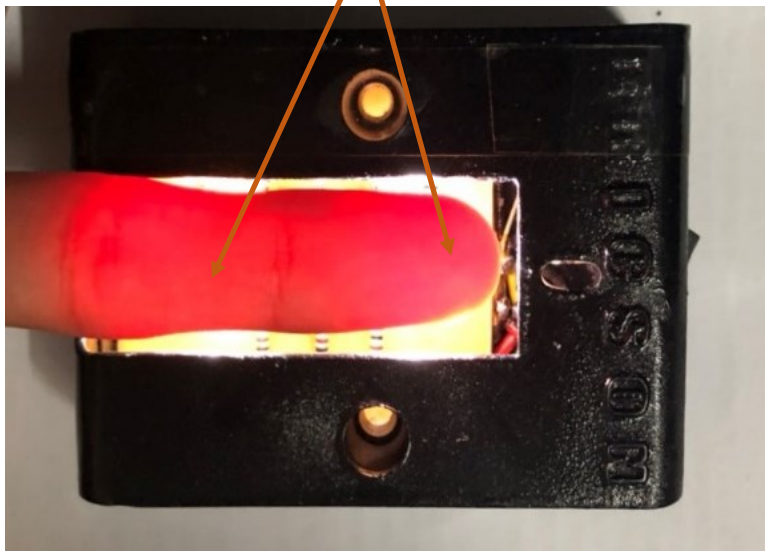
Turn ON the LED Board Lights.

2(B)

Capture a 10-second video using a Smartphone

2(C)





Step 3: Put Finger on the LED-Board (LB-1070nm)

Finger is put touches the LED when LEDs OFF

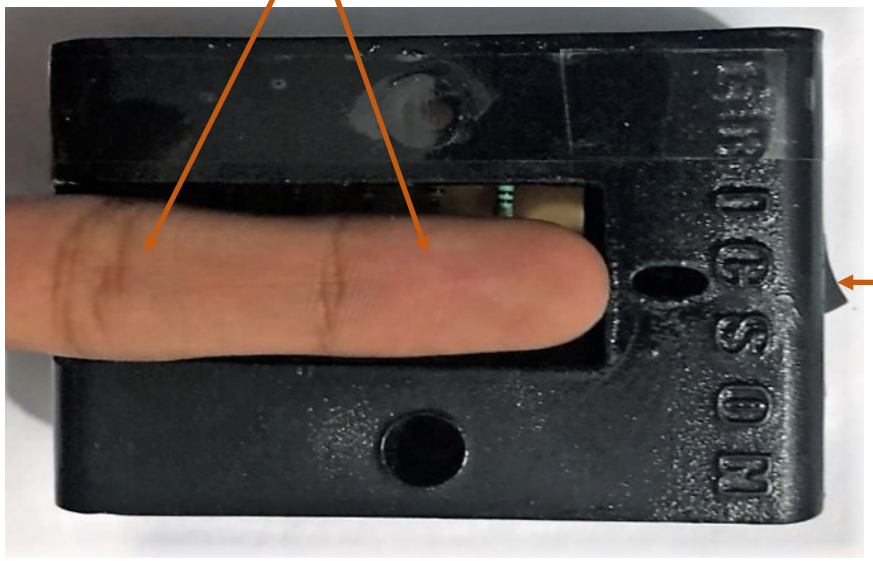
3(A)

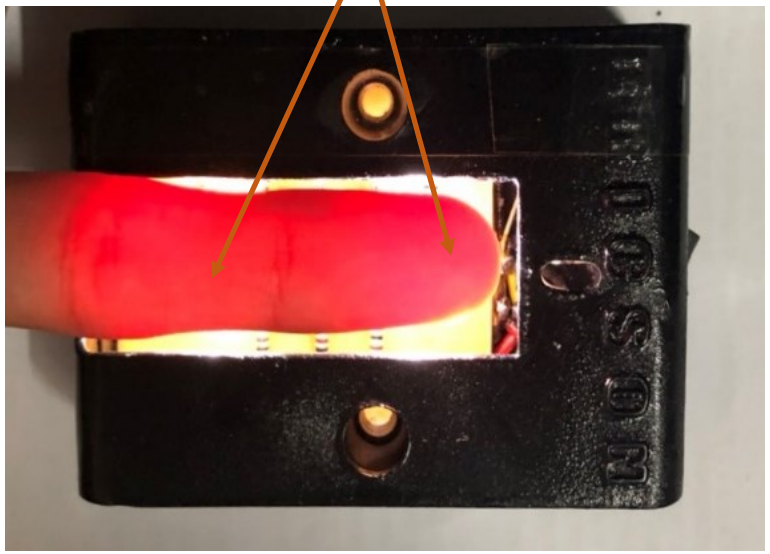
Turn ON the LED Board Lights.

3(B)

Capture a 10-second video using a Smartphone

3(C)





Step 4:Collect Age, Gender, Hb, Glucose, and HbA1c

+

- Gender
- Age
- Gold Standard Hemoglobin Level
- Gold Standard Glucose Level
- Gold Standard HbA1C Level

Step 5: Save Video File Recorded on LB-850 and Others Board as Follows

Sub=ID_Sex=M_Age=aa_Hb=dddd_HbA1c=aaaa_GL=ggg_LB0850nm_xxxxxx.mp4

Sub=ID_Sex=M_Age=aa_Hb=dddd_HbA1c=aaaa_GL=ggg_NB_xxxxxx.mp4

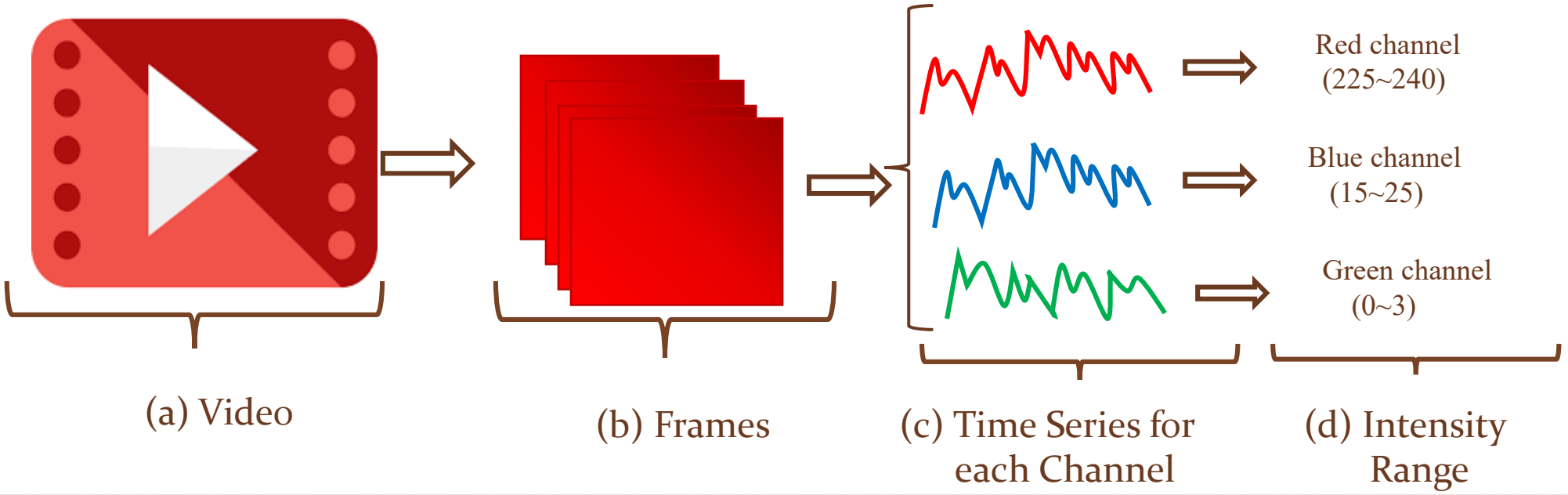
Example:

Sub=1001_Sex=F_Age=15_Hb=9.9_HbA1c=4.6_GL=4.7_LB850_134218.mp4

Sub=1001_Sex=F_Age=15_Hb=9.9_HbA1c=4.6_GL=4.7_NB_134220.mp4

Data Preprocessing

Video Processing



Features Extraction

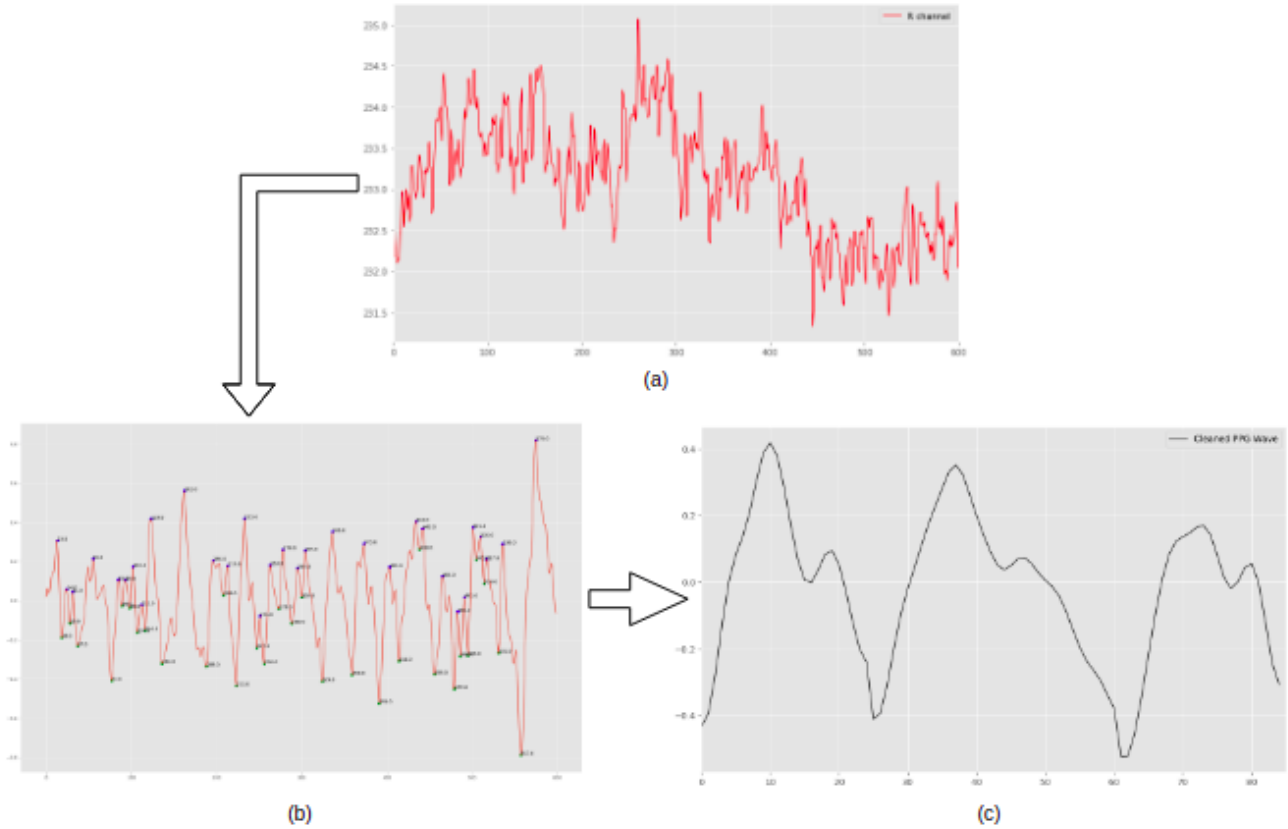


Fig : (a) Time series of the red channel (b) PPG waves (c) Selected best three PPG waves

Features Extraction(Cont.)

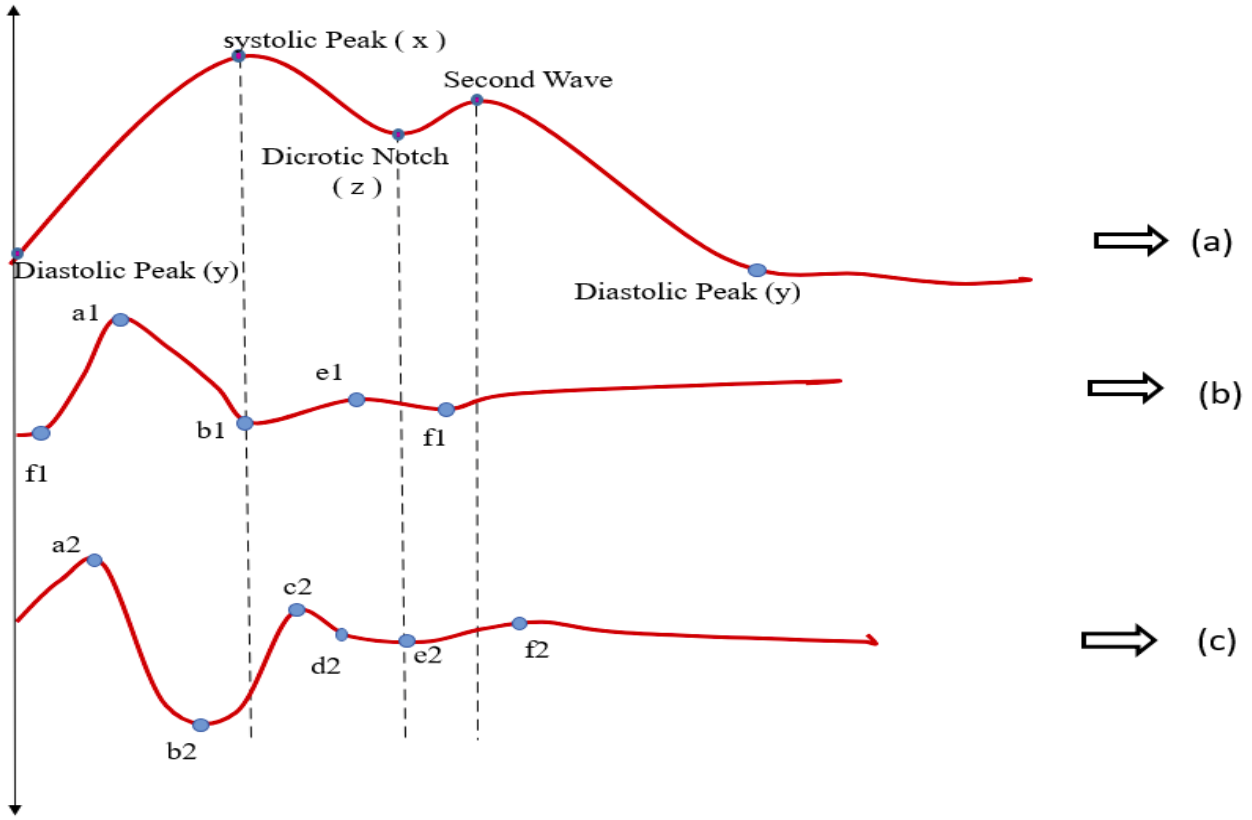


Fig : (a) Original PPG wave (b) 1st order der. PPG (c) 2nd order der. PPG

Models

❖ Support Vector Regression(SVR)

- **Dataset are considered in high dimensional feature space.**
- **Finds out the maximum margin in case using SVs which can be called critical points of the dataset.**

❖ Linear Regression(LR)

- The theorem behind every linear model is following

$y(w, x) = w_0 + w_1 x_1 + \ldots + w_n x_n$

Models(Cont.)

❖ Random Forest Regression

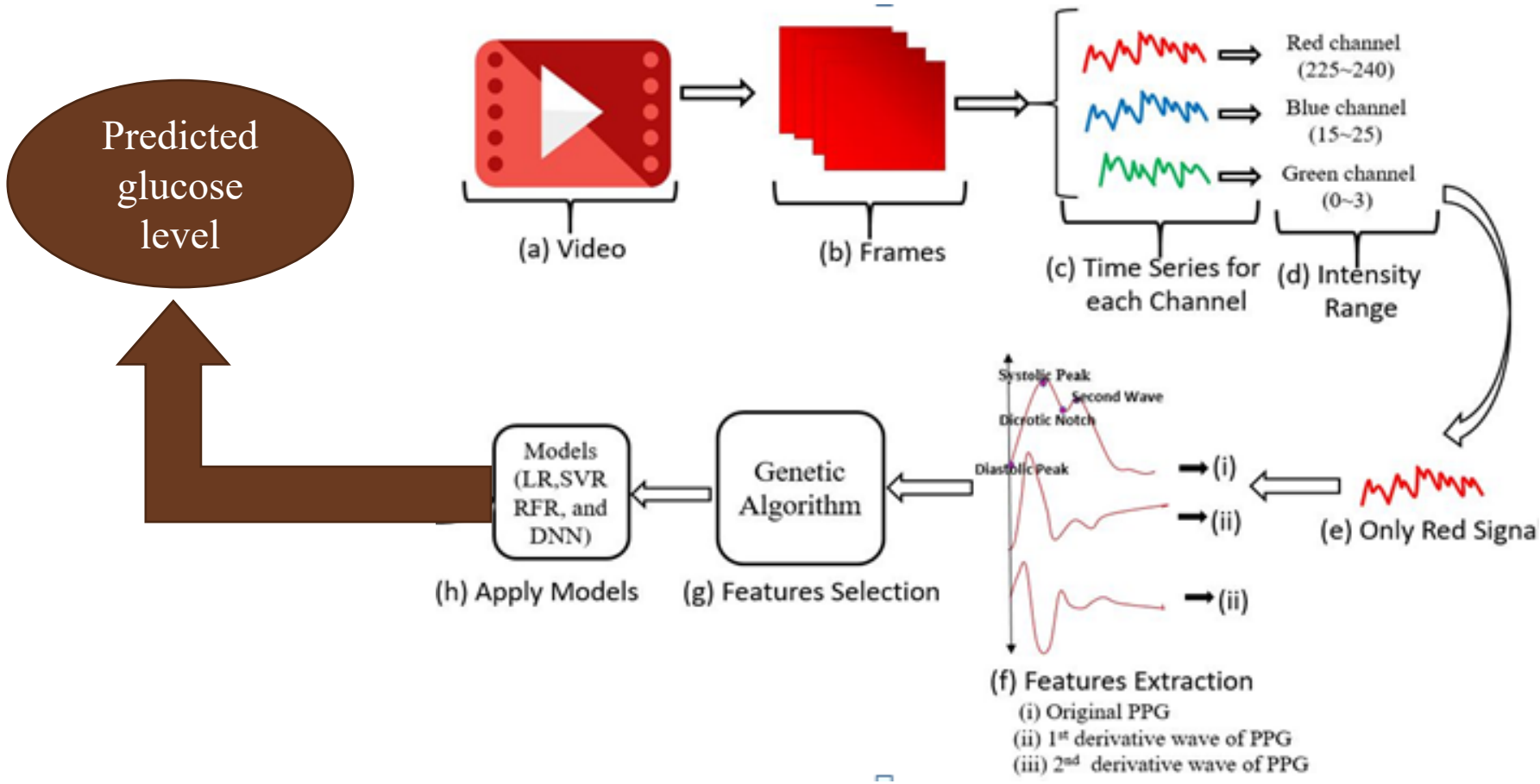
1. Pick a random K data point from the training set.
2. Build the decision tree associated to these K data points.
3. Choose the number of N-tree(100) for trees that are formed and repeat steps 1 and 2.
4. For a new data point, form the N-tree that predict the category to which the data points belongs and assign the new data point to the category that wins the majority vote.

Models(Cont.)

❖ Deep Neural Network(DNN)

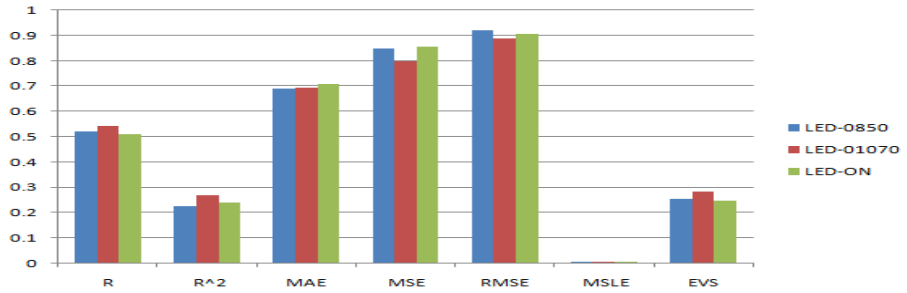
1. Deep learning (also known as deep structured learning or hierarchical learning) is part of a broader family of machine semi-supervi learning methods.
2. Learning can be supervised or unsupervised.
3. The two major techniques of supervised learning are classification and regression.
4. Regression models have a dense layer at the end, but with a single output and no nonlinear activation.
5. Thus the dense layer just returns the sum of the activations from the previous layer.
6. In addition, the loss function used is typically mean absolute error(MAE).

System Overview



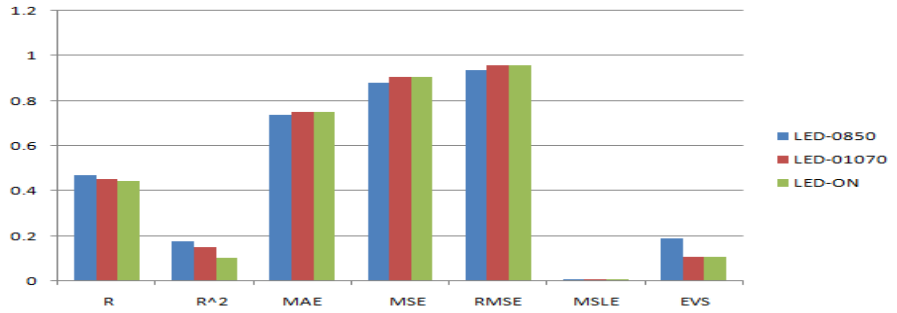
Results Analysis

(A)Linear Regression



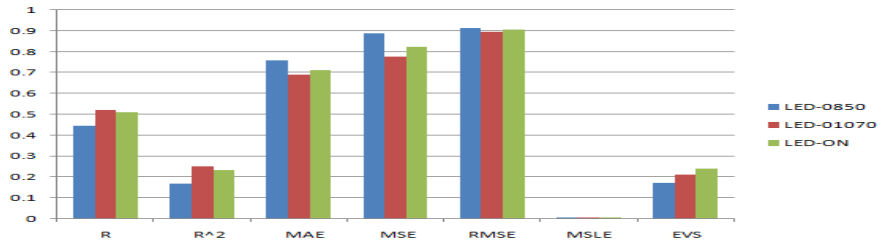
	R	R^2	MAE	MSE	RMSE	MSLE	EVS
LED-0850	0.523	0.227	0.69	0.85	0.92	0.007	0.254
LED-01070	0.543	0.27	0.694	0.797	0.887	0.007	0.283
LED-ON	0.509	0.242	0.708	0.855	0.906	0.008	0.249

(B)Support Vector Regression



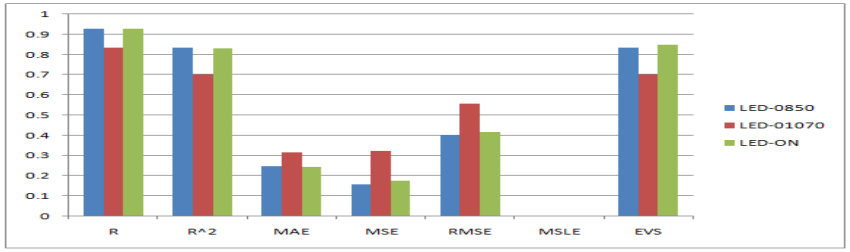
	R	R^2	MAE	MSE	RMSE	MSLE	EVS
LED-0850	0.469	0.178	0.737	0.879	0.937	0.008	0.189
LED-01070	0.452	0.153	0.749	0.905	0.959	0.008	0.157
LED-ON	0.443	0.105	0.755	0.952	0.985	0.008	0.109

(C)Random Forest Regression



	R	R^2	MAE	MSE	RMSE	MSLE	EVS
LED-0850	0.445	0.169	0.759	0.887	0.915	0.007	0.171
LED-01070	0.521	0.251	0.692	0.778	0.895	0.006	0.213
LED-ON	0.512	0.235	0.711	0.823	0.905	0.006	0.24

(D)Deep Neural Network



	R	R^2	MAE	MSE	RMSE	MSLE	EVS
LED-0850	0.927	0.835	0.248	0.156	0.401	0.002	0.835
LED-01070	0.835	0.703	0.315	0.325	0.557	0.003	0.702
LED-ON	0.929	0.832	0.243	0.175	0.415	0.002	0.848

Conclusion

- We get data more simplistically and efficient way.
- How we can pre-process these data, and lastly, how to build up a model.
- The primary goal was to build a mobile application as it would help the user to collect their data.
- We are giving a proposal that we should compare and evaluate all the machine learning approaches (e.g. Linear Regression(LR), Support Vector Regression(SVR), Random Forest Regression(RFR), and Deep Neural Network(DNN) described in theoretical and practical consideration.

THANK YOU ☺