Grenze International Journal of Engineering and Technology, Jul 2019

Assessment and Prediction of Quality of Service of Wireless Networks using Support Vector Machines

Siddharth Goutam[1], Srija Unnikrishnan[2], Sundary Prabavathy[3], Neel Kudu[4] and Aradhana Goutam[5]
[1]Research Scholar, Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai, Maharashtra, India – 400050
siddharthagoutam@gmail.com
[2]Principal, Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai, Maharashtra, India – 400050
[3]Associate Professor and Head of Department of Science & Humanities, Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai, Maharashtra, India – 400050
[4]B.E(Computer Engineering), Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai, Maharashtra, India – 400050
[5]Associate Professor, IES Management College and Research Centre, Bandra (West), Mumbai, Maharashtra, India – 400050

***Abstract*—In this paper, we have assessed and predicted the Quality of Service of wireless networks using Support vector machines. The Quality of Service offered by the wireless networks is an important criterion while making a decision for vertical handover. The Quality of Service of the wireless network has been predicted by using Latency, Jitter and Packet Loss. We have performed the statistical analysis of the accuracy and mean square error obtained during k fold validations.**

***Index Terms*— Quality of Service (QoS), Latency, Jitter, Packet Loss, Support Vector Machines (SVMs).**

I. INTRODUCTION

The mobile users require highest level of Quality of Service (QoS) while moving across next generation wireless networks.

The demand of the users is to have the highest QoS while using audio, video or multimedia applications. This can be achieved by using Efficient Vertical Handover Decision Algorithm (VHDA). [1]

$QoS = f(Latency, Jitter, Packet\ Loss)$ [2] [3]

The VHDA should ensure that the QoS of the user is not degrading and it is maintained while switching from one network to another. [4]

In this paper, we have assessed and predicted the QoS of the wireless networks using Support Vector Machines (SVMs).

The organization of the research paper is as follows: Theoretical Background is captured in Section II. Section III gives the design and implementation. Section IV gives the simulation results and Statistical Analysis is captured in Section V. Conclusion is given in Section VI.

Grenze ID: 01.GIJET.5.2.512

II. Theorectical Background

Quality of Service of wireless network is dependent on network parameters like Latency, Jitter and Packet Loss.

$QoS \propto \frac{1}{Latency}$ (1)

$QoS \propto \frac{1}{Jitter}$ (2)

$QoS \propto \frac{1}{Packet\ Loss}$ (3)

Reduction in Latency, Jitter and Packet Loss will result in improvement of QoS. [2]
Support Vector Machines (SVMs) is a type of classification technique which can be utilized for linear and non-linear datasets. SVM uses the concept of the hyper-plane while performing the classification.
The following equation describes a hyper-plane.

$W.X + b = 0$ (4)

W denotes weight vector
X denotes real vector

$W = \{w_1, w_2, \dots\dots\dots, w_n\}$

$X = \{x_1, x_2, \dots\dots\dots.., x_n\}$

n – number of attributes
b – a scalar
If b = w_0 and for $x = \{x_1, x_2, x_3\}$ equation 4 can be written as

$w_0 + w_1x_1 + w_2x_2 + w_3x_3 = 0$ (5)

If a point is above the hyper-plane then

$w_0 + w_1x_1 + w_2x_2 + w_3x_3 > 0$ (6)

And if a point is below the hyper-plane then

$w_0 + w_1x_1 + w_2x_2 + w_3x_3 < 0$ (7) [5] [6] [7]

III. Design and Implementation

Fig 1 shows the Fuzzy Inference System.

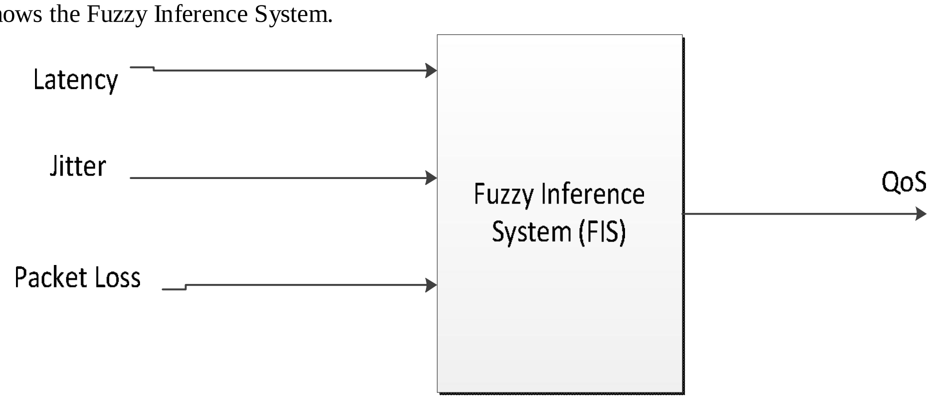

Figure 1 Fuzzy Inference System

The assessment of QoS has been done with the dataset $\{x_1, x_2, x_3\} = \{Latency, Jitter, Packet\ Loss\}$. SVM algorithm calculates the output vectors $\{Good, Moderate, Poor\}$ from which QoS of the network can be ascertained.
Fig 2 captures the flow chart for SVM algorithm.

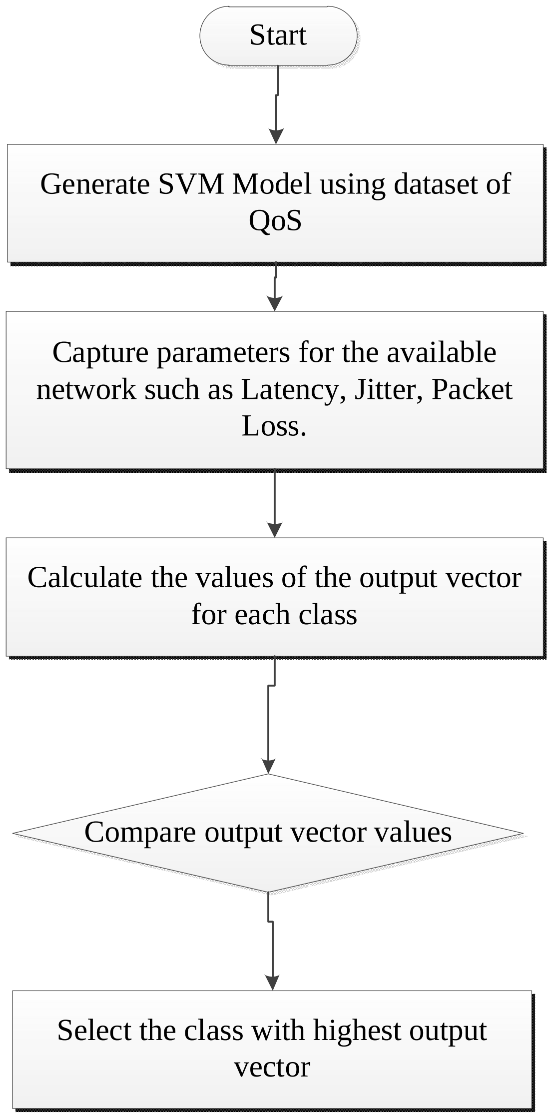

Figure 2 Flowchart for SVM Algorithm

IV. SIMULATION RESULTS

WEKA (Waikato Environment for Knowledge Analysis) workbench has been used for simulation. Universe of Discourse based on practical values is given in Table I.

TABLE I. UNIVERSE OF DISCOURSE

S. No	Network Parameters	Measured in	Varies From	Varies To
1	Latency	msecs	0	6
2	Jitter	msecs	0	6
3	Packet Loss	Percentage	0	6

Figure 3 captures the example for QoS.

```
========= Support Vector Machine Quality of Service Prediction Model =========
Please Enter the required values of the Network to be checked
All '*' marked fields are mandatory

Enter the Latency value (in ms) of network to be checked*: 4

Enter the Packet Loss value (in %) of network to be checked*: 0

Enter the Jitter value (in ms) of network to be checked*: 1


For given input parameters
Output Vector value for Poor =  0.002
Output Vector value for Moderate =  0.9785
Output Vector value for Good =  0.0194


The Quality of Service is Moderate! Network parameters should be improved slightly
```

Figure 3 Example for QoS

V. Statistical Analysis

We have performed the statistical analysis basis the following parameters –

i. Correctly classified instances
ii. Incorrectly classified instances
iii. Mean Square Error
iv. Root Mean Square Error

The dataset has been categorized into k mutually exclusive subsets (folds). We have taken k = 3, 4 and 5.
Table II provides the details of the correctly classified instances and incorrectly classified instances for k fold validation.

TABLE I Details of Instances

k Fold Validation	Correctly Classified Instances	Incorrectly Classified Instances	Total Instances
k = 3	340	3	343
k = 4	341	2	343
k = 5	342	1	343

Figure 4 & 5 provide the correctly and incorrectly classified instances with respect to k fold validation respectively.
Observations from Table II –

i. We have observed that number of the correctly classified instances increase with increase in the number of validations. Hence correctly classified instances are directly proportional to number of validations.
ii. The numbers of incorrectly classified instances decrease with the increase in the number of validations. Hence incorrectly classified instances are inversely proportional to the number of validations.

Figure 6 captures the mean absolute error with respect to k fold validation.
We have observed that mean absolute error reduces with the increase in the number of validations.
Figure 7 provides the variation of root mean square error with respect to k fold validation.

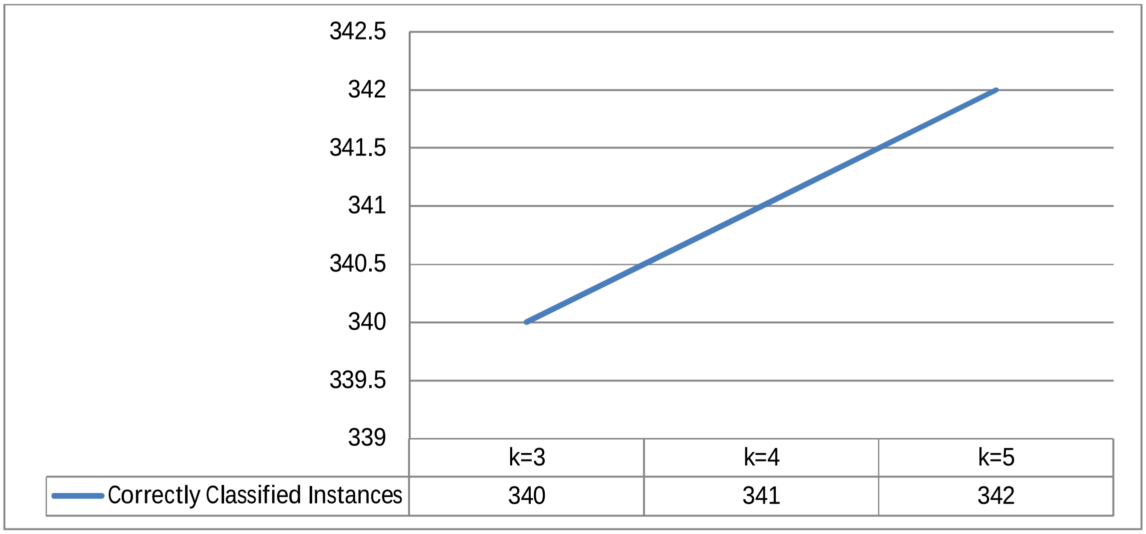

Figure 4 Correctly Classified Instances

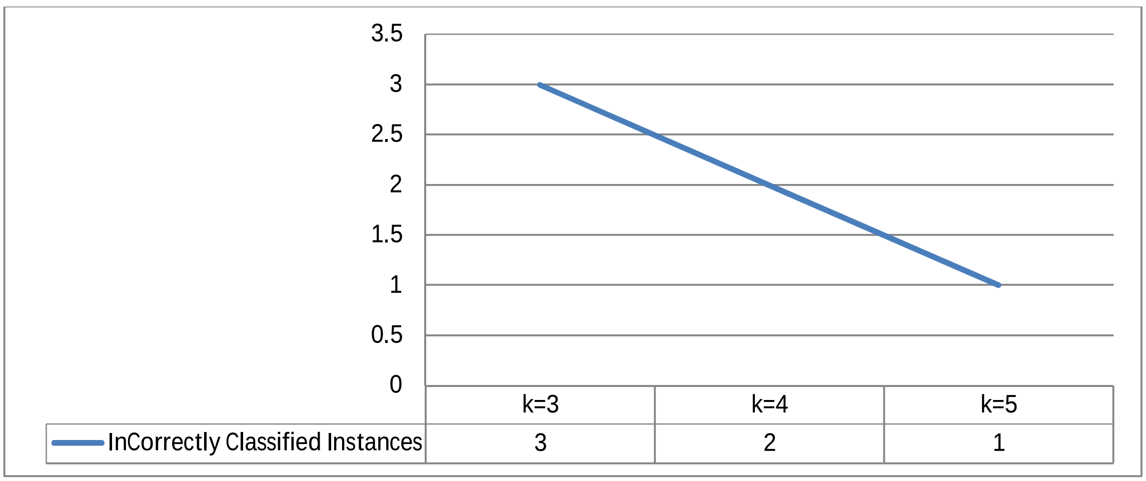

Figure 5 Incorrectly Classified Instances

We conclude that the root mean square error reduces with the increase in the number of validations. Hence we conclude that mean square error and root mean square error are inversely proportional to the number of validations.

Figure 8 and 9 provides the variation of relative absolute error and root relative absolute error with respect to k fold validation.

We conclude that the relative absolute error reduces with the increase in the number of validations

TP rate is defined as the ratio of the number of positives which are correctly classified and the total number of positives.

Figure 10 provides the details of the TP rates vs k folds cross-validations.

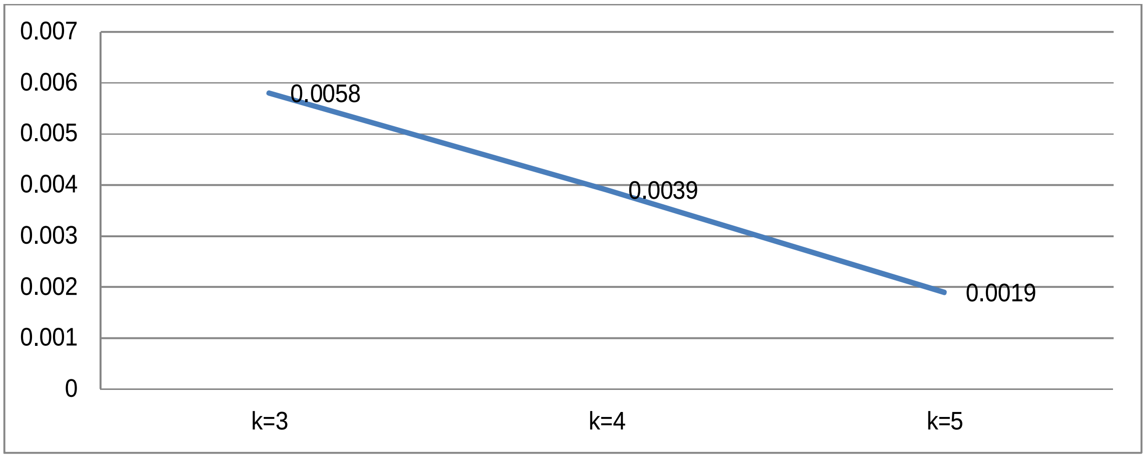

Figure 6 Mean Absolute Error

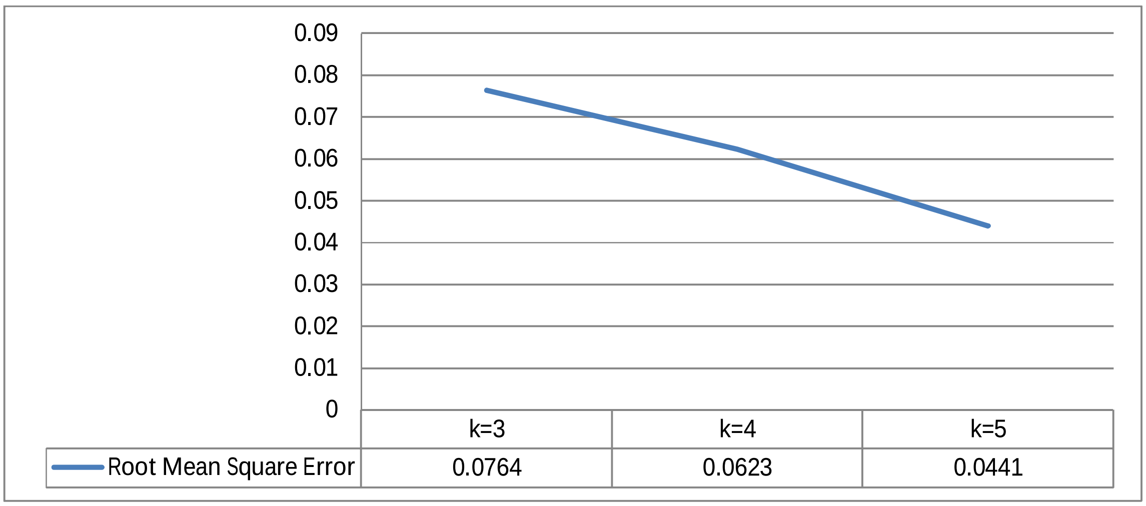

Figure 7 Root Mean Square Error

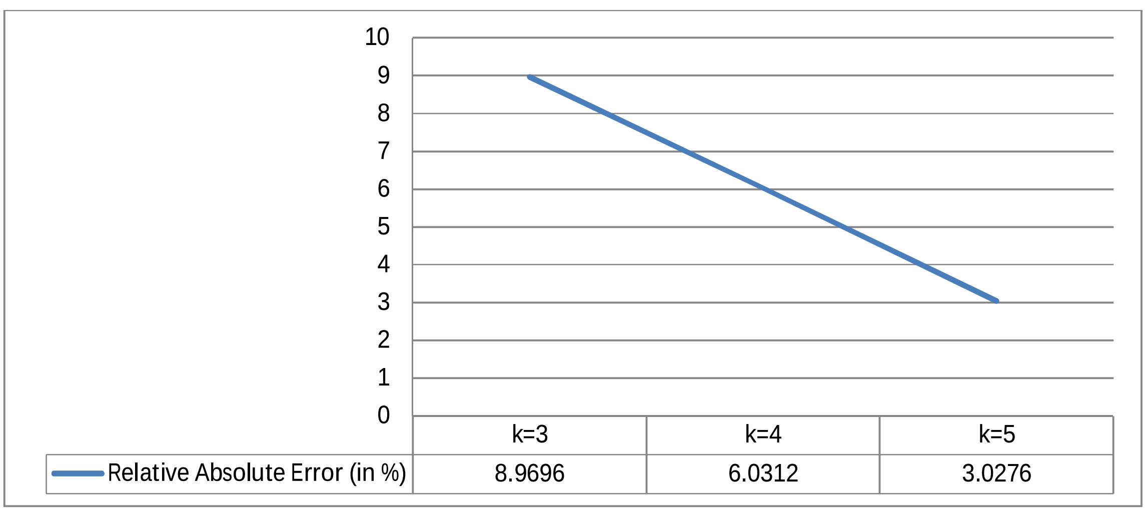

Figure 8 Relative Absolute Error

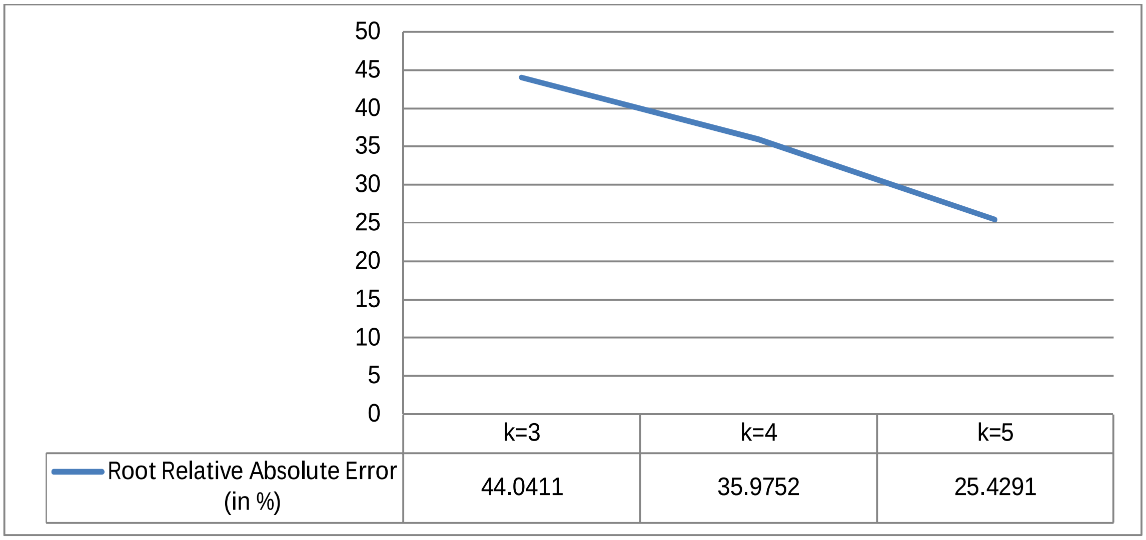

Figure 9 Root Relative Absolute Error (in %)

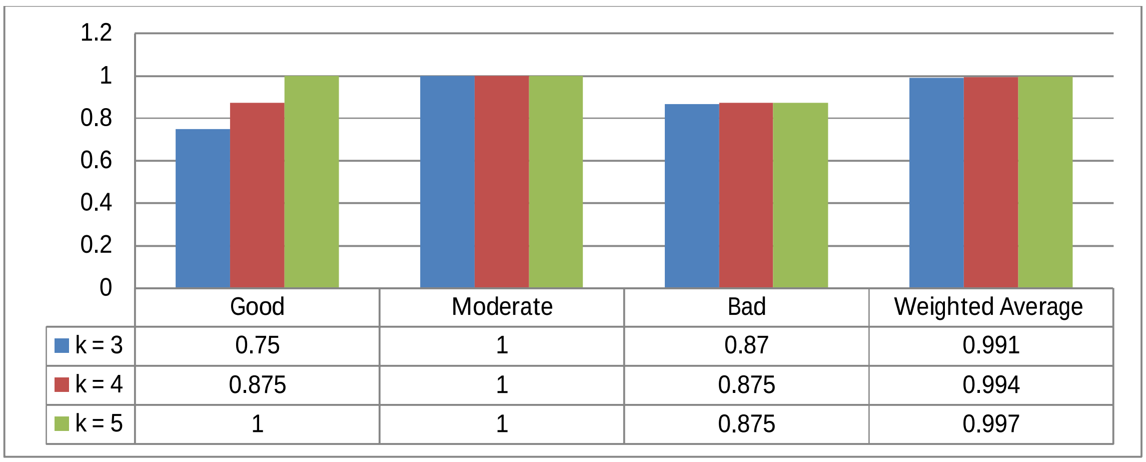

Figure 10 TP Rate for k folds cross validation

VI. Conclusion

In this paper, we have predicted the QoS of wireless networks using support vector machines. The model used for implementation considers practical and real life conditions. We conclude by using statistical analysis that the accuracy of the algorithm increases with the number of folds of validation. The algorithm can further be refined by capturing more network performance parameters.

References

[1] Kantubukta Vasu, Sumit Maheshwari, Sudipta Mahapatra, and Cheruvu Siva Kumar, "QoS-aware fuzzy rule - based vertical handoff decision algorithm incorporating a new evaluation model for wireless heterogeneous networks," EURASIP Journal on Wireless Communications and Networking, vol. 1, no. 322, pp. 1-22, 2012.

[2] Siddharth Goutam and Srija Unnikrishnan, "QoS based Vertical Handover Decision Algorithm using Fuzzy Logic," in IEEExplore, Mumbai, 2019.

[3] Siddharth Goutam and Srija Unnikrishnan, "Analysis & Comparison of Decision Tree Algorithms for Vertical Handover in Wireless Networks," in Eighth International Conference on Advances in Electrical Measurements and Instrumentation Engineering - EMIE 2019, Cochin, 2019.

[4] Johann Marquez Barja and Carlos T. Calafate, "Evaluation of a technology-aware vertical handover algorithm based on the IEEE 802.21 standard," in 2011 IEEE Wireless Communications and Networking Conference, Cancun, Quintana Roo, Mexico, 2011.
[5] Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining Concepts and Techniques, 3rd ed. MA, USA: Elsevier Morgan Kaufmann Publishers, 2011.
[6] Yashmin Ahuja and Sumit Kumar Yadav, "Multiclass Classification and Support Vector machine," Global Journal of Computer Science and Technology Interdisciplinary, vol. XII, no. XI, pp. 15-20, 2012.
[7] Durgesh K. Srivastava and Lekha Bhambhu, "Data Classification Using Support Vector machine," Journal of Theoretical and Applied Information Technology (JATIT), pp. 1-7, 2005-2009.