# SYSTEMATIC SURVEY ON CREDIT CARD FRAUD TRANSACTION DETECTION TECHNIQUES

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## ABSTRACT

MasterCard (CC) plays a critical norm in the current riches. It transforms into a vital piece of the nuclear family, business, and overall activities. While utilizing CCs can offer tremendous benefits whenever utilized circumspectly and securely, huge credit and monetary harm can be brought about by fake action. False Visa exchanges cost firms and purchasers enormous monetary misfortunes consistently, and fraudsters persistently endeavor to track down new innovations and strategies for committing deceitful exchanges. The discovery of false exchanges has turned into a huge component influencing the more prominent use of electronic installment. Consequently, there is a requirement for proficient and compelling methodologies for distinguishing misrepresentation in charge card exchanges. This paper presents Writing review on Visa Extortion Recognition strategies. The principal point is to get Visa exchanges; so individuals can utilize e-banking securely and without any problem. The qualities, whether positive or negative, are referenced for misrepresentation identification strategies. It likewise specifies the as of now utilized cutting edge procedures to counter these assaults and features its limits.

**Keywords:** *Credit Card, Fraudulent Transactions, E-Banking.*

## 1. INTRODUCTION

These days' utilization of Visas in non-industrial nations has turned into a coming. Clients use it for buying, deal with tabs, and for online trades. It gives specific focal points like the effortlessness of acquirement, keeps client records of credit reimbursement, the security of purchases, etc. [1]. In any case, the gigantic degree uses of Visas and the shortfall of suitable security structures achieve billion-dollar mishaps to MasterCard coercion.

Since MasterCard associations are generally hesitant to pronounce such real factors, it is difficult to get an accurate assessment of the hardships [2]. In any case, certain data concerning the money related mishaps achieved with Visa distortion is straightforwardly accessible. MasterCard exchanges act as the base information for the course of extortion recognition. A few indispensable properties of the exchange information influence the recognition interaction generally. The significant properties of charge card exchange information that influences the expectation interaction are information giganticness and information lopsidedness

With the most recent innovation and overall correspondences, misrepresentation has expanded fundamentally. 'Misrepresentation' in Visa exchanges is unapproved and is the undesirable use of a record by somebody other than the proprietor of that record. Visa Extortion can be characterized as a situation where an individual purposes another person's Mastercard for individual reasons while the proprietor and the card giving specialists know nothing about the way that the card is being utilized. Mastercard misrepresentation includes taking the fundamental qualifications from the cardholder and utilizing it unapproved way by the fraudsters either by utilizing calls or SMS [3]. This extortion in Visa may likewise happen utilizing some product applications that are heavily influenced by fraudsters. The subtleties of charge card ought to be kept hidden. Various ways of taking Visa subtleties are phishing sites, take/lost Mastercards, fake Visas, burglary of card subtleties, captured cards and so forth. Vital avoidance measures can be taken to stop this maltreatment and the way of behaving of such deceitful practices can be examined to limit it and safeguard against comparative events later on

The issues of deceitful action have consequently increased the requirement for charge card extortion distinguishing proof frameworks. Deceitful data is hard to acquire since it is intriguing. Recognition of extortion includes checking and breaking down the way of behaving of various clients to gauge location undesirable way of behaving. To really identify Visa misrepresentation, we need to know the different advancements, calculations and types engaged with distinguishing charge card extortion [4].

Mastercard extortion discovery depends on the investigation of recorded exchanges. Exchange information are predominantly made out of various properties (for example charge card identifier, exchange date, beneficiary, measure of the exchange). Programmed frameworks are fundamental since it isn't generally imaginable or simple for a human expert to recognize deceitful examples in exchange datasets, frequently portrayed by countless examples, many aspects and online updates. Likewise, the cardholder isn't dependable in revealing the burglary, misfortune or deceitful utilization of a card.

There are two different ways of Mastercard exchange: actually and basically for example CNP (Card not Present). In physical, card is requiring truly to make a swipe. While in the virtual card, a few subtleties are there to swipe a card like CVV number, card holder name, secret phrase, security question and so on for net banking. In Card not Present (CNP) misrepresentation, fraudster endeavor to delude the framework by masking to be some other individual [5]. Mail and the web are significant courses for extortion against dealers who sell and boat product, and influences authentic mail request and web vendors. In Skimming, they are getting individual information in regards to another person's charge card used in a generally typical exchange. There is a small gadget (skimmer) which is utilized to swipe and store tremendous measure of casualty's data. In phishing, Con artists could utilize a scope of plans to bait clients into giving them their card data through stunts comparing to sites recreation to be of a bank or installment framework. At the point when card is take or lost, there are opportunities for a hoodlum that he makes unapproved exchange before cardholder block the card.

Extortion Location Frameworks (FDS) are computerized AI based arrangements that Mastercard organizations utilize to recognize the fake exchanges even before end clients input. Objective of such a framework is to identify the deceitful exchange before it is focused on the data set and in this way keep the extortion from occurring. An ideal FDS ought to likewise limit the bogus discoveries where a certified exchange is interfered with making bother the end-client.

AI can be characterized as a field in computerized reasoning that gives the framework the capacity to gain from the experience consequently without the human mediation and plans to foresee the future results as precise as conceivable using different algorithmic models [6]. AI is totally different than the regular calculation draws near, where frameworks are unequivocally customized to work out or tackle an issue. AI manages the information that are utilized to prepare a model where the model learns various examples in the information and utilizations that information to foresee obscure outcomes. Normally, AI has three classes: administered, solo and support learning.

Regulated learning can be characterized as an AI approach in which both info and result names are given to the model to prepare. The managed model purposes the information and result named information for preparing, and it removes the examples from the information. The most normally utilized administered learning calculations are: Choice tree, Strategic relapse, Backing vector machine. In Unaided Learning, the machine utilizes unlabeled information and learns on itself with no oversight. The machine attempts to track down an example in the unlabeled information and gives a reaction. The most generally utilized solo learning calculations are: K-implies grouping, Progressive bunching, Apriori calculation. Numerous calculations in view of the two methodologies have been proposed in writing.

## 2. LITERATURE SURVEY

Asha RB, Suresh Kumar KR, et. al. [7] presents, Visa misrepresentation discovery utilizing fake brain organization. Internet business and numerous other web-based destinations have expanded the internet based installment modes, expanding the gamble for online cheats. A significant number of the cycle like information mining, AI algorithmic methodologies are applied to distinguish the extortion in the Mastercard exchanges however didn't obtain impressive outcome. Thus, there is a need of viable and proficient calculations to fundamentally be fostered that works. we attempt to stay away from the fraudster utilizing our charge card before the exchange gets endorsed by utilizing fake brain network calculation and contrasted and scarcely any other AI calculations. This paper points in utilizing the numerous calculations of AI, for example, support vector machine (SVM), k-closest neighbor (KNN) and fake brain organization (ANN) in anticipating the event of the misrepresentation. Dataset utilized is the exchanges made by client in an European bank in the year 2013-14. The dataset utilized in the trial comprise of 31 characteristics out of which 30 credits comprise of data connected with name, age, account data, etc and last property give the result of the exchange in one or the other 0 or 1. The plan of proposed framework is displayed in Fig. 1. The design portrays that first, client necessities to enroll and afterward login into the framework by entering the certifications like client name, secret phrase, and email-id and telephone number. Than it shows the calculation choice windows where client need to choose the calculation. Subsequent to choosing the calculation, information pre-handling happens, which includes information purging, and standardization of dataset before took care of into the real model then parting of information. Presently the model is prepared utilizing AI calculation lastly, tried and anticipated the final products regardless of whether exchange is misrepresentation.

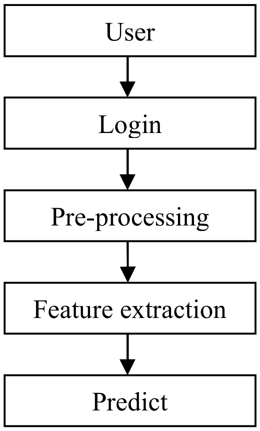

*Fig. 1: Complete Architecture Of Proposed System*

*Table 1: Comparative Performance*

| Algorithms | Accuracy | Precision | Recall |
|---|---|---|---|
| SVM | 93.4 | 97.43 | 89.76 |
| KNN | 99.82 | 71.42 | 39.3 |
| ANN | 99.92 | 81.15 | 76.19 |

The Table 1 shows the consequences of the pre-owned calculations on the exhibition measurements like exactness, accuracy and review. The final product is assessed in view of the disarray grid and accuracy, review and exactness is determined. It contains two classes: real class and anticipated class. The disarray measurements rely upon these elements:

True Positive (TP): in which both the values positive that is 1.

True Negative (TN): it is case where both values are negative that is 0.

False Positive (FP): this is the case where true class is 0 and non-true class is 1.

False Negative (FN): It is the case when actual class is 1 and non-true class is 0.

$$Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)} \ldots.(1)$$

$$Precision = \frac{TP}{(TP + FP)} \ldots.(2)$$

$$Recall = \frac{TP}{(TP + FN)} \ldots.(3)$$

The precision execution shows that Visa extortion discovery utilizing fake brain organizations (99.92%) predicts at higher exactness then Help vector machine (93.4%) and k-closest neighbor (99.82%) calculations for misrepresentation location in Mastercard exchanges.

Aya Abd el Naby, Ezz El-Commotion Hemdan, Ayman El-Sayed, et. al. [8] depicts Profound Learning Approach for Charge Card Misrepresentation Identification. The course of Mastercard misrepresentation recognition starts with stacking the charge card dataset in the proposed model. We present a model for anticipating real exchanges or extortion on Kaggle's Visa dataset. The datasets incorporate exchanges that occurred north of two days and were credited by European cardholders with Mastercard in September 2013. Then, at that point, use preprocessing of oversampling Destroyed technique for imbalancing Visa information. The dataset was separated into 80% for preparing and 20% for approval. Apply profound learning calculation (CNN). The proposed model is OSCNN (Over Testing with Convolution Brain Organization) which depends on oversampling preprocessing and CNN (convolution brain organization). The OSCNN model beginnings with oversampling the minority class with a proportion of 0.25 that the minority class to the greater part class proportion becomes 75:25. This proportion was decided to defeat the overfitting brought about by the Destroyed. The last layer of our model is the completely associated layer finishing with a thick capability for our paired discovery task with a solitary result hub. We applied the calculation by changing the ages number until getting the ideal exactness. Figure 1 shows the proposed model for anticipating false and ordinary Visa buys.

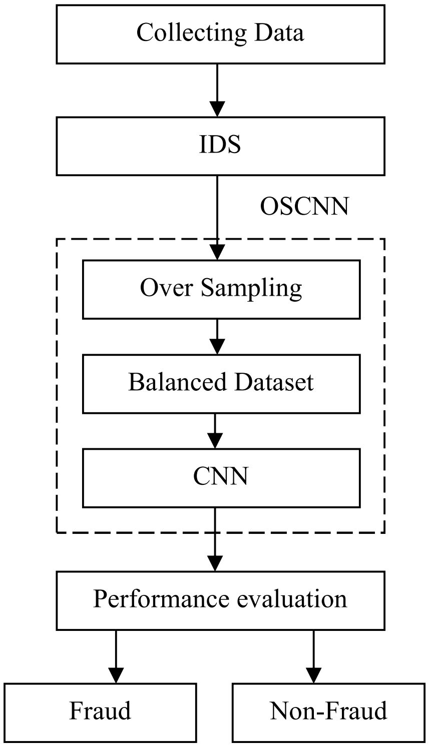

*Fig 2: Proposed System (Oscnn)*

The outcomes are gotten by demonstrating the first dataset with Multi-Facet Perceptron (MLP) and CNN then applying Destroyed on the dataset and assess with MLP and CNN then, at that point, think about the outcomes and pick the most dependable model. The final product is assessed in light of the disarray lattice and accuracy, review and precision is determined. The age's number has been adjusted in light of the fact that the ideal exactness is in the 50 ages. From tests, they demonstrated that the proposed model OSCNN furnished the best exactness in contrasted and the MLP and the MLP+SMOTE models.

*Table 2: Comparative Performance*

| **Parameters** | | **MLP** | **MLP+SMOTE** | **OSCNN** |
|---|---|---|---|---|
| Accuracy | 30 Epochs | 88 | 96 | 97 |
| | 50 Epochs | 88 | 97 | 98.7 |
| Precision | 30 Epochs | 40 | 97 | 97 |
| | 50 Epochs | 40 | 97 | 97 |
| Recall | 30 Epochs | 40 | 89 | 91 |
| | 50 Epochs | 40 | 89 | 91 |

In this way, we recommend the proposed OSCNN strategy and applied it to the dataset and the precision from 0.88 to 0.989 was worked on in contrast with the MLP and the MLP with Destroyed to guarantee model execution.

Altyeb Altaher Taha, Sharaf Jameel Malebary et. al. [9] presents A Keen Way to deal with Visa Misrepresentation Location Utilizing an Enhanced Light Slope Helping Machine. In the proposed approach, a Bayesian-based hyper boundary enhancement calculation is shrewdly coordinated to tune the boundaries of a light slope helping machine (LightGBM). The primary commitment of our exploration is a smart methodology for distinguishing extortion in Visa exchanges utilizing an enhanced light slope helping machine in which a Bayesian-based hyper boundary streamlining calculation is used to upgrade the boundaries of the light slope supporting machine. To show the viability of our proposed OLightGBM for recognizing extortion in Mastercard exchanges, tests were performed utilizing two certifiable public charge card exchange informational indexes comprising of deceitful exchanges and authentic ones. The primary informational index comprises of 284,807 Mastercard exchanges made by the Visa proprietors in September 2013 in Europe. The subsequent informational collection is the UCSD-FICO Information Mining Challenge 2009 Dataset, which is a genuine informational index of online business exchanges. To get more precise outcomes,

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a cross approval system is utilized in this paper to prepare and test the model. The general structure of the proposed smart methodology for Mastercard misrepresentation identification is delineated in Fig. 3.

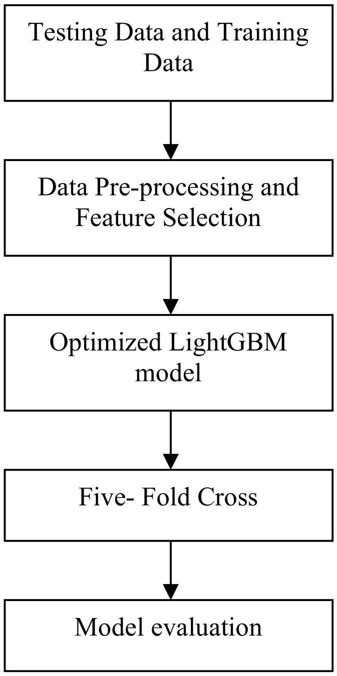
Testing Data and Training Data
Data Pre-processing and Feature Selection
Optimized LightGBM model
Five- Fold Cross
Model evaluation

*Fig. 3: Overall Framework Of The Proposed Approach*

Choosing huge and significant elements is basic for the compelling identification of Mastercard misrepresentation when the quantity of highlights is enormous. LightGBM uses the data gain (IG) technique to choose the main highlights and hence decline the dimensionality of the preparation information. In the proposed approach, a Bayesian based hyper boundary improvement calculation is shrewdly coordinated to tune the boundaries of the LightGBM calculation. The elite presentation LightGBM calculation can rapidly deal with a lot of information and the disseminated handling of information. LightGBM utilizes the slope based one side examining (GOSS) technique to safeguard the precision of the data gain assessment. The presentation of the proposed keen methodology is assessed in view of two genuine informational indexes and contrasted and other AI procedures utilizing execution assessment measurements.

To accomplish more precise appraisals, cross approval is utilized to prepare and test the model in every subset of the two informational indexes; then, the normal of the multitude of noted measurements is determined over the informational index. In this exploration, we direct a 5-crease CV test to survey the presentation of the proposed approach. Every informational index is partitioned arbitrarily into five separate subsets of equivalent size. At each step of approval, a solitary subset (20% of the informational index) is saved as the approval informational index for testing the presentation of the proposed approach, while the leftover four subsets (80% of the informational index) are utilized as the preparation informational index. This cycle is then rehashed multiple times until every subset has been utilized. The normal of the exhibitions of the five test subsets is determined, and the end-product is the all-out presentation of the proposed approach on a 5-overlap CV test.

Disarray Network, Accuracy, Review, Exactness (ACC), AUC (Region Under Bend) and F1-score are involved boundaries in this strategy. Table 3 shows a presentation assessment of the proposed approach in view of the 5-overlap CV technique utilizing the two genuine informational indexes. The Disarray Framework for estimating charge card misrepresentation identification execution utilizes the accompanying terms:
TP (i.e., genuine positive) alludes to the quantity of deceitful charge card exchanges appropriately arranged.
FP (i.e., bogus positive) means the quantity of real extortion Visa exchanges named misrepresentation.
FN (i.e., bogus negative) means the quantity of fake Visa exchanges named typical.
TN (i.e., genuine negative) alludes to the quantity of typical Mastercard exchanges accurately arranged. The actions that were utilized are characterized as follows.

$$Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)} \ldots.(4)$$

$$Precision = \frac{TP}{(TP + FP)} \ldots.(5)$$

$$Recall = \frac{TP}{(TP + FN)} \ldots.(6)$$

$$F1 - Score = 2 * \frac{Precision \times Recall}{(Precision + Recall)} \ldots.(7)$$

*Table 3: Performance Evaluation Of The Proposed Approach*

| Parameters | Dataset 1 (for average 5 folds) | Dataset 2 (for average 5 folds) |
|---|---|---|
| AUC | 90.2 | 92.9 |
| Accuracy | 98.4 | 98.3 |
| Recall | 40.54 | 28.33 |
| Precision | 97.3 | 91.7 |
| F1-Score | 56.9 | 43.27 |

*Table 4: Accuracy Comparison*

| Approach | Accuracy (%) |
|---|---|
| Isolation Forest | 95 |
| Random Forest | 95.5 |
| ANN | 92 |
| Proposed Approach | 98.4 |

Table 4 shows an exhibition correlation between the proposed approach and other exploration results in light of accomplished exactness for similar informational collection. The proposed approach acquired the most elevated Precision (98.40%) than different techniques. The trial results demonstrate that the proposed approach outflanked the other AI calculations and accomplished the best execution as far as Exactness, AUC, Accuracy and F1-score.
Sangeeta Mittal, Shivani Tyagi, et. al. [12] presents Execution Assessment of AI Calculations for Charge Card Misrepresentation Location. For charge card organizations and traders, identifying these false exchanges among huge number of typical transactions is in-plausible. Assuming that adequate information is gathered and made accessible, AI calculations can be applied to take care of this issue. In this work, famous managed and solo AI calculations have been applied to distinguish Mastercard fakes in an exceptionally imbalanced dataset. A range of directed gaining calculation from traditional to ongoing ones has been thought of. These incorporate tree-based calculations, Bayesian methodologies, Brain networks both traditional and profound learning and half breed calculations. Irregular Woods, Brain Organizations (NN), Profound Learning (DL), Backing Vector Machine (SVM), Guileless Bayes (NB), Calculated Relapse (LR), Broadened Slope Helped Tree (XGBT), Quadratic Discriminant Investigation (QDA), K-Closest Neighbor (KNN) and Half and half Regulated Approaches are chosen as managed learning calculations. Unaided strategies bunch indistinguishable information pushes and think about them to having a place with same class. These are accordingly extremely valuable in distinguishing anomalies, pushes that don't have a place with any of the bunches. Hence, unaided techniques are especially valuable here as the fakes cases being excessively not many than typical cases, these can be considered as exceptions. A few strategies for solo identification that have been utilized in this study are Self getting sorted out maps (SOM), K-implies, Seclusion Woods (IF) and Nearby Exception Element (LOF). The dataset was gathered and dissected during an exploration coordinated effort of Worldline and the AI Gathering of ULB (College Libre de Bruxelles) on large information mining and extortion location by Andrea Dal Pozzolo and his friends [20]. The dataset has absolute of 284,807 exchanges made in September 2013 by European cardholders. The informational index contains 492 misrepresentation exchanges, which is profoundly imbalanced.

Positive Prescient Worth or Accuracy, Negative Prescient Worth, Explicitness, Responsiveness, Adjusted Exactness, Predominance and Demonstrative Odd Proportion (DOR) are involved boundaries in this review. Adjusted Precision and Demonstrative Chances Proportion are two measures to distinguish grouping adequacy in imbalanced datasets. Out of undeniably picked strategies NN, ANN, XGBT LR, gathering model, IF and LOF gave close to consummate outcomes. DOR is likewise one more adjusted metric where higher qualities are deciphered as improved results. XGBT gave best DOR while all cross breed models gave comparative outcomes. Unaided Students, On the off chance that LOF scored best among solo as well as generally moreover. Subsequently, solo, explicitly IF and LOF are the general victors for managing exceptionally imbalanced datasets. It is presumed that solo calculations handle the dataset skewness in better ways and subsequently perform above and beyond all measurements totally and moderately to different procedures.

## 3. CONCLUSION

This paper introduced a Writing review on Visa misrepresentation discovery strategies. Visa misrepresentation identification is a curious grouping issue because of exceptionally high irregularity in cases of typical and false exchanges as specific illustrations. Albeit new innovation is accessible and broadly upheld by banks and vendors universally to decrease or maybe destroy the repercussions of charge card extortion, a few specialists are beginning to challenge its plan and execution. Charge card exchanges act as the base information for the course of extortion discovery. Different Mastercard misrepresentation identification methods are examined and made sense of in this paper. Exactness, Accuracy, Review, F1-score are as often as possible involved execution boundaries in Visa misrepresentation identification. Besides, associations are keen on finding techniques that can diminish cost and increment the benefit; they can find and choose the strategy from above investigations.

## REFERENCES

[1] Steven Lufthanza Bong, Albertus Baskara Yunandito Adriawan, Ghina Kamilah, Evaristus Didik Madyatmadja, "Analysis of Consumer Behavior in online shopping on Social Media", 2023 International Conference On Cyber Management And Engineering (CyMaEn), Year: 2023

[2] Yathartha Singh, Kiran Singh, Vivek Singh Chauhan, "Fraud Detection Techniques for credit card Transactions", 2022 3rd International Conference on Intelligent Engineering and Management (ICIEM), Year: 2022

[3] C.H Sumanth, Pokala Pavan Kalyan, Bolisetti Ravi, S Balasubramani., "Analysis of credit card fraud Detection using Machine Learning Techniques", 2022 7th International Conference on Communication and Electronics Systems (ICCES), Year: 2022

[4] N. Prabha, S. Manimekalai, "Imbalanced data Classification in Credit Card fraudulent activities Detection using Multi-Class Neural Network", 2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS), Year: 2022

[5] Madhushika Delgolla, Thilina Halloluwa, Anuradha Rathnayake, "A rule based approach to minimize false-positive declines in Electronic card not present financial transactions using feature engineering techniques", 2021 21st International Conference on Advances in ICT for Emerging Regions (ICter), Year: 2021

[6] Prabhat Singh, Vishesh Chauhan, Shivam Singh, Priya Agarwal, Shrey Agrawal, "Model for Credit Card Fraud Detection using Machine Learning Algorithm", 2021 International Conference on Technological Advancements and Innovations (ICTAI), Year: 2021

[7] Asha RB, Suresh Kumar KR, "Credit card fraud detection using artificial neural network", Global Transitions Proceedings 2 (2021)

[8] Aya Abd el Naby, Ezz El-Din Hemdan, Ayman El-Sayed, "Deep Learning Approach for Credit Card Fraud Detection", 2 nd IEEE International Conference on Electronic Engineering, Menoufia University, Egypt ICEEM2021

[9] Altyeb Altaher Taha, Sharaf Jameel Malebary, "An Intelligent Approach to Credit Card Fraud Detection Using an Optimized Light Gradient Boosting Machine", IEEE Access, VOLUME 8, 2020

[10] Rahul Goyal, Amit Kumar Manjhvar, Vikas Sejwar, "Credit Card Fraud Detection in Data Mining using XGBoost Classifier", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-9 Issue-1, May 2020

[11] S. Abinayaa, H. Sangeetha, R. A. Karthikeyan, K. Saran Sriram, D. Piyush, "Credit Card Fraud Detection and Prevention using Machine Learning", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-9 Issue-4, April, 2020

[12] Sangeeta Mittal, Shivani Tyagi, "Performance Evaluation of Machine Learning Algorithms for Credit Card Fraud Detection", 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence), 2019

[13] Akhil Sethia, Raj Patel, Prof. Purva Raut, "Data Augmentation using Generative models for Credit Card Fraud Detection", 2018 4th International Conference on Computing Communication and Automation (ICCCA), 2018

[14] M.Kavitha, Dr.M.Suriakala, "Hybrid Multi-Level Credit Card Fraud Detection System by Bagging Multiple Boosted Trees (BMBT)", 2017 IEEE International Conference on Computational Intelligence and Computing Research, 2017

[15] John Richard D. Kho, Larry A. Vea, "Credit Card Fraud Detection Based on Transaction Behavior", Proc. of the 2017 IEEE Region 10 Conference (TENCON), Malaysia, November 5-8, 2017

[16]M V Ganeswara Rao, P Ravi Kumar, T Balaji, " A High Performance Dual Stage Face

Detection Algorithm Implementation using FPGA Chip and DSP Processor " , Journal of Information Systems and Telecommunication (JIST),2022,pp 241-248, doi: 10.52547/jist.31803.10.40.241

[17]T Balaji, P.Ravi Kumar, M.V.Ganeswara Rao, Geetha Devi Appari, "Creating The Best Directed Random Testing Method To Minimize Interactive Faults- Empirical Perspective", Journal Of Theoretical And Applied Information Technology, 2023,101(7),Pp-2540-2546