Lie Detection Technique using Video from the Ratio of Change in the Appearance

S. M. Emdad Hossain, Sallam Osman Fageeri, Arockiasamy Soosaimanickam, Mohammad Abu Kausar and Aiman Moyaid Said

Department of Information Systems, University of Nizwa, Oman
emdad.hossain@unizwa.edu.om

Abstract
Lying is nuisance to all, and all liars knows it is nuisance but still keep on lying. Sometime people are in confusion how to escape from or how to detect the liar when they lie. In this research we are aiming to establish a dynamic platform to identify liar by using video analysis especially by calculating the ratio of changes in their appearance when they lie. The platform will be developed using a machine learning algorithm along with the dynamic classifier to classify the liar. For the experimental analysis the dataset to be processed in two dimensions (people lying and people tell truth). Both parameter of facial appearance will be stored for future identification. Similarly, there will be standard parameter to be built for true speaker and liar. We hope this standard parameter will be able to diagnosed a liar without a pre-captured data.

Keywords:
Nuisance, Liar, Detection, Escape, Parameter, LDA, kNN, MLP

1. Introduction

Detecting lie in general; becoming challenging due to different strategic-lying. The word of strategic lying is applied here with the sense of using normal behavioral approach occurring abnormal incidence which is out of common nature of human being. A common human characteristic is; telling truth is natural and lying is always artificial. This is perhaps the core hypothesis of this research. When a people say something true; their physical movement including appearance will be different from those who are telling lie. Research shows it is in fact true for same-people; when they are telling lie the appearance will be different when they say true [1]. Using advanced statistical tools within machine learning framework we are going to establish our claim using a well reputed data set from Miami University Deception Detection Database [2]. Research on lip movement and lie detection is not very new filed of research, but the approach and process of detection summing-up with new technique. Over the decade the researchers keep on extracting and publishing findings in various scholarly platform. Depending on the exploited features to determine deception the prior research generally can be categorized as verbal and non-verbal.

Manuscript received July 5, 2022
Manuscript revised July 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.7.20

The rest of this paper is organized as follows. Section 2 presents a necessary background about the state-of-arts in the fields related to the current study. Section 3 describes the methods used, including the algorithms that guided the research such as linear discriminate analysis (LDA) [11] followed by kNN [12], Logistic Regression [13] and MLP [14]; dataset used. Section 4 presents results and discussion, mostly the result shown in a form of figures generated by Microsoft azure, along with a summary discussion of the obtained results, and Section 6 presents the conclusions.

2. Literature Review

Desai et al. [3] proposed a method of classifying speech segments based on recurrent neural networks (RNNs). The performance of the proposed method was compared against some of the traditional machine learning methods namely, Logistic Regression and Support Vector Machine (SVM). The researchers relied on different combinations of features to detect the deception and the results showed that a set of both acoustic features and lexical features did not outperform the model which was built based on the lexical features only. Similar approach has been applied by some other scholars where the researcher claimed there are facial expressions or head movements displayed by the speaker during the deceptive or truthful interaction [4] by which identification may take place without error.

On the other hand, to detect the deception without annotation, Wu et al. [5] attempted to use vision, audio and text information available in video to successfully determine the lairs. The new system fuses both low and high level micro-expression to achieve a high level of effectiveness. Additionally, the author discusses the advantage of including the Mel-frequency Cepstral Coefficients features to improve the performance even further. Researcher also claimed The ability to accurately discriminate truths from lies in legal settings is crucial, as judgment errors can have grave consequences [6]. However, what appears to be detrimental effects of

including information from transcripts on the performance of the proposed system. In a similar manner, [7] explored the usage of video, audio, text and microexpression features to profile the truth tellers and liars. Their multi-modal neural model demonstrated a high level of accuracy. Surprisingly, the microexpression features were not the main contributors of discovering the deception.

In addition to the visual features, the physiological and thermal measurements of humans were reported by researchers to distinguish the deception status successfully [8]. The research outlines the experimental and data collecting procedures for studying different aspects of detecting deception. Practically, the used measures could be beneficial under realistic environment settings. Further, thermography is a technique that records the thermal radiation generated by the functioning of physical systems, or by the heat interaction with its internal characteristics [9]. The image or video collected by using thermal camera provides information on changes in temperature without any physical contact which one key point to trace on lie or true.

Unlike previously mentioned studies in [10] illustrated the benefits of including EEG and Gaze modalities with the audio and video information. Toward that objective, the researchers proposed a multimodal dataset for deception detection, which combines both the cognitive aspect with vision of the deception. An assortment of different feature extraction and prediction methods demonstrated that gaze and EEG features have the aptitude to deliver a deeper understanding of identifying deceit tasks.

However, detecting deception from the ration of change in a person's appearance did not get much attention in the research community. This might be due to lack of quality data, feature extraction method or classification method. By considering all identified and discussed issues above; in this paper we are proposing an auspicious method to detect the lie and lire using number of dynamic algorithms and classifiers including data-manipulation framework. Next part of the paper we are going to discuss the identification method in details.

3. Methodology

For the experimental evaluation we applied a reputed database called Miami University Deception Detection Database (MU3D) belongs to Miami University, USA. The dataset is well organized with adequate information. In total 320 sequence of videos for eighty (80) individuals are available in the database. Data from multiple background for both males and females are collected equally. Each individual talked about their social relationship in two different forms (true and false). Four different videos are generated from every individual i.e., positive truth, negative truth, positive lie, negative lie in various parameter [2]. Using the stated data set to subtraction of background and to extract the features we applied linear discriminate analysis (LDA) [11] followed by kNN [12], Logistic Regression [13] and MLP [14] classifier for classify the instance correctly.

Number of definitive reasons are there for selecting LDA and maximize the ratio of within and between scatter matrix which we assume will lead to greater true identification rate.
Suppose that w1,w2, . . . ,wc and n1, n2, . . . , nc denote the classes and the number of concatenated feature vectors h within each class, respectively,
with w = w1 ∪ w2 ∪ · · · ∪ wc and n^ = n1 + n2 +· · ·+nc. Note that the value of n^ is two times of n. c is the number of classes. To rise the ratio of "between-class scatter matrix SB to the within-class scatter matrix" LDA pursues "W" as transformation matrix.

$$\sum_{i=1}^{c} ni(Mi-M)(Mi-M)^T$$

Sw=J(W)|WTSBW|/|WTSwW|.
The within-class scatter matrix is

$$\text{Sw} = \sum_{i=1}^{c}\sum_{h\varepsilon w_i}(h-Mi)(h-Mi)^T$$

and the between-class scatter matrix is

$$\text{SB} = \sum_{i=1}^{c} ni(Mi-M)(Mi-M)^T$$

where Mi = $M_i = (1/ni)\sum_{h\varepsilon w_i}$

and $M = (1/n^{\wedge})\sum_{h\varepsilon w} h$ are the means of the class i and the grand mean, respectively.

We applied all promising blends of true speaking feature (face features) and false speaking feature to maximize the number of concatenated feature vectors. Characteristics of true and lie speaking has considered for feature vector. Eventually, truce face and lie face features has measured to construct the feature vectors for each person.

However, after extracting the fine features using LDA, we will identify the true and lie speaking using from kNN, MLP and Logistic Regression. The identifying using kNN we applied simple Euclidean distance formula which is:

$$d(p,q) = d(q,p) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2}$$

$$= \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2}.$$

It takes n number of dimensions. The data point which is located at the minimum distance from the test point is assumed to belong to the same class. In general, the working mechanism involved initializing k on chosen number of neighbour [15]. Subsequently, the measure of distance between current and query takes place. And then [16]:

- Index along with distance to add in the ordered collection.
- Identify the smallest to largest
- Identify initial entry (k)
- level-up the entry
- Redirect the mode

Further, in Logistic Regression the independent variable (X) is the key to relates logistic curves [17] and the initial equation looks:

$$P = \frac{e^{a+bX}}{1 + e^{a+bX}}$$

In this instance, P is representing probability of a 1, whereas the natural logarithm is represented by e along with the actual parameter of the model "a" and "b". When the value of X is zero (0), P is the value of "a" yields. Similarly, "b" works to adjust quick changes of probability in consist of changing X as a single unit. Most important thing to consider is: b can't interpret like general regression with non linier relationship of P and X. [17].

Furthermore, neural network is base of Multi-layered Perceptron (MLP) which has applied for the experimental evaluation in this research. It works very similar like any other classifier e.g. SVM, NB etc. [18]. But in terms of accuracy and the performance we found it is different than any other algorithms. Because it works like:

$$f(x) = (\sum_{i=1}^{m} w_i * x_i) + b$$

Where:

m represents the neuron numbers from earlier layer.

w represents random weight,

x represents input value,

b represents random bias.

Same approach is repeating for both output and hidden layers [19]. However, with all three stated and explained classifiers the set of experiments ended-up along with notable result within expectation. The experiment details illustrated in next section of the paper.

4. Results and Discussion

For experimental evaluation we applied stated data set using elaborated algorithm and classifiers. We conducted three different set of experiments using a unique framework which is shown in figure 1. To validate the method, we applied very well know datasets extracted from MU3D consists of 320 videos as stated in the methodology section.

This performance estimate is based on a 16 GB RAM, Intel Core i7 processor. Depending on the CPU, RAM requirements, and internal operations, the durations of certain functions may vary. The following are the time durations achieved using the specifications listed below:

- Processor: Intel Core i7
- RAM: 16 Gb
- Operating System: Windows 10
- Microsoft Azure
- Total Database samples: 320 Samples

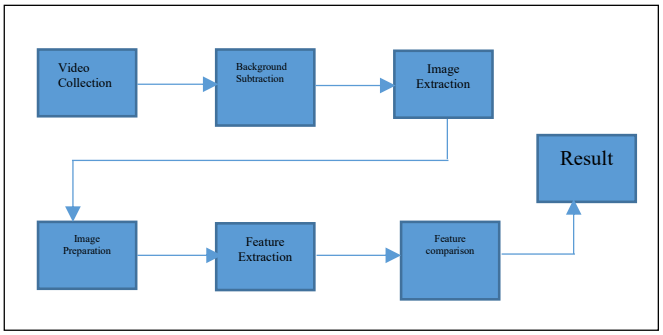

Fig 1: Framework for the experiments

In all experiments we considered, if the Eigen value of true speaking and Eigen value of false speaking are not same; it true or correct identification. in this instance, we collected Eigen value of true speaking and Eigen value of false speaking and compared in our proposed platform to get the result. The results are shown below for individual classifier.

The first experiments we conducted with MLP, and the result shows very much optimistic. The figure 2, figure 3 and the table 1 shows the result clarification

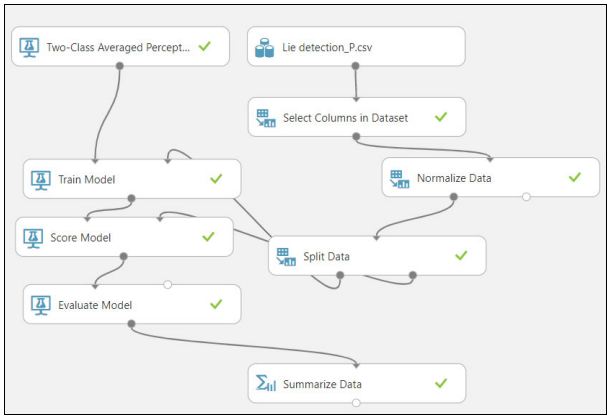

Fig. 2: Alorigthm schenario of MLP

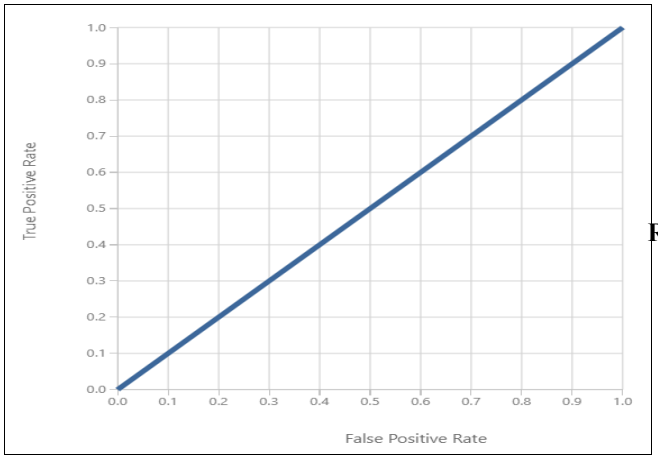

Fig. 3: Recognition Rate of Logistic Regression

Table 1: Recognition Parameter of kNN (Neural Network)

Score Bin	Positive Examples	Negative Examples	Fraction Above Threshold	Accuracy	F1 Score	Precision	Recall	Negative Precision	Negative Recall	Cumulative AUC
[0.900,1.000]	159	1	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.800,0.900]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.700,0.800]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.600,0.700]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.500,0.600]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.400,0.500]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.300,0.400]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.200,0.300]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.100,0.200]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000
[0.000,0.100]	0	0	1.000	0.994	0.997	0.994	1.000	1.000	0.000	0.000

As can be seen from the graph and the table above the result is outstanding. Perhaps; in all three classifier giving 99% accuracy in detecting false statement or lie where the precision and recall 99% and 100 % respectively. At the same time, it also proven that the LDA transformed features into multivariate classifiers which has a remarkable capability to model the feature variations in the face and retain the identity of true or false information.

5. Conclusions

At the end of successful consecutive experiments; it is time to recap that a person telling lie or saying truth is not very far to identify accurately using machine. Perhaps; all our applied classifiers here in this research prominently detecting as per our expectation. And the correct detection rate more than 99%. One of important finding of this research is; the correct detection rate is almost same for all classifiers. It means; the feature and of lying and feature of saying truth are very much different therefore; it is not difficulty for detecting the lie or true. At the same time the performance for all classifiers are distinguishable especially for deception detection. It is eventually opening the potentiality to apply the platform in public place. To make the path more wider we will continue our experiments to dig-down the reason and achieve the 100% accuracy.

References

[1] Learning Mind, The 6 Subtle Facial Expressions which Reveals Lie and Inauthenticity, copyright © Learning Mind 2012-2019, All Rights Reserved, https://www.learning-mind.com/facial-expressions-lies/, access date: 24th December 2019

[2] Lloyd, E. P., Deska, J. C., Hugenberg, K., McConnell, A. R., Humphrey, B., & Kunstman, J. W. (2017). Miami University deception detection video database, https://sc.lib.miamioh.edu/handle/2374.MIA/6067

[3] Shloka D, Maxwell S, Zachary M, Neural Lie Detection with the CSC Deceptive Speech Dataset, Stanford University, USA, access date: 30th January 2021.

[4] Veronica P ´ erez-Rosas, Mohamed Abouelenien, Rada Mihalcea, ´ Yao Xiao, CJ Linton, Mihai Burzo, erbal and Nonverbal Clues for Real-life Deception Detection, Proceedings of the 2015 Conference on Empirical Methods in Natural Language Processing, pages 2336–2346, Lisbon, Portugal, 17-21 September 2015. c 2015 Association for Computational Linguistics.

[5] Zhe W, Bharat S, Larry S. D, Subrahmanian V. S, Deception Detection in Videos, The Thirty-Second AAAI Conference on Artificial Intelligence (AAAI-18), Copyright c 2018, Association for the Advancement of Artificial Intelligence (www.aaai.org). All rights reserved.

[6] Deborah B, Jane G-D, Kevin R. B, The Impact of Presentation Modality on Perceptions of Truthful and Deceptive Confessions, Journal of Criminology, Hindawi, Volume 2013 |Article ID 164546 | https://doi.org/10.1155/2013/164546

[7] Gangeshwar K , Navonil M, Soujanya , Erik C, A Deep Learning Approach for Multimodal Deception Detection, A*STAR Artificial Intelligence Initiative (A*AI), Institute of High Performance Computing, Temasek Laboratories, School of Computer Science and Engineering, Nanyang

Technological University, Singapore, Centro de Investigacin en Computacin, IPN, Mexico, March 2018
[8] Veronica P, Rada M, Alexis N, Mihai B, A Multimodal Dataset for Deception Detection, Computer Science and Engineering, University of North Texas, Computer Science and Electrical Engineering, University of Michigan, Mechanical Engineering, University of North Texas, Computer Science, Engineering, and Physics, University of Michigan, access date: January 2021
[9] Cómo citar este artículo: S. Bedoya-Echeverry, H. Belalcázar-Ramírez, H. Loaiza-Correa, S. E. Nope-Rodríguez, C. R. Pinedo-Jaramillo, and A. D. Restrepo-Girón, "Detection of lies by facial thermal imagery analysis," Rev. Fac. Ing., vol. 26 (44), pp. 47-59, Ene. 2017
[10] V. Gupta, M. Agarwal, M. Arora, T. Chakraborty, R. Singh and M. Vatsa, "Bag-of-Lies: A Multimodal Dataset for Deception Detection," 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), Long Beach, CA, USA, 2019, pp. 83-90, doi: 10.1109/CVPRW.2019.00016.
[11] Martinez, A. M.; Kak, A. C. (2001). "PCA versus LDA". IEEE Transactions on Pattern Analysis and Machine Intelligence. 23 (=2): 228–233. doi:10.1109/34.908974.
[12] Jiang, L., Cai, Z., Wang, D. et al. Bayesian Citation-KNN with distance weighting. Int. J. Mach. Learn. & Cyber. 5, 193–199 (2014). https://doi.org/10.1007/s13042-013-0152-x
[13] Harrell, F. E. (2015). Regression modeling strategies: With applications to linear models, logistic and ordinal regression, and survival analysis (2nd ed.). Switzerland: Springer International Publishing.
[14] Almeida, L.B. Multilayer perceptrons, in Handbook of Neural Computation, IOP Publishing Ltd and Oxford University Press, 1997.
[15] Shubham P, The Euclidean Distance Formula, k Nearest Neighbor Classifier (kNN)-Machine Learning Algorithms (March 2018), https://equipintelligence.medium.com/k-nearest-neighbor-classifier-knn-machine-learning-algorithms-ed62feb86582.
[16] Onel H, The KNN Algorithm, Machine Learning Basics with the K-Nearest Neighbors Algorithm (September 2018), https://towardsdatascience.com/machine-learning-basics-with-the-k-nearest-neighbors-algorithm.
[17] Michael T. Brannick, The Logistic Curve, Logistic Regression, Course Materials and Research Website, http://faculty.cas.usf.edu/mbrannick/regression/Logistic.html.
[18] Amal N, A Beginner's Guide To Scikit-Learn's MLPClassifier (June 2019), COPYRIGHT ANALYTICS INDIA MAGAZINE PVT LTD, https://analyticsindiamag.com/a-beginners-guide-to-scikit-learns-mlpclassifier/.
[19] Vasco F, Equation of a Multi-Layer Perceptron Network, Data Science (Oct 2020), https://datascience.stackexchange.com/questions/84016/equation-of-a-multi-layer-perceptron-network.

Author's Profile

S.M. Emdad Hossain currently an Acting Head and Assistant Professor in the Department of Information Systems, College of Economics, Management and Information Systems, University of Nizwa. He has received his PhD degree in Information Science and Engineering from University of Canberra, Australia along with Post-Doc from Embry-Riddle Aeronautical University, USA. He has diverse educational and teaching experience from number of countries around the world. He is in the technical review committees and regular reviewer for several IEEE, Elsevier, ISI, and IET journals/conferences. His research interest includes multi-modal systems, computer vision, pattern recognition, data mining, medical image computing and mobile banking.

Sallam Osman Fageeri is an Assistant Professor at the College of Economics, Management & Information Systems (CEMIS) at University of Nizwa. he obtained his M.sc and PhD in information technology from Sikkim Manipal University India and Universiti Teknologi PETRONAS Malaysia respectively. he is an assistant professor and former dean of Faculty of computer science and information technology, Al-zaiem Alazhari University, Khartoum, Sudan. His main research interests are on Computational Intelligence, machine learning and mobile computing.

Arockiasamy Soosaimanickam is currently an Acting Dean of College of Economics Management and Information Systems, University of Nizwa, Sultanate of Oman. Dr. Arockiasamy obtained his Master's degree from Bharathidasan University, MPhil and PhD in Computer Science from Bharathiar University, India. His main expertise and research interests are in the field of Image Processing and Data Mining. He is also involved in various Research Projects inside and outside Oman. He has published over 50 Research papers in International / National Journals and conferences to his credit. He has been invited as a keynote speaker in various International / National conferences in India and abroad as well. He is an External Reviewer of various National / International Journals. He has been acting as an External Examiner for evaluating PhD thesis for many Universities in India. Recently, he has received an award, "Fabulous Global Education Leader" by World Education Congress on 4th July, at Hotel TajLand Ends, Mumbai. This award is for his contributions in the field of Education in different capacity.

Mohammad Abu Kausar is working as an Assistant Professor in the Department of Information Systems, College of Economics, Management and Information Systems, University of Nizwa. He obtained his Master's degree from G. B. Pant University of Agriculture & Technology, Pantnagar, India, MBA (IT) form Symbiosis, Pune, India, Ph.D from Jaipur National University, India. He is the active member of many associations like Computer Society of India (CSI), IEEE, International Association of Engineers (IAENG), The World Association of Technology Teachers (WATT), Computer Science Teachers Association (CSTA), The Institute of Computer Science, Social Informatics and Telecommunication

Engineering (ICST), Universal Association of Computer and Electronics Engineers (UACEE). His research interests include Information Retrieval, Web application, Programming Languages, Database and Data Mining.

Aiman Moyaid was an Assistant Professor at the College of Economics, Management & Information Systems (CEMIS) at University of Nizwa. Aiman received his Bachelor of Information Technology & Computer Sciences from Yarmouk University, Jordan, in 2007, Master in Information Technology from Universiti Teknologi PETRONAS and his Ph.D. in Information Technology from Universiti Teknologi PETRONAS in 2014. Aiman`s main research interests include Data Mining, Data Stream Mining, Text mining, Outlier Detection.