Novel Framework for Job Interview Processing Automation Based on Intelligent Video Processing

Conference Paper · April 2024

DOI: 10.23919/FRUCT61870.2024.10516365

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Novel Framework for Job Interview Processing Automation Based on Intelligent Video Processing

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***Abstract*—In this research, we introduce a novel framework for assessing participants' abilities and job performance through analyzing personality traits and nonverbal cues. We introduce a comprehensive analysis of the correlation between nonverbal features and job performance, shedding light on the most nonverbal cues noticed by the interviewers through the job interviews and how these cues affect the hiring decision. The proposed framework analyzes video interviews to estimate personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism) and nonverbal features (eye gaze, facial landmarks, head movements, smiling, posture, speech, and etc.). The knowledge base utilizes the extracted features to assess job performance and sales abilities. We implemented the framework and detected smiling through the video analysis using VPTD dataset. The findings show a significant moderate correlation based on Spearman's correlation coefficient (p_value less than 0,05) with extraversion and self-estimated abilities to work in sales.**

I. Introduction

The importance of nonverbal communication in the dynamic world of employment and recruitment procedures is frequently underestimated despite its great influence. As the crucial link between job candidates and potential employers, job interviews are more than just spoken conversations. They are rich environments where nonverbal clues subtly convey a range of information, influencing opinions about a candidate's suitability, competence, and likelihood of succeeding in the company. This study delves deeply into the complex interactions between job seekers' nonverbal indicators during interviews and how those interactions affect their hireability and performance on the job. Numerous indicators, such as posture, vocal tone, facial expressions, gestures, and eye contact, are included in nonverbal communication and can provide a complex picture of a candidate's character, attitude, and emotional condition. Understanding the meaning of these cues not only improves the effectiveness of interview assessments but also has significant consequences for workplace dynamics, employee engagement, and organizational performance [1], [2].

Nonverbal communication plays a more significant part in the complex world of hiring and recruiting than just talking; it is a quiet but effective means by which people express their abilities, attitudes, and personalities. As the primary means of accessing work possibilities, job interviews provide an ideal environment for the expression and interpretation of nonverbal cues, which may have significant effects on an applicant's hireability and subsequently performance at work. Nonverbal communication is incredibly important in a wide range of sectors and professions. It is woven throughout interpersonal relationships and organizational dynamics. Proficiency in nonverbal communication may be the difference between success and mediocrity in career paths like sales, customer service, and hospitality [3]. Positive results and customer satisfaction may be fostered by including a professional, friendly, and attentive handshake along with an attentive posture and pleasant smile in conversations. On the other hand, subliminal signs of unease, disinterest, or dishonesty can damage reputations, sap trust, and sabotage corporate objectives.

In addition to being crucial in jobs involving direct interaction with customers, nonverbal communication is a mirror reflecting a person's inner attributes, such as soft skills and personality traits. Intelligent observers may learn a great deal about a person's character and possibly fit in a certain position or organizational culture from their nonverbal vocabulary. These traits can range from resilience and flexibility to assertiveness and empathy. Candidates who maintain eye contact, use confident motions, and display expressive facial expressions, for example, may be seen as more assertive and able to handle high-pressure situations. Likewise, nodding, mimicking, and sympathetic gestures are ways that people exhibit active listening. These behaviors convey receptiveness, empathy, and interpersonal prowess—qualities that are highly valued in cooperative team environments. Moreover, the emergence of remote and virtual work arrangements has underlined the necessity of nonverbal communication in navigating digital environments. People must use nonverbal cues including voice tone, body language, and online presence in virtual interviews and distant collaborations to project authenticity, involvement, and trustworthiness. The significance of nonverbal communication in dynamic work situations is highlighted by the increasing need to portray professionalism, build relationships, and communicate excitement through virtual channels. Through illuminating the critical function of nonverbal communication in hiring and recruitment procedures, this study seeks to equip academics and professionals with practical knowledge that can be applied to enhance interview techniques, reduce bias, and promote inclusive hiring policies. Organizations may eventually cultivate diverse, resilient, and high-performing teams that are ready for success in today's dynamic workforce by using the transforming power

of comprehensive candidate evaluations and deep knowledge of nonverbal indicators [4], [5].

This research aims to analyze the subtleties of nonverbal communication in job interviews and reveal its significant effects on hiring and job success. We want to clarify the complex dynamics of nonverbal cues, how they influence interviewers' impressions, and how reliable they are for predicting a candidate's fitness for a job through a synthesis of the body of research and empirical data. We also look at the fascinating interactions that are thought to exist between some nonverbal behaviors and competencies, organizational fit, and personality factors. The study also aims to propose a systematic framework for assessing people's suitability for sales roles by utilizing our understanding of nonverbal clues. This study aims to give an academic and empirical basis for evaluating participants' fit for sales-related tasks by methodically analyzing relevant nonverbal actions and their relationship to fundamental personality traits.

The novelty of this research can summarize as follows:

- Providing a novel framework for estimating nonverbal cues combined with personality traits to assess job hireability and sales abilities.
- Highlighting the impact of nonverbal cues on job interview performance.

The rest of the paper is divided as follows: Section II explores the related works about analyzing nonverbal features in job interviews. Section III presents the proposed framework. Section IV delves into the implementation part and the experiments. Section V concludes the research and provides future work.

II. Related Work

This section offers a thorough analysis of the literature on the subject of nonverbal cues in job interviews and how they affect interviewer perceptions, hiring choices, and candidate assessment. This section attempts to clarify the complex dynamics of nonverbal communication in the context of job interviews by looking at important research and more recent developments in the field. Through the integration of varied viewpoints and empirical discoveries, the aim is to lay the groundwork for the current research and highlight significant topics that require more exploration.

In their study [6], they look at new marketing trends and highlight how important it is to provide customers with engaging shopping experiences in addition to high-quality products. Through the analysis of facial expressions, it seeks to understand customers' emotional reactions during the appreciation of a product. Test volunteers were shown photos of the product, and a database of emotive facial expressions was gathered. Both supervised and unsupervised techniques were used to extract and evaluate geometric and appearance facial features and landmarks. In 78% of the cases, clustering algorithms were able to distinguish between positive and negative facial expressions. Their study shows how geometric features and landmarks extracted from facial expressions can correlate with customers' emotions about a given product and formulate their impressions.

The authors of [7] studied multiple nonverbal cues(e.g., facial expressions, lexical, speech, prosody, smiling) in order to understand the behavior of participants in job interviews and the reasons behind accepting or rejecting an applicant. They gathered a dataset of 128 participants from MIT students who agreed to conduct a face-to-face job interview with a specialist while recording the session with two cameras. Labels representing the ground truth, as determined by nine independent experts' assessments. With correlation values of 0.73 or higher, the framework they developed was able to predict interview characteristics like friendliness and excitement. Their findings show that being fluent, confident, engaging, using fewer filler words, and smiling more can help enhance the participant's performance in job interviews.

The importance of nonverbal behaviors in formulating the first impression and how they can affect the interviewee's hireability was discussed by [8]. They focus on understanding what are the most important nonverbal cues noted by the interviewers during the interview in order to evaluate the participant's soft skills and personality. They studied many important nonverbal features such as mouth movement, eye contact, smiles(real and fake), facial expressions, and posture. Their finding shows, depending on analyzing the data they collected for this research, that: eye contact and smiling are the two crucial features examined by the interviewers.

Through their study [9], the authors examine the correlations between facial expressions, eye contact, and perceived soft skills in two different work environments: encounters at the reception desk and job interviews. Although these behavioral indicators have only been studied in isolated settings in the past, this study uses multimodal sensors and cutting-edge computer vision algorithms to explore the relationships between them in a variety of professional environments. They gathered a dataset consisting of 314 videos in total for the participants at the reception desk (153 videos) and through the video interviews (161 videos). The dataset was annotated by paid raters. In both job interviews and reception desk settings, there are modest relationships shown by Pearson's correlation analysis between particular facial expressions, eye gaze cues, and perceived soft skills. Their findings indicate a positive correlation between eye gaze and facial expressions with hireability.

The researchers in [10] take into account the possible impact of appearance on social interactions and personality development as they examine the complex link between self-reported personality traits, first impressions, and facial features. The results imply that some personality qualities may be inferred from facial features to some degree and that facial features influence first impressions. However, neither visual characteristics nor first impressions can be used to consistently infer personality traits by the prediction model created in this study. Notably, face characteristics are a better way to make initial impressions. To graphically represent what factors impact first impressions for different traits, the study also creates artificial

TABLE I
THE RESULTS OF PREVIOUS RESEARCH WITH THE METHODS USED

Author	Facial expressions	Geometric facial features	Facial landmarks	Lexical	Speech	Eye contact
Popa et al [6]	+	+	+	–	–	–
Naim et al [7]	+	–	+	+	+	–
Cortez et al [8]	–	–	–	–	–	+
Muralidhar et al [9]	+	–	–	–	–	+
Wolffhechel et al [10]	+	+	–	–	–	+
Leigh et al [11]	–	–	–	–	+	+
Bharadwaj et al [12]	+	–	–	+	+	+
Stros et al [13]	+	–	–	+	+	+
Sandra et al [14]	–	–	–	–	–	–
Pauser et al [15]	–	–	–	+	+	–
Nguyen et al [16]	–	–	–	–	+	–
Martin-Raug et al [17]	+	–	–	–	+	+
Kim et al [18]	+	–	–	–	–	+

TABLE II
THE RESULTS OF PREVIOUS RESEARCH WITH THE METHODS USED

Author	Smiling	Prosody	Mouth movements	Head movements	Posture	Gender	Appearance
Popa et al [6]	–	–	–	–	–	–	–
Naim et al [7]	+	+	–	–	–	–	–
Cortez et al [8]	+	–	+	–	+	+	–
Muralidhar et al [9]	+	–	–	+	–	–	–
Wolffhechel et al [10]	+	–	+	–	–	+	–
Leigh et al [11]	–	+	+	+	+	–	+
Bharadwaj et al [12]	–	+	–	+	+	–	–
Stros et al [13]	–	+	–	+	+	–	–
Sandra et al [14]	–	–	–	+	+	–	–
Pauser et al [15]	–	+	–	–	+	–	–
Nguyen et al [16]	–	–	–	–	+	–	–
Martin-Raug et al [17]	–	+	–	+	–	–	+
Kim et al [18]	–	–	–	–	–	–	+

faces representing these features. The research also identifies some indicators for certain traits such as friendliness (wider mouth with lips pointed up) and dominance (broader face and a more prominent eyebrow ridge). They also clarify that using short videos for assessing personality traits and first impressions gives better results than using just a photograph.

Research [11] aims to examine the effects of salespeople's nonverbal cues in corporate selling environments. They concentrate on five distinct nonverbal cues: posture, eye contact, gestures, hesitancy in speech, and clothes. The purpose is to evaluate how these nonverbal cues affect buyers' assessments of the sales presentation and their social perceptions of the salesperson. The study's conclusions show that buyers' opinions of the salesman and their assessments of the sales presentation are influenced by certain nonverbal clues. The findings demonstrate that maintaining eye contact improves views of the salesperson's empathy and tactfulness, as well as the presentation's credibility. However, there is no significant correlation between eye contact and dependability, professionalism, or trustworthiness. It has been discovered that a salesperson's perceived professionalism and skill are positively impacted by their professional clothing. The results show that speech hesitancy negatively affected the sales presentation's perceived persuasiveness and level of attention.

The researchers of [12] discuss how business-to-business (B2B) transactions are changing, with a growing number of buyers and sellers interacting digitally. They define digital sales interactions (DSIs), provide a typology for DSIs, present a framework for comprehending how buyers' thoughts and actions are influenced by auditory and visual cues, offer theoretical vantage points for examining salesperson communication, investigate the use of machine learning to study effective communication, and highlight potential avenues for future B2B marketing research. According to their research, a salesperson's body language, speaking pace, facial emotions, and body movements all have a significant impact on the opinions and intentions of customers to make a purchase. Additionally, they discovered that the thoughts and actions of receivers may be influenced by the sender's visual and auditory clues.

To identify the key individual aspects in sales that are most important for creating favorable customer impressions and ultimately increasing sales effectiveness. A conceptual personal sales model was created by [13]. It makes the argument that a salesperson's genuineness affects the way customers see them and, ultimately, the success of their sales. It has been demonstrated that a salesperson's emotive, behavioral, and cognitive profiles all influence their authenticity. The model they proposed highlighted the impact of multiple nonverbal cues (e.g., Immediacy Cues, Relaxation, Movements, Facial

Expressions) on sales effectiveness and customer satisfaction.

In their study [14], the authors scrutinize body language characteristics that set salesmen apart from one another and determine whether these characteristics are precursors to perceived charisma. The results show that specific arm gestures, arm positions, and action functions significantly impact charismatic looks, which can lead to positive perceptions of the salesman. They examined how charisma, a relatively new idea in sales research, might improve sales effectiveness and performance. Based on social science research that indicates charisma has a beneficial effect on organizational performance, this study explores how nonverbal gestures affect consumers' perceptions of salesperson charisma and affect their responses in various cultural contexts. The research findings also show that, especially in low-gesture cultures, certain symmetrical arm positions, motions, and functions greatly influence how charismatic a salesman is regarded to be. In high-gesture cultures, on the other hand, asymmetrical gestures are preferred because they make salespeople appear more charismatic, which raises their evaluations and improves client sentiments.

The authors of [15] gather data for sales research in a novel approach using wearable electronics and sociometric badges: automatically tracking the nonverbal communication behaviors (e.g., kinesics, paralanguage, and proxemics) of both the salesperson and the consumer. According to the research, a charismatic look has a beneficial impact on a salesperson's ability to elicit favorable reactions from customers and improve sales effectiveness when compared to constrained or static nonverbal cues. The findings imply that rather than communicating in a static and monotonous manner, salespeople may improve their perceived charisma by embracing a dynamic communication style, which is marked by a change in voice and volume. In turn, charisma moderates the connection between a salesperson's communication style and the responses of customers, highlighting the significance of charisma in producing positive results.

The relationship between speech, posture, and hand gestures, highlighting the multimodal character of these gestures and their significance in enhancing vocal content was examined by [16]. The study uses a combination of hand annotations and automated extraction approaches to predict two important organizational constructs: personality and job interview evaluations. It focuses on body communication cues in real dyadic employment interviews. The results highlight the importance of body language in expressing several social dimensions, including internal moods, personality characteristics, and interview results. The study also highlights how speaking status further improves the predictive accuracy of personality and hireability ratings, confirming the multimodal nature of nonverbal communication. This study shows how body language indications may be used to predict the results of employment interviews.

The importance of nonverbal clues in addition to verbal communication during job interviews is emphasized by [17]. It finds that important nonverbal characteristics including professional appearance, eye contact, and movement of the head are highly impacting interview scores through a meta-analysis of 63 research with around 5000 participants. It's interesting to note that nonverbal clues and evaluations are not much impacted by interview style or length. The study also reveals disparities based on gender, showing that some nonverbal cues may have a greater impact on women than on men and that interviewers may have relied on gender preconceptions. Overall, the results highlight how crucial nonverbal cues are in predicting interview success for prospective candidates.

Research [18] focuses on service environments such as the hotel sector and looks at how employee qualities like appearance, eye contact, and civility affect client behavior. It emphasizes how important these qualities are to developing goodwill and employee satisfaction between customers and staff. In particular, the study reveals that polite conduct and regular eye contact greatly enhance the connection between customers and employees, which in turn affects customer happiness. The study highlights that nonverbal and behavioral clues are more noticeable to consumers and that staff courtesy has a greater impact on rapport than appearance and eye contact. Furthermore, there is a strong interaction effect between eye contact and civility, indicating that higher degrees of rapport are reached when courtesy and eye contact are coupled. The results highlight how crucial staff conduct is to creating satisfying client experiences during service interactions.

We discussed many previous researches in the field of studying the effect of nonverbal cues in job interviews and interactions with customers. There still many other studies examined the correlation between nonverbal cues in the face-to-face interaction and interviewing environment such as (facial expressions [19], [20], gender [21], [22], eye contact [23]–[25], smiling [26], [27], posture [28], etc.). We analyzed in this study the most significant research from our point of view.

As shown by previous studies, there are many nonverbal behaviors and cues related to hireability and job performance. Many of these cues are more correlated than the others. In Tables I and II we illustrate the nonverbal traits mentioned by different researchers.

III. Framework

This section presents a unique framework that estimates important personality qualities and evaluates nonverbal indicators found in prior research to evaluate sales skills. Through the integration of concepts from social theory, psychology, and sales studies, this framework seeks to offer a holistic method for comprehending and assessing the efficacy of sales professionals.

Our proposed framework depends on two main aspects (personality traits estimation and nonverbal cues detection). It has been demonstrated that personality traits, which influence things like communication style, negotiating strategies, and client relationship management, have a major impact on sales performance. It is possible to estimate the personality profiles of sales professionals by using well-respected instruments for personality evaluation, such as the Big Five personality

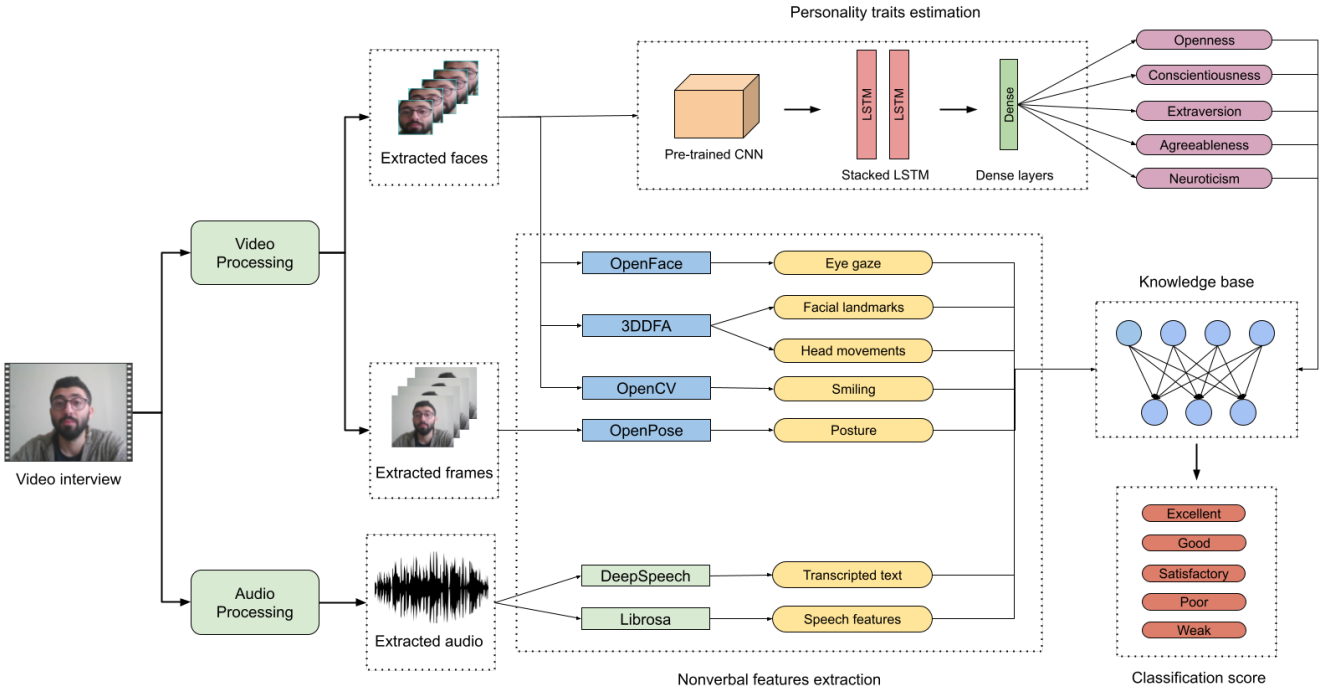

Fig. 1. The proposed framework for job performance and sales abilities estimation

characteristics. To estimate personality traits a CNN features extractor followed by LSTM was proposed by us [29]. The model was able to estimate the Big Five personality traits when tested on the VPTD dataset [30].

At the same time, nonverbal indicators such as tone of voice, body language, eye contact, and facial expressions are important in interpersonal communication because they affect how people perceive one another's credibility, dependability, and friendliness. Sophisticated analytical techniques, like computer vision and machine learning algorithms, can be used to objectively evaluate sales individuals' nonverbal expressions during video interviews.

Preceding from our previous analysis of nonverbal cues and the crucial part they play in reflecting important indicators through the video interview. We highlight some important nonverbal cues and they can be perceived by the interviewers. These nonverbal features combined with personality traits can help with a reliable and accurate estimation of soft skills, job performance, and sales abilities.

The proposed framework contains a base knowledge of personality traits and nonverbal cues. The general rules defined by the knowledge base are described as follows. Geometric facial features: a high ratio of face breadth to height is an indicator of dominant personality. Speech: Using more unique, speaking fluently, and fewer filler words is an indicator of confidence and credibility. Eye contact: Holding active eye contact with the interviewer shows engagement and respect. Smiling: Real smiles that match the conversation show friendliness and extroversion. Prosody: Changing of tone and using a unique style of talking can captivate the interviewer and increase engagement. Head movements: Nodding through the interviewer's speech shows engagement and active listening. Posture: Sitting with a good and relaxed posture and showing confidence while crossing hands or bad posture can show anxiety and nervousness. Appearance: A professional and neat appearance is perceived better by the interviews and reflects seriousness and professionalism.

The proposed framework for assessing personality traits and nonverbal cues from video interviews is shown in Fig. 1. The framework utilizes multiple computer vision and machine learning techniques to analyze the video and audio to extract the different features. The model will combine the knowledge to predict the participant's sales abilities depending on the extracted features.

The implementation of the proposed framework should help companies manage job interviews more analytically. Providing the interviewers with many important features about the participant's personality traits and nonverbal cues. Helping them by deciding on hiring the participant and providing feedback.

IV. Experiments

As we described in the Framework section. We will evaluate personality traits and nonverbal features in order to assess sales abilities. In our research [29] we estimated personality traits by analyzing video interviews using CNN-features extractor followed by LSTM. Then a knowledge base depending on personality traits was built. The rules for the knowledge base were defined while taking into account that people who work in sales have high levels of (Extroversion, Conscientiousness,

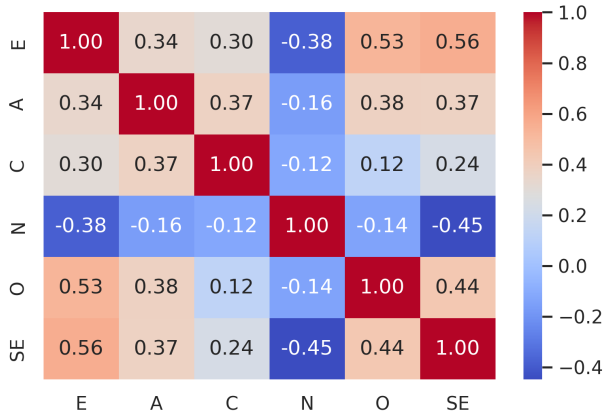

Fig. 2. The heat-map for personality traits and sales estimation

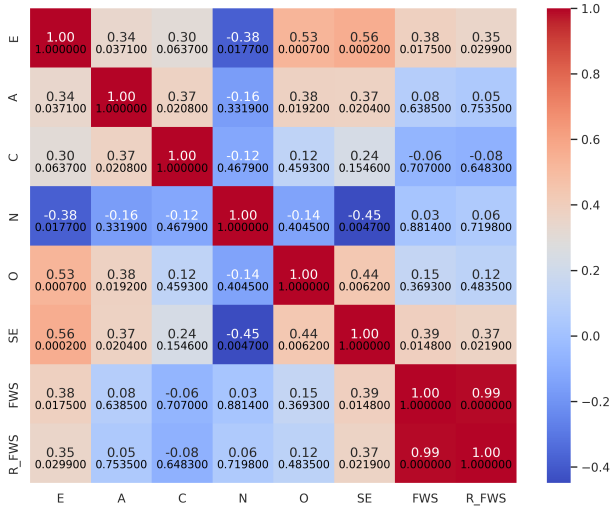

Fig. 3. The heat-map with the smiling features

and Openness) and low levels of (Neuroticism and Agreeableness) compared to others. This approach was experimented on the VPTD dataset. The results supported our proposed approach and a heat-map showing the correlation between the personality traits and self-estimated evaluation for working in sales are shown in Fig. 2.

We expanded the previous research by adding nonverbal features for the assessment process. We tried to prove the hypothesis (smiling correlates positively with extroversion and sales abilities evaluation in job interviews). An estimation for the nonverbal feature (smiling) was implemented in this study. We detected the frames when the participants were smiling during the video interview. We calculated the ratio of the frames with smiles from the total frames. This implementation for the smiling detection was tested on the VPTD dataset. The results show a significant correlation (p_value less than 0.05) between smiling with Extroversion and Self-Estimated (SE). The heat-map for the experiment is shown in Fig. 3. We can see that there is a moderate correlation between smiling (FWS: frames with smiles, R_FWS: ratio of frames with smiles) with (Extroversion and SE(Self-estimated)).

To visualize our findings, we scattered the dataset on a logarithmic plot as shown in Fig. 4 where the x-axis represents the participant's extroversion and the y-axis represents FWS (frames with smiles). The plot shows that participants who smile more are probably more extroverted than others. The plot highlighted the participants who had extroversion traits higher than 0.6 in red.Through visualizing we can notice the nonlinear correlation between smiling and extroversion. This also proves our proposal framework to evaluate smiling and how it can assess in estimating job performance and sales abilities.

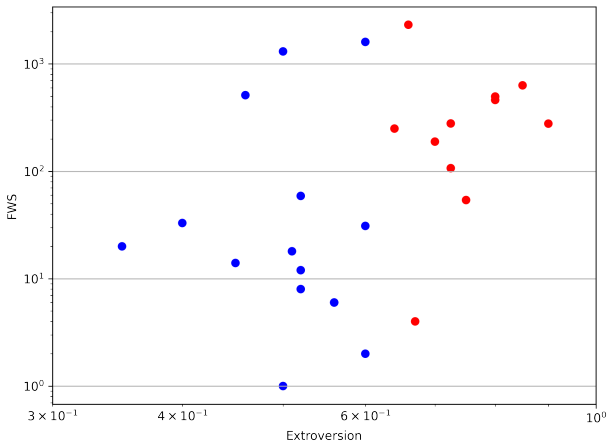

Fig. 4. The scatter of the dataset with high extraversion scores

V. Conclusion

A novel framework assessing participants' sales abilities by analyzing participants' personality traits and nonverbal features was proposed. Based on hardware implementation the framework supports the real-time job interview processing. In order to shed light on the most common nonverbal cues observed by interviewers during job interviews and how these cues influence hiring decisions, we presented a thorough investigation of the relationship between nonverbal characteristics and work performance. We implemented smile extraction and studied the correlation between Extraversion and SE (Self-estimated). We demonstrated the findings on the VPTD dataset where the results approved our proposed approach.

In this paper, we proved the correlation between nonverbal cues (smiling) with sales abilities and extraversion. The findings support our hypothesis and proposed framework for job performance estimation. The paper provides a significant contribution by understanding the multiple features that can affect the job interview process and providing a framework that can estimate these many feathers and help the interviewer with making reliable hiring decisions.

Future work will focus on implementing the rest parts of the frameworks and testing on real datasets as well as to highlight the list of properties for an organization to evaluate the possibility to use the proposed framework.

ACKNOWLEDGMENT

This work was supported by the Russian State Research FFZF-2022-0005.

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