IEEE Access
Multidisciplinary : Rapid Review : Open Access Journal

Received 23 September 2024, accepted 12 November 2024, date of publication 15 November 2024,
date of current version 26 November 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3498836

RESEARCH ARTICLE

The Effectiveness of Acoustic Voice Quality Index to Identify People With Parkinson's Disease

NEMUEL D. PAH[1,2], (Senior Member, IEEE), VERONICA INDRAWATI[1], (Member, IEEE), AGUNG PRAYITNO[1], (Member, IEEE), AND DINESH K. KUMAR[2], (Senior Member, IEEE)
[1]Electrical Engineering Department, Universitas Surabaya, Surabaya 60293, Indonesia
[2]School of Engineering, RMIT University, Melbourne, VIC 3000, Australia

Corresponding author: Nemuel D. Pah (nemuelpah@staff.ubaya.ac.id)

This work was supported by the Penelitian Fundamental Reguler (PFR) Kemendikbudristek under Grant 047/SP-Lit/LPPM-01/KemendikbudRistek/FT/VI/2024.

This work involved human subjects or animals in its research. Approval of all ethical and experimental procedures and protocols was granted by the Ethics Committee of the Clìnica Noel, in Medellìn, Colombia.

ABSTRACT Developing portable computerized diagnostic tools for Parkinson's disease (PD) based on Parkinsonian dysarthria requires identifying the voice features most sensitive to PD symptoms. Numerous studies have explored the correlations of various acoustic features with PD diagnosis and progression. Despite achieving high accuracies in some cases, these proposed features or methods have not yet been integrated into publicly available PD diagnostic tools due to their limited robustness. The Acoustic Voice Quality Index (AVQI), introduced by Maryn, has the potential to be a voice severity measure capable of distinguishing people with PD from healthy individuals. This study investigates the effectiveness of AVQI in identifying people with PD and the reliable preprocessing techniques to compute AVQI from short-duration sustained vowels. AVQI data extracted from the PC-GITA dataset underwent several statistical analyses to compare the validity of AVQI using truncated and concatenated sustained vowels. Statistical distribution and receiver operating characteristic (ROC) curve analyses were used to assess AVQI's effectiveness. The results demonstrate that AVQI can distinguish PD among female participants with an accuracy of 75.33% and an area under the curve (AUC) of 0.74. These findings also confirm the suitability of using concatenated sustained vowels for calculating AVQI from short recordings. They highlight AVQI's potential application in portable PD diagnostic tools, underscoring its relevance in clinical practice.

INDEX TERMS Hypokinetic dysarthria, dysphonia, voice quality, Parkinson's disease, AVQI.

I. INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease that is associated with the loss of dopaminergic neurons within the substantia nigra [1]. It is ranked as the second most common neurodegenerative condition after Alzheimer's disease [1], and its incidence is anticipated to increase to approximately 12.9 million individuals by 2040 [2]. PD is characterized by various motor and non-motor deficits [3]. The current standard for diagnosing PD includes a clinical evaluation using either the Unified Parkinson Disease Rating Scale (UPDRS) [4] or the Hoehn and Yahr (H&Y) scale [5]. These evaluations assess motor symptoms, such as tremors, rigidity, bradykinesia, postural impairment, or dysarthria, and non-motor symptoms, such as functional limitations and cognitive decline [6].

Voice impairments have been reported to occur approximately five years before motor symptoms develop [7]. Identifying the voice impairments may open the possibility of the early detection of PD. These changes in voice are termed hypokinetic dysarthria and impact approximately 90% of individuals with PD [8]. Parkinsonian hypokinetic dysarthria is characterized by dysphonic characteristics such as reduced voice intensity, increased acoustic noise and nasality, reduced

The associate editor coordinating the review of this manuscript and approving it for publication was Paolo Crippa.

speech prosody, imprecise articulation, a narrower pitch range, mono loudness, longer pauses, vocal tremor, breathy voice quality, and disfluency [9].

Many studies have extracted acoustic features and investigated their correlation with PD diagnosis or progression [10]. The commonly extracted acoustic features are pitch and formant frequency variation, number of pulses, jitter, shimmer, autocorrelation, Mel-frequency cepstral coefficient (MFCCs), and the harmonics-to-noise ratio (HNR) [11], [12], [13], [14], [15]. The effectiveness of these features was assessed using a range of statistical analyses, including their statistical distribution, statistical hypothesis tests, and machine learning approaches. Pah et al. [16], [17] and Motin et al. [18] reported the effectiveness of using jitter, shimmer, formants, and harmonic features in support vector machine (SVM) models to identify people with PD (PwPD). Ali et al. [19] developed a linear discriminant analysis (LDA) that used the above features to detect PwPD with an accuracy of $>80\%$. Tsanas et al. [20] used the MFCC features to classify PwPD, achieving significant accuracy. Sakar et al. [12], [13] applied machine learning and a wavelet-based model to sustained vowel (SV) features to diagnose PD. However, the above methods only extract acoustic features from SVs, which limits their ability to fully capture the level of voice quality related to dysarthria in PwPD.

Other studies have reported efforts to diagnose PD or quantify dysarthria among PwPD using acoustic features extracted from text reading, diadochokinetic, or other forms of phonation. Vàsques-Correa et al. [21] developed an automatic evaluation method to quantify dysarthria in PwPD based on phonation, articulation, prosody, and intelligibility features extracted from SVs, text reading, and diadochokinetic voice. Rusz et al. [22] developed a smartphone-based method to capture the speech abnormalities of PwPD by extracting acoustic features from sustained phonation, syllable repetition, and monologue speech. While these studies have achieved high accuracies, the proposed approaches have not been developed into publicly available PD diagnostic tools due to their lack of robustness. The performance of the proposed methods decreases significantly when tested on different datasets or demographics [23]. This shortcoming highlights the need for an acoustic feature or voice quality index that is more robust to demographic variability to diagnose dysarthria in PwPD.

In recent years, studies [24], [25] have developed computer-based tools or indexes to quantify voice quality to replace perceptual assessment scales such as Roughness-Breathiness-Hoarseness (RBH) [26]; Grade-Roughness-Breathiness-Asthenia-Strain (GRBAS) [27]; or Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) [28]. One voice quality index is the Acoustic Voice Quality Index (AVQI) introduced by Maryn and Weenink [29], [30], which is an objective measure of acoustic voice quality that is correlated to auditory-perceptual ratings. The AVQI has been validated across various languages, demographics, and pathological conditions [30], [31], [32]. The AVQI allows clinicians and researchers to develop computational approaches to measure changes in voice quality with pathological conditions such as PD.

While studies have sought to assess the effectiveness of the AVQI for PD, most have not found any significant correlations between the AVQI and PD diagnosis or severity. Convey et al. [33] studied the relationship between the AVQI and voice quality in PD and found that AVQI correlated strongly with the Grade-Roughness-Breathiness-Asthenia-Strain-Instability (GRBASI) [27] measure of perceptual voice quality but weakly with the H&Y PD severity score. Moya-Galé et al. [34] identified a change in the AVQI of PwPD from before to after intensive voice and articulation therapies. In the other longitudinal study, Convey et al. [35] observed a statistical change in the AVQI of early-stage PwPD over one year. Steurer et al. [36] studied the characteristics of mild and moderate dysarthria in PwPD and found a nonsignificant correlation between the AVQI and voice function. Cushnie-Sparrow et al. [37] found no significant correlation between the AVQI and the medical conditions of PwPD.

To our knowledge, no published study has assessed the ability of the AVQI to distinguish PwPD from healthy individuals. One limitation in measuring the AVQI of PwPD is their pathological and physical limitations in pronouncing the required three-second SV recordings, which must be addressed before the effectiveness of the AVQI for PD can be assessed.

This study aimed to investigate the effectiveness of the AVQI in diagnosing PD. It reports a statistical analysis of the AVQI of PwPD compared to aged-match healthy subjects and a preprocessing technique to measure the AVQI of individuals with short SV recordings.

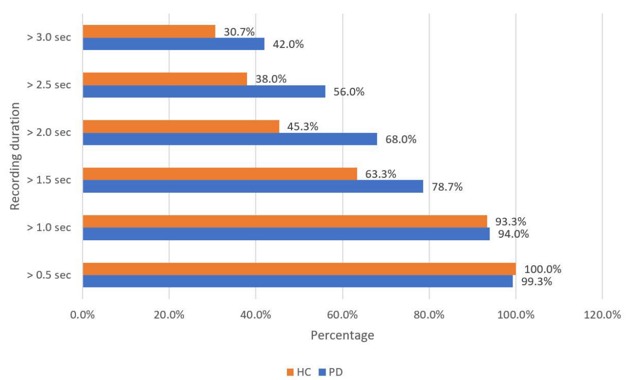


FIGURE 1. The distribution of sustained vowel (SV) /a/ duration in the PC-GITA dataset.

II. METHODS

A. AVQI

The AVQI is a multiparametric index that estimates the level of dysphonia. It was first introduced by Maryn et al.

TABLE 1. PwPD clinical severity score.

Clinical Score	(mean ± SD)		P-value of T-test
	Male	Female	
UPDRS	37.76 ± 22.09	37.56 ± 14.03	0.970
H&Y	2.14 ± 0.73	2.24 ± 0.597	0.598

in 2009 [38] and has been modified several times to the current version of v.03.01 [30]. The AVQI equation combines time, frequency, and quefrency domains. It includes the smoothed cepstral peak prominence (CPPS), HNR, shimmer local (Shim), Shim dB (ShdB), slope of the long-term average spectrum (Slope), and tilt of the regression line through the spectrum (Tilt), as shown in (1).

$$AVQI_{v.03.01} = 2.8902(4.152 - 0.177\ CPPS - 0.006\ HNR - 0.037\ Shim + 0.941\ ShdB + 0.01\ Slope + 0.093\ Tilt) \tag{1}$$

The CPPS is the main contributor of the AVQI [29], [39], representing the distance between the first rahmonic peak and the point with equal quefrency on the regression line through the smoothed cepstrum.

The AVQI is linearly scaled between 0 and 10, with lower values indicating higher acoustic voice quality (a lower level of dysphonia). The AVQI threshold for being considered dysphonic varies between languages [30]. In the context of this work, the dysphonia threshold was 2.28 [40]. The AVQI is calculated from voiced segments of phonetically balanced continuous speech (CS) concatenated with three-second SV /a/ voice samples.

B. DATASETS

The AVQI values measured and analyzed in this work were computed from the voice recordings in the PC-GITA dataset provided by Orozco-Arroyave et al. [41]. The recordings were obtained from 100 native Colombian-Spanish speakers, including 50 PwPD and 50 healthy controls (HCs). Each group consists of 25 male and 25 female participants. Table 1 presents the clinical score of PwPD. The table indicates a match between UPDRS and H&Y scores of male and female PwPD. The HC group was age-matched with the PwPD group. This data collection protocol was approved by the Ethics Committee of the Clìnica Noel, in Medellìn, Colombia.

The voices were recorded in a noise-controlled booth using a professional omnidirectional microphone, and the recordings were stored as "wav" files with a sampling rate of 44,100 Hz and 16-bit resolution.

The PC-GITA dataset contains the recordings of three repetitions of SVs /a/, /e/, /i/, /o/, and /u/, diadochokinetic recordings, and the recording of CS as text readings. When calculating the AVQI, this work only considered the recordings of the SV /a/ at normal pitch and volume. As suggested by Hernàndez et al. [40] for Spanish speakers, the phonetically-balanced CS text reading was truncated to contain only the first 33 syllables as follows: *"Ayer fui al mèdico. Què le pasa? Me preguntò. Yo le dije: Ay doctor! Donde pongo el dedo me duele. Tiene la"*.

The AVQI calculation requires a recording of SV /a/ with a three-second duration. However, due to the pathological and other physical capabilities of the subjects in the PC-GITA dataset, only 30.7% of HC recordings and 42.0% of PwPD recordings have a duration of ≥ 3 seconds (Figure 1).

C. AVQI WITH SHORT SUSTAINED VOWEL

Since the duration of /a/ in most of the recordings in the PC-GITA dataset was less than 3 seconds (Figure 1),), it was necessary to investigate the validity of calculating the AVQI for individuals with shorter recordings of /a/. A statistical analysis was conducted to validate calculating the AVQI from shorter SV recordings. This experiment only considered the subjects with more than 3-second recordings of /a/ and used the 33-syllable CS text reading recordings from the subjects. Their AVQIs were compared between the full three-second recordings of /a/ ($AVQI3_{sec}$) and truncated recordings of /a/ ($AVQI_{<3\ sec}$), i.e., 2.5 s, 2.0 s, 1.5 s, 1.0 s, and 0.5 s.

The validity of the AVQIs was assessed based on the correlation coefficient (R^2) and a probability test comparing the slope and intercept similarity between the linear regression model (2) and the ideal condition if the two measurements were identical (3).

$$AVQI_{<3\ sec} = a_1\ AVQI3_{sec} + a_0 \tag{2}$$
$$AVQI_{<3\ sec} = AVQI3_{sec} \tag{3}$$

The slope and intercept similarity were investigated using the t-statistic of the two-sided hypothesis test [42]. The two models were considered dissimilar if p_{slope} and/or $p_{intercept}$ were below 0.05.

D. AVQI WITH CONCATENATED SUSTAINED VOWEL

We investigated an alternative strategy for calculating the AVQI for individuals with short recordings of /a/ by concatenating these short SV recordings. The experiment setting was similar to the above experiment, but the $AVQI_{<3\ sec}$ was calculated using a short vowel recording that had been concatenated several times to create a three-second recording. A similar statistical analysis was applied to confirm the validity of AVQI calculated using this strategy. Figure 2 illustrates the setup of the two experiments.

E. STATISTICAL ANALYSIS OF AVQI

After investigating the validity of the proposed method to calculate the AVQI for individuals with SV recordings of <3 seconds, the validated method (using concatenated vowels) was used to calculate the AVQI of all subjects in the PC-GITA dataset. The AVQI was calculated using the AVQI v.03.01 written in Praat code [43], downloaded from the site provided by Curtis [44].

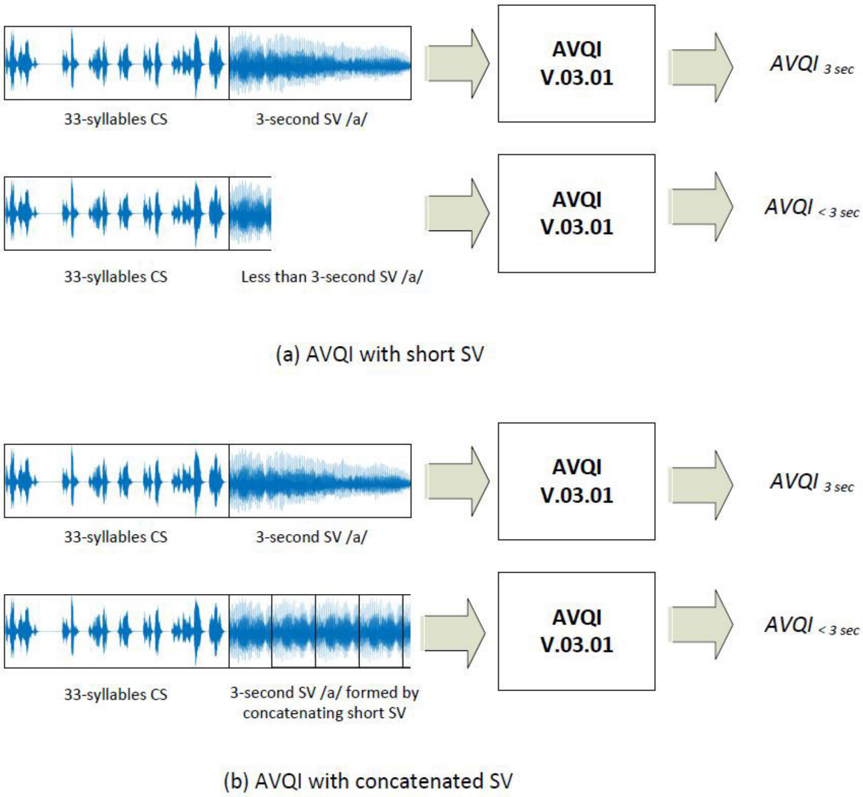


FIGURE 2. The setup of the experiments to validate the AVQI calculation strategy with short and concatenated SV recordings.

The AVQI was calculated using the SV /a/ and the 33-syllable phonetically-balanced CS text reading. The AVQI was calculated using the three SV repetitions. In total, there were 150 AVQIs for PwPD and 150 AVQIs for the HCs.

Statistical analysis, performed using MATLAB 2022 (MathWorks), was conducted to investigate the ability of the AVQI to discriminate PwPD from HCs. The Anderson–Darling test [45] indicated that the AVQI of both groups was non-normally distributed. The effectiveness of the AVQI was assessed by observing the statistical distribution of the two groups, the p-value of the Mann–Whitney U test [46], the Cohen's d effect size [47], and the area-under-the-curve (AUC) of Receiver Operating Characteristic (ROC) curve [48]. The 95% confidence level was considered for the Mann–Whitney U test, and a p-value of <0.05 was considered statistically significant. The ROC curve was also used to identify the optimum AVQI threshold to classify PwPD from HCs. The R^2 of the linear regression model was calculated to investigate correlations between the AVQI and clinical UPDRS and H&Y PD scores and age.

III. RESULTS

A. VALIDITY OF AVQI WITH SHORT SUSTAINED VOWEL

Figure 3 presents the correlation between the ideal AVQI calculated based on SV /a/ with a three-second duration and the AVQI calculated based on SV /a/ recordings of <3 seconds. Five correlations are shown for five different durations of SV /a/ (i.e., $\mathrm{AVQI}_{2.5\ \mathrm{sec}}$, $\mathrm{AVQI}_{2.0\ \mathrm{sec}}$, $\mathrm{AVQI}_{1.5\ \mathrm{sec}}$, $\mathrm{AVQI}_{1.0\ \mathrm{sec}}$, and the $\mathrm{AVQI}_{0.5\ \mathrm{sec}}$). The plots show the distribution of the AVQI values, the linear regression model (blue line), and the ideal regression model if the AVQI calculated based on shorter /a/ recordings is the same as the AVQI calculated based on a three-second SV /a/ recording (red line).

$\mathrm{AVQI}_{3.0\ \mathrm{sec}}$ and $\mathrm{AVQI}_{2.5\ \mathrm{sec}}$ (Figure 3a) were significantly and strongly correlated (R^2 = 0.9894), with the blue and the red lines visually overlapping. However, $p_{intercept}$ was <0.05, indicating that $\mathrm{AVQI}_{2.5\ \mathrm{sec}}$ differed statistically from the ideal $\mathrm{AVQI}_{3.0\ \mathrm{sec}}$.

The shorter the SV /a/ duration, the more invalid the calculated AVQI (Figure 3b-e). While R^2 remained >0.8, p_{slope} and $p_{intercept}$ were significant (<0.05), indicating $\mathrm{AVQI}_{<3\ \mathrm{sec}} \neq \mathrm{AVQI}_{3\ \mathrm{sec}}$, as also confirmed by the lines in the figures. A shorter SV /a/ duration resulted in a higher AVQI.

B. VALIDITY OF AVQI WITH CONCATENATED SUSTAINED VOWEL

The results of the experiment investigating the validity of the AVQI calculated from concatenated SV recordings are presented in Figure 4. The three-second SV recordings were created by concatenating short segments multiple times to

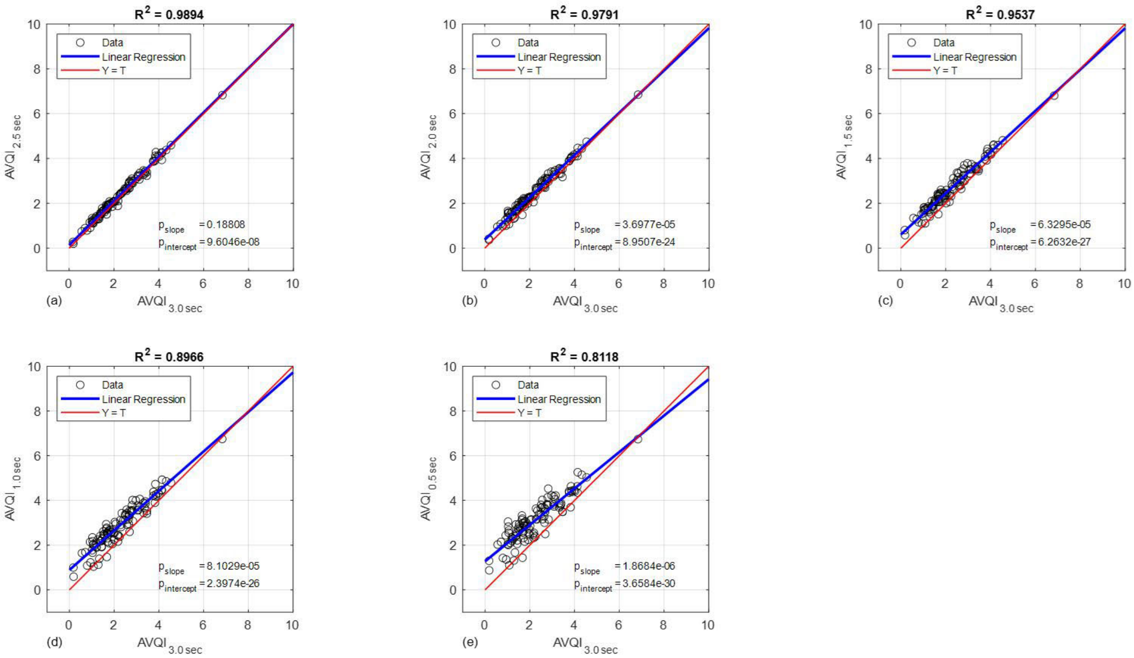


FIGURE 3. The correlation between AVQIs calculated from three-second SV /a/ recordings ($AVQI_{3\ sec}$) and from truncated SV /a/ recordings ($AVQI_{<3\ sec}$). The blue line represents the linear regression model, and the red line (Y = T) represents the ideal similarity between $AVQI_{3\ sec}$ and $AVQI_{<3\ sec}$.

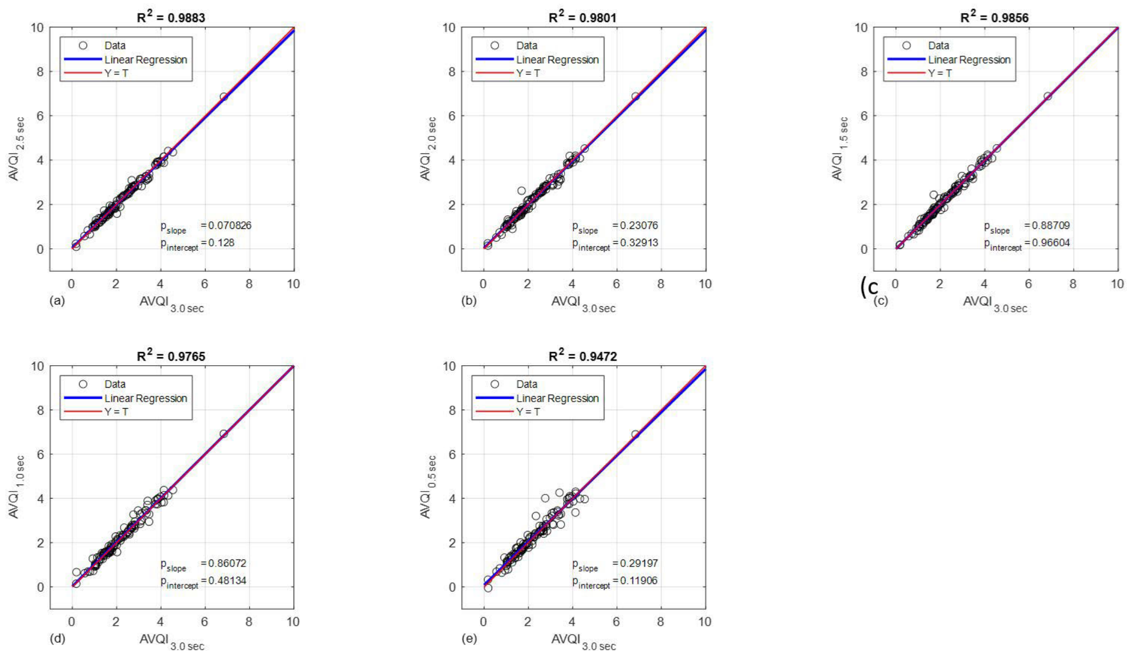


FIGURE 4. The correlation between AVQIs calculated from three-second SV /a/ recordings ($AVQI_{3\ sec}$) and from truncated SV /a/ ($AVQI_{<3\ sec}$) concatenated into three-second recordings. The blue line represents the linear regression model, and the red line (Y = T) represents the ideal similarity between $AVQI_{3\ sec}$ and $AVQI_{<3\ sec}$.

achieve a total duration of $\geq$3 seconds. Specifically, SVs with durations of 2.5 s, 2.0 s, and 1.5 s were duplicated and concatenated once, while SVs with durations of 1.0 s and 0.5 s were duplicated and concatenated three and six times, respectively. The inputs to AVQI calculation were the first 3.0 s of the concatenated SVs.

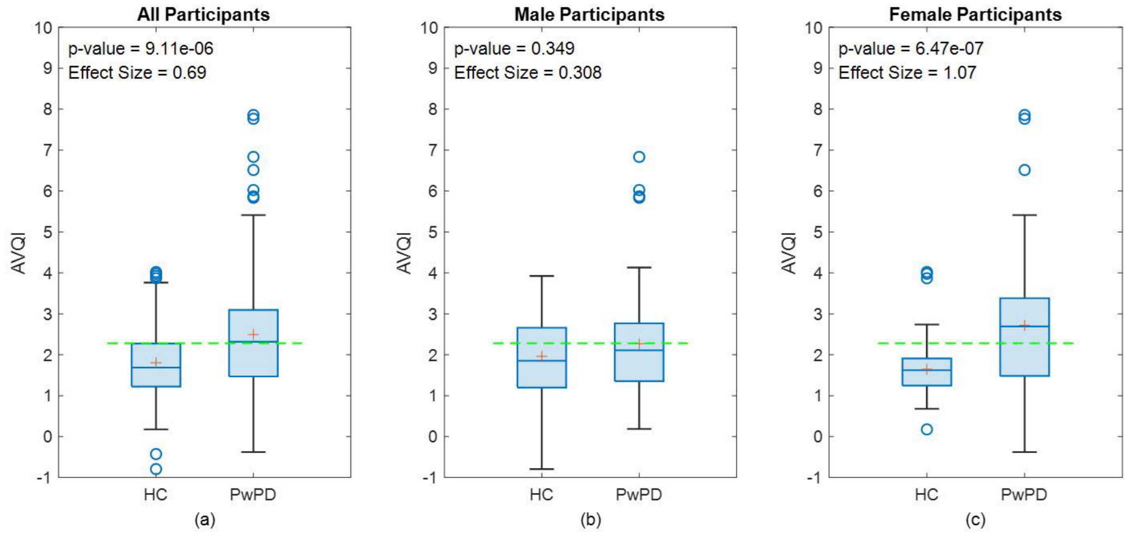


FIGURE 5. **Statistical distribution of the AVQIs of HC and PwPD. The green dashed line represents the AVQI threshold of 2.28.**

The figure shows that the AVQI calculated based on these concatenated SVs was statistically similar to the AVQI calculated using continuous three-second SVs. The R^2 ranged from 0.9472 to 0.9883, and all p_{slope} and $p_{intercept}$ were >0.05. These results confirm the validity of calculating the AVQI based on concatenated SV /a/ recordings.

C. STATISTICAL DISTRIBUTION OF AVQI

Figure 5a shows the statistical distribution of the AVQI of the HC and PwPD groups. The mean AVQI was lower in the HC group than in the PwPD group and below the AVQI threshold level of 2.28 [40], suggesting a better voice quality among HCs than PwPD. The mean AVQI of the PwPD was slightly above the AVQI threshold. While the two distributions mostly overlapped, the p-value of the Mann–Whitney U test and Cohen's d (effect size) of 0.69 indicates a fair separation between the two distributions.

The boxplots in Figures 5b and 5c show that the separation of the AVQI distribution between PwPD and HCs was only evident among female participants, with a p-value of <0.05 and Cohen's d (effect size) of 1.07. In contrast, the AVQI distribution among male participants did not differ significantly between PwPD and HCs. This result indicates the effectiveness of the AVQI in differentiating PwPD from HC, but only among females.

The effectiveness of the AVQI in discriminating PwPD from HCs among female participants is illustrated in Figure 6 and 7. The ROC curve of female participants in Figure 6 has an AUC of 0.74 with the optimum AVQI threshold of 2.31. Figure 7 compares the confusion matrix of male and female participants when discriminating PwPD based on the AVQI with a threshold of 2.31. Any participants with an AVQI above the threshold were predicted as PwPD, and vice versa. The classification approach among female participants showed a promising accuracy of 75.33% with a precision of 88.00% and an F1-score of 70.40%. The classification approach also had a significantly high selectivity of 92.00% with a fair sensitivity of 58.67% among female participants.

The correlations of AVQI (all participants, males only, and females only) with UPDRS scores, H&Y scores, and age were investigated using the R^2 of the linear regression model. All the calculated R^2 were significantly low ($0.0013 \leq R^2 \leq 0.1269$), indicating a lack of correlation between the AVQI and the commonly used PD diagnostic scores and age.

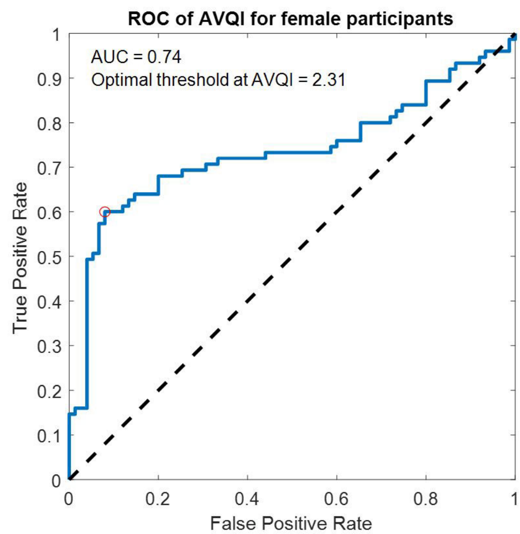


FIGURE 6. **The ROC curve of AVQI among female participants.**

IV. DISCUSSION

Numerous studies have explored the usefulness of the AVQI in diagnosing PD or monitoring its progression [33], [34],

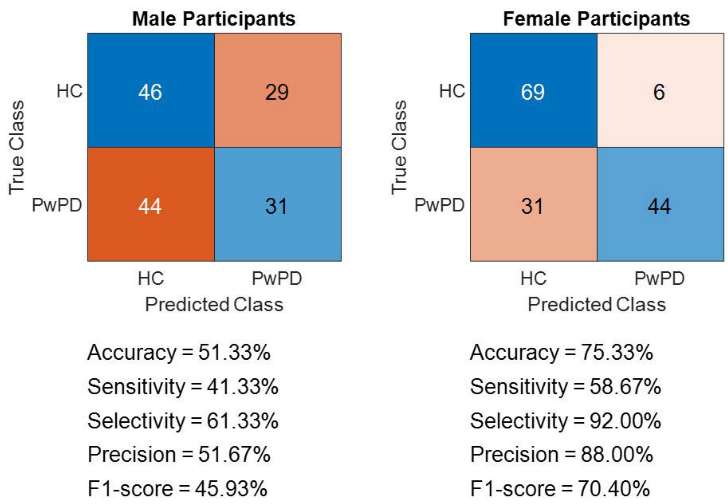


FIGURE 7. The confusion matrix for AVQI among male and female participants.

[35], [36], [37]. Some have identified AVQI changes in PwPD following speech therapy or as the disease becomes more severe. However, no significant correlation has been found between AVQI and PD clinical scores, and the effectiveness of the AVQI in distinguishing PwPD from HC has not been evaluated.

This study investigated the effectiveness of the AVQI in identifying PwPD and validated a preprocessing technique to calculate the AVQI for individuals with short SV recordings. It had three major findings: (1) concatenating short SV /a/ recordings to achieve a total SV duration of three seconds was a valid method to calculate the AVQI for individuals with short SV /a/ recordings, (2) the AVQI is effective in discriminating PwPD from HC among females, and (3) the AVQI is weakly correlated with PD clinical scores and age.

Due to pathological and physiological conditions, PwPD often find it difficult to produce a three-second SV in one breath. Our statistical analysis confirmed that the AVQIs calculated based on concatenated short SV recordings were as accurate as those calculated based on a continuous three-second SV recording ($R^2 > 0.94$ and p_{slope} and $p_{intercept} > 0.05$) for all examined short SV durations, starting from 0.5 s. This finding is expected because the calculation of AVQI v.03.01 already uses the concatenation process [29]. AVQI v.03.01 involves fragmenting the voiced sections of CS, removing the silent sections, and concatenating the voiced frames of the CS to form a continuous CS of about three seconds. This result establishes a scientific basis for using this approach to calculate the AVQI for PwPD with short SV recordings. It can also be used to calculate the AVQI for those with short SV recordings in other applications or purposes.

A notable finding of this study is the efficacy of the AVQI to statistically distinguish PwPD from HCs among females. The two distributions were significantly separated, with a p-value of <0.05, an effect size of 1.07, and an AUC of 0.74. However, this separation was not observed among male participants. This finding suggests that dysphonia symptoms are present in female PwPD and that the AVQI can effectively quantify these symptoms. Conversely, it suggests the possibility of fewer dysphonia symptoms in male PwPD or limitations in the ability of the AVQI to assess dysphonia in male PwPD.

The differences in dysphonia symptoms between male and female PwPD have been previously reported. Pah et al. [49] reported a significant increase in apparent vocal tract length (AVTL) among male PwPD, which was not observed among female PwPD. The phenomenon was observed in two datasets: PC-GITA and the Italian Parkinson's Voice and Speech Dataset. Hejná et al. [50] observed the cepstral peak prominence (CPP) of males and females in two languages (Czech and Danish) and found that female speakers were breathier than male speakers.

One possible explanation for this phenomenon is that vocal tract anatomy differs between males and females [51]. However, additional research is necessary to explore the pathological and physiological basis of this finding and investigate which vocal features are most influenced by the differences in dysphonia symptoms between males and females.

The ROC curve indicates the optimal AVQI threshold (2.31) to distinguish female PwPD from HCs. This threshold is almost similar to the dysphonia threshold (2.28) suggested by Hernàndez et al. [40]. This similarity confirms the ability of the AVQI to detect the level of dysphonia among female PwPD. Classifying female PwPD based on this threshold achieved a promising accuracy of 75.33% with a precision of 88.00%.

The absence of correlations between the AVQI and the widely used PD clinical scales documented in this study aligns with findings reported in other studies [33], [36], [37]. Their absence can be explained by scales such as the UPDRS and H&Y assessing PD severity through comprehensive scoring of diverse symptoms, encompassing both motor and non-motor aspects.

Overall, this study found that the AVQI effectively identified female PwPD. However, the limitation of this study was that it only examined one dataset. The generality of its findings should be investigated in other datasets with different languages and demographic settings. While the classification based on the AVQI achieved high accuracy among female participants, its sensitivity still needs improvement, possibly by combining it with other voice quality indexes.

V. CONCLUSION

This study investigated the efficacy of the AVQI in detecting PD. Its findings show that the AVQI accurately distinguished PD among female participants. It also validated concatenating short SV recordings as a reliable preprocessing method for calculating the AVQI. This finding opens the possibility for developing portable computerized methods or devices to identify PD based on voice quality that will help improve the quality of life of PwPD.

REFERENCES

[1] L. M. de Lau and M. M. Breteler, "Epidemiology of Parkinson's disease," *Lancet Neurol.*, vol. 5, no. 6, pp. 525–535, 2006. [Online]. Available: https://www.ncbi.nlm.nih.gov/pubmed/16713924

[2] E. R. Dorsey, T. Sherer, M. S. Okun, and B. R. Bloem, "The emerging evidence of the Parkinson pandemic," *J. Parkinson's Disease*, vol. 8, no. s1, pp. S3–S8, Dec. 2018.

[3] A.-M. Tăuţan, B. Ionescu, and E. Santarnecchi, "Artificial intelligence in neurodegenerative diseases: A review of available tools with a focus on machine learning techniques," *Artif. Intell. Med.*, vol. 117, Jul. 2021, Art. no. 102081.

[4] C. G. Goetz et al., "Movement disorder society-sponsored revision of the unified Parkinson's disease rating scale (MDS-UPDRS): Scale presentation and clinimetric testing results," *Movement Disorders, Off. J. Movement Disorder Soc.*, vol. 23, no. 15, pp. 2129–2170, 2008.

[5] J. M. Rabey and A. D. Korczyn, "The Hoehn and Yahr rating scale for Parkinson's disease," in *Instrumental Methods and Scoring in Extrapyramidal Disorders*, H. Przuntek, Ed. Berlin, Germany: Springer-Verlag, 1995, pp. 7–17, doi: 10.1007/978-3-642-78914-4_2.

[6] C. Simonet, A. Schrag, A. J. Lees, and A. J. Noyce, "The motor prodromes of Parkinson's disease: From bedside observation to large-scale application," *J. Neurol.*, vol. 268, pp. 2099–2108, Dec. 2019. [Online]. Available: https://www.ncbi.nlm.nih.gov/pubmed/31802219

[7] B. Harel, M. Cannizzaro, and P. J. Snyder, "Variability in fundamental frequency during speech in prodromal and incipient Parkinson's disease: A longitudinal case study," *Brain Cognition*, vol. 56, no. 1, pp. 24–29, Oct. 2004.

[8] E. Schalling, K. Johansson, and L. Hartelius, "Speech and communication changes reported by people with Parkinson's disease," *Folia Phoniatrica et Logopaedica*, vol. 69, no. 3, pp. 131–141, 2017.

[9] S. Yang, F. Wang, L. Yang, F. Xu, M. Luo, X. Chen, X. Feng, and X. Zou, "The physical significance of acoustic parameters and its clinical significance of dysarthria in Parkinson's disease," *Sci. Rep.*, vol. 10, no. 1, pp. 1–9, Jul. 2020, doi: 10.1038/s41598-020-68754-0.

[10] Q. C. Ngo, M. A. Motin, N. D. Pah, P. Drotár, P. Kempster, and D. Kumar, "Computerized analysis of speech and voice for Parkinson's disease: A systematic review," *Comput. Methods Programs Biomed.*, vol. 226, Nov. 2022, Art. no. 107133, doi: 10.1016/j.cmpb.2022.107133.

[11] J. Goyal, P. Khandnor, and T. C. Aseri, "Classification, prediction, and monitoring of Parkinson's disease using computer assisted technologies: A comparative analysis," *Eng. Appl. Artif. Intell.*, vol. 96, Nov. 2020, Art. no. 103955, doi: 10.1016/j.engappai.2020.103955.

[12] B. E. Sakar, M. E. Isenkul, C. O. Sakar, A. Sertbas, F. Gurgen, S. Delil, H. Apaydin, and O. Kursun, "Collection and analysis of a Parkinson speech dataset with multiple types of sound recordings," *IEEE J. Biomed. Health Informat.*, vol. 17, no. 4, pp. 828–834, Jul. 2013. [Online]. Available: https://www.ncbi.nlm.nih.gov/pubmed/25055311

[13] C. O. Sakar, G. Serbes, A. Gunduz, H. C. Tunc, H. Nizam, B. E. Sakar, M. Tutuncu, T. Aydin, M. E. Isenkul, and H. Apaydin, "A comparative analysis of speech signal processing algorithms for Parkinson's disease classification and the use of the tunable Q-factor wavelet transform," *Appl. Soft Comput.*, vol. 74, pp. 255–263, Jan. 2019, doi: 10.1016/j.asoc.2018.10.022.

[14] D. Braga, A. M. Madureira, L. Coelho, and R. Ajith, "Automatic detection of Parkinson's disease based on acoustic analysis of speech," *Eng. Appl. Artif. Intell.*, vol. 77, pp. 148–158, Jan. 2019, doi: 10.1016/j.engappai.2018.09.018.

[15] L. Moro-Velázquez, J. A. Gómez-García, J. I. Godino-Llorente, J. Villalba, J. R. Orozco-Arroyave, and N. Dehak, "Analysis of speaker recognition methodologies and the influence of kinetic changes to automatically detect Parkinson's disease," *Appl. Soft Comput.*, vol. 62, pp. 649–666, Jan. 2018, doi: 10.1016/j.asoc.2017.11.001.

[16] N. D. Pah, M. A. Motin, and D. K. Kumar, "Phonemes based detection of Parkinson's disease for telehealth applications," *Sci. Rep.*, vol. 12, no. 1, pp. 1–9, Jun. 2022, doi: 10.1038/s41598-022-13865-z.

[17] N. D. Pah, M. A. Motin, P. Kempster, and D. K. Kumar, "Detecting effect of levodopa in Parkinson's disease patients using sustained phonemes," *IEEE J. Transl. Eng. Health Med.*, vol. 9, 2021, Art. no. 4900409.

[18] M. A. Motin, N. D. Pah, S. Raghav, and D. K. Kumar, "Parkinson's disease detection using smartphone recorded phonemes in real world conditions," *IEEE Access*, vol. 10, pp. 97600–97609, 2022.

[19] L. Ali, C. Zhu, Z. Zhang, and Y. Liu, "Automated detection of Parkinson's disease based on multiple types of sustained phonations using linear discriminant analysis and genetically optimized neural network," *IEEE J. Transl. Eng. Health Med.*, vol. 7, pp. 1–10, 2019.

[20] A. Tsanas, M. A. Little, P. E. McSharry, J. Spielman, and L. O. Ramig, "Novel speech signal processing algorithms for high-accuracy classification of Parkinson's disease," *IEEE Trans. Biomed. Eng.*, vol. 59, no. 5, pp. 1264–1271, May 2012.

[21] J. C. Vásquez-Correa, J. R. Orozco-Arroyave, T. Bocklet, and E. Nöth, "Towards an automatic evaluation of the dysarthria level of patients with Parkinson's disease," *J. Commun. Disorders*, vol. 76, pp. 21–36, Nov. 2018, doi: 10.1016/j.jcomdis.2018.08.002.

[22] J. Rusz, J. Hlavnicka, T. Tykalová, M. Novotný, P. Dušek, K. Šonka, and E. Ružicka, "Smartphone allows capture of speech abnormalities associated with high risk of developing Parkinson's disease," *IEEE Trans. Neural Syst. Rehabil. Eng.*, vol. 26, no. 8, pp. 1495–1507, Aug. 2018.

[23] M. Hireš, P. Drotár, N. D. Pah, Q. C. Ngo, and D. K. Kumar, "On the inter-dataset generalization of machine learning approaches to Parkinson's disease detection from voice," *Int. J. Med. Informat.*, vol. 179, Nov. 2023, Art. no. 105237, doi: 10.1016/j.ijmedinf.2023.105237.

[24] B. Barsties and M. De Bodt, "Assessment of voice quality: Current state-of-the-art," *Auris Nasus Larynx*, vol. 42, no. 3, pp. 183–188, Jun. 2015.

[25] B. Barsties v. Latoszek, P. Mathmann, and K. Neumann, "The cepstral spectral index of dysphonia, the acoustic voice quality index and the acoustic breathiness index as novel multiparametric indices for acoustic assessment of voice quality," *Current Opinion Otolaryngol. Head Neck Surg.*, vol. 29, no. 6, pp. 451–457, 2021.

[26] A. Ghio, J. Revis, D. Smithson-Barrière, S. Jarzé, and A. Giovanni, "Reliability and correlations between overall severity, roughness and breathiness in the perception of dysphonic voices: Investigating cognitive aspects," *J. Voice*, vol. 38, no. 1, pp. 136–143, Jan. 2024.

[27] M. Hirano and K. R. McCormick, "Clinical examination of voice," *J. Acoust. Soc. Amer.*, vol. 80, no. 4, p. 1273, 1986.

[28] M. P. Karnell, S. D. Melton, J. M. Childes, T. C. Coleman, S. A. Dailey, and H. T. Hoffman, "Reliability of clinician-based (GRBAS and CAPE-V) and patient-based (V-RQOL and IPVI) documentation of voice disorders," *J. Voice*, vol. 21, no. 5, pp. 576–590, Sep. 2007.

[29] Y. Maryn and D. Weenink, "Objective dysphonia measures in the program praat: Smoothed cepstral peak prominence and acoustic voice quality index," *J. Voice*, vol. 29, no. 1, pp. 35–43, Jan. 2015.

[30] B. Barsties and Y. Maryn, "External validation of the acoustic voice quality index version 03.01 with extended representativity," *Ann. Otol., Rhinol. Laryngol.*, vol. 125, no. 7, pp. 571–583, Jul. 2016.

[31] T. Jayakumar and J. J. Benoy, "Acoustic voice quality index (AVQI) in the measurement of voice quality: A systematic review and meta-analysis," *J. Voice*, vol. 38, no. 5, pp. 1055–1069, Sep. 2024.

[32] M. Faham, A.-M. Laukkanen, T. Ikävalko, L. Rantala, A. Geneid, S. Holmqvist-Jämsén, K. Ruusuvirta, and S. Pirilä, "Acoustic voice quality index as a potential tool for voice screening," *J. Voice*, vol. 35, no. 2, pp. 226–232, Mar. 2021.

[33] R. B. Convey, A.-M. Laukkanen, S. Ylinen, and N. Penttilä, "Analysis of voice in Parkinson's disease utilizing the acoustic voice quality index," *J. Voice*, vol. 23, pp. 1–10, Jan. 2024, doi: 10.1016/j.jvoice.2023.12.025.

[34] G. Moya-Galé, J. Spielman, L. A. Ramig, L. Campanelli, and Y. Maryn, "The acoustic voice quality index (AVQI) in people with Parkinson's disease before and after intensive voice and articulation therapies: Secondary outcome of a randomized controlled trial," *J. Voice*, vol. 22, pp. 1–10, Apr. 2022.

[35] R. B. Convey, A.-M. Laukkanen, S. Ylinen, and N. Penttilä, "Analysis of voice changes in early-stage Parkinson's disease with AVQI and ABI: A follow-up study," *J. Voice*, vol. 24, pp. 1–11, Jun. 2024, doi: 10.1016/j.jvoice.2024.05.009.

[36] H. Steurer, E. Schalling, E. Franzén, and F. Albrecht, "Characterization of mild and moderate dysarthria in Parkinson's disease: Behavioral measures and neural correlates," *Frontiers Aging Neurosci.*, vol. 14, May 2022, Art. no. 870998.

[37] D. Cushnie-Sparrow, S. Adams, A. Abeyesekera, M. Pieterman, G. Gilmore, and M. Jog, "Voice quality severity and responsiveness to levodopa in Parkinson's disease," *J. Commun. Disorders*, vol. 76, pp. 1–10, Nov. 2018, doi: 10.1016/j.jcomdis.2018.07.003.

[38] Y. Maryn, P. Corthals, P. Van Cauwenberge, N. Roy, and M. De Bodt, "Toward improved ecological validity in the acoustic measurement of overall voice quality: Combining continuous speech and sustained vowels," *J. Voice*, vol. 24, no. 5, pp. 540–555, Sep. 2010, doi: 10.1016/j.jvoice.2008.12.014.

[39] Y. Maryn, N. Roy, M. De Bodt, P. Van Cauwenberge, and P. Corthals, "Acoustic measurement of overall voice quality: A meta-analysis," *J. Acoust. Soc. Amer.*, vol. 126, no. 5, pp. 2619–2634, Nov. 2009.

[40] J. D. Hernández, N. M. L. Gómez, A. Jiménez, L. M. Izquierdo, and B. B. V. Latoszek, "Validation of the acoustic voice quality index version 03.01 and the acoustic breathiness index in the Spanish language," *Ann. Otol., Rhinol. Laryngol.*, vol. 127, no. 5, pp. 317–326, May 2018.

[41] J. R. Orozco-Arroyave, J. D. Arias-Ledono, J. F. Vargas-Bonilla, and M. C. Gonzalez-Rativa, "New Spanish speech corpus database for the analysis of people suffering from Parkinson's disease," in *Proc. Int. Conf. Lang. Resour. Eval.*, Reykjavik, Iceland, May 2014, pp. 342–347.

[42] J. H. Zar, "Comparing simple linear regression equations," in *Biostatistical Analysis*. Upper Saddle River, NJ, USA: Prentice-Hall, 1999, ch. 18.

[43] B. P. Boersma and V. Van Heuven, "Speak and unSpeak with P RAAT," *Glot Int.*, vol. 5, nos. 9–10, pp. 341–347, 2001.

[44] J. Curtis. (2022). *Acoustic Voice Quality Index (AVQI)*. [Online]. Available: https://www.jamescurtisphd.me/tutorials/voice/avqi

[45] L. Jäntschi and S. D. Bolboaca, "Computation of probability associated with Anderson–Darling statistic," *Mathematics*, vol. 6, no. 6, pp. 1–16, 2018.

[46] J. H. McDonald, *Handbook of Biological Statistics*, 3rd ed., Baltimore, MD, USA: Sparky House Publishing, 2014.

[47] G. M. Sullivan and R. Feinn, "Using effect size—Or why the P value is not enough," *J. Graduate Med. Educ.*, vol. 4, no. 3, pp. 279–282, Sep. 2012.

[48] T. Fawcett, "ROC graphs: Notes and practical considerations for researchers," *Mach. Learn.*, vol. 31, no. 1, pp. 1–38, 2004.

[49] N. D. Pah, M. A. Motin, G. C. Oliveira, and D. K. Kumar, "The change of vocal tract length in people with Parkinson's disease," in *Proc. 45th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. (EMBC)*, Jul. 2023, pp. 1–4.

[50] M. Hejná, P. Šturm, L. Tylečková, and T. Bořil, "Normophonic breathiness in Czech and Danish: Are females breathier than males?" *J. Voice*, vol. 35, no. 3, pp. 498.e1–498.e22, May 2021.

[51] K. Pisanski, V. Cartei, C. McGettigan, J. Raine, and D. Reby, "Voice modulation: A window into the origins of human vocal control?" *Trends Cognit. Sci.*, vol. 20, no. 4, pp. 304–318, Apr. 2016, doi: 10.1016/j.tics.2016.01.002.

NEMUEL D. PAH (Senior Member, IEEE) received the B.E. degree in electronics from the Institut of Teknologi Sepuluh Nopember, Surabaya, Indonesia, in 1992, and the M.Eng. and Ph.D. degrees in electronics engineering from RMIT University, Melbourne, VIC, Australia, in 1999 and 2003, respectively. He is currently an Associate Professor with the University of Surabaya, Indonesia, and a Visiting Associate Professor with RMIT University, Melbourne, Australia. His research interests include signal processing of bioelectrical signals, image processing, and applications of AI in biomedical engineering.

VERONICA INDRAWATI (Member, IEEE) received the B.E. degree in electronics from STTS, Surabaya, Indonesia, in 1990, and the M.T. degree in electronics engineering from Institut Teknologi Bandung, Indonesia, in 1993. She is currently an Associate Professor with the University of Surabaya, Indonesia. Her research interests include control systems and signal processing.

AGUNG PRAYITNO (Member, IEEE) received the B.Eng. degree in electrical engineering from the Sepuluh Nopember Institute of Technology (ITS), Surabaya, Indonesia, in 2003, the M.Eng. degree in control system engineering from Hogeschool van Arnhem en Nijmegen, The Netherlands, in 2010, and the Ph.D. degree in engineering and technology from the Sirindhorn International Institute of Technology, Thammasat University, Thailand, in 2022. He is currently an Associate Professor with the Department of Electrical Engineering, University of Surabaya, Indonesia. His research interests include the cooperative control of multi-agent systems, model reference adaptive control, optimal control, and signal processing.

DINESH K. KUMAR (Senior Member, IEEE) received the B.E. degree from Indian Institute of Technology (IIT), Madras, India, and the Ph.D. degree from IIT Delhi, India, in 1990. He has been a Professor with RMIT University, Melbourne, since 1997, where he leads research in biosignals and his passion is to develop devices for affordable diagnostics. He has experience in two start-ups. He has authored more than 420 articles and seven books. He has been a Senior Professorial Fellow in Brazil and a Vajra Fellow in India. He is on the TGA (Australia) Advisory Panel for medical devices and a fellow of the Australasian Institute of Digital Health (AIDH).

IEEE Access

Multidisciplinary | Rapid Review | Open Access Journal

OVER 10 YEARS OF QUALITY OPEN ACCESS PUBLISHING

An IEEE Journal | Volume 11

About (https://ieeeaccess.i about/)

Sections (https://ieeeaccess.i sections/)

Authors (https://ieeeaccess.i authors/)

IEEE Access (https://ieeeaccess.ieee.org)

Reviewers (https://ieeeaccess.i reviewers/)

Editorial Leadership (https://ieeeaccess.i editorial-leadership/)

Home (https://ieeeaccess.ieee.org/) | Editorial Leadership (https://ieeeaccess.ieee.org/editorial-leadership/) | **Editorial Board**

Editorial Board

The IEEE *Access* Editorial Board members are IEEE Life Fellows, IEEE Fellows, or IEEE Senior Members who are recognized as technical experts in their fields. You can learn more about their responsibilities by visiting our Editorial Leadership (/editorial-leadership/) page. Below you will find a complete list of our board members. You can click on the bio link to learn more about each member.

DEREK ABBOTT

The University of Adelaide, Adelaide, SA, Australia

View Bio → (https://ieeeaccess.ieee.org/editorial-team/derek-abbott/)

JUN CAI

Concordia University, Canada, Montreal, Quebec, Canada

View Bio → (https://ieeeaccess.ieee.org/editorial-team/jun-cai/)

ZHIPENG CAI

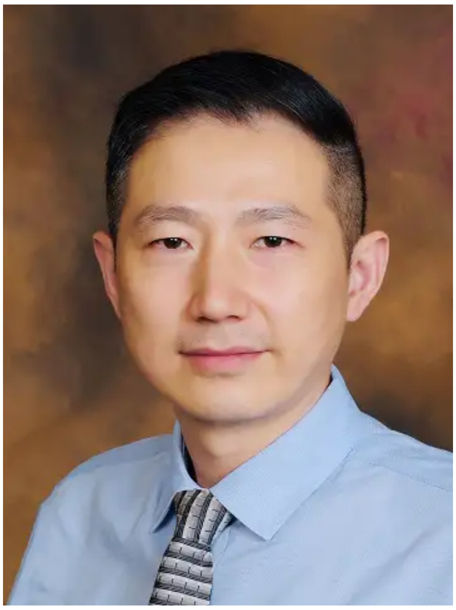
Georgia State University, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/zhipeng-cai/)

KUN-SHAN CHEN

Nanjing University, Jiangsu, China

View Bio → (https://ieeeaccess.ieee.org/editorial-team/kun-shan-chen/)



YIXIN CHEN

Washington University, St. Louis, MO, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/yixin-chen/)

J.-C. CHIAO

Southern Methodist University, Dallas, TX, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/j-c-chiao/)

AYMAN S. EL-BAZ

University of Louisville/Bioengineering Department, Louisville, KY, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/ayman-s-el-baz/)

HOAY B. GOOI

Nanyang Technological University, Singapore

View Bio → (https://ieeeaccess.ieee.org/editorial-team/hoay-b-gooi/)

GIUSEPPE IANNACCONE

University of Pisa, Pisa, Italy

View Bio → (https://ieeeaccess.ieee.org/editorial-team/giuseppe-iannaccone/)

ATIF IQBAL

Qatar University, Doha, Qatar

**View Bio →
(https://ieeeaccess.ieee.org/editorial-team/atif-iqbal/)**

YUMI IWASHITA

NASA-JPL California Institute of Technology, Pasadena, CA, USA

**View Bio →
(https://ieeeaccess.ieee.org/editorial-team/yumi-iwashita/)**

ABBAS JAMALIPOUR

University of Sydney, Sydney, Australia

View Bio → (https://ieeeaccess.ieee.org/editorial-team/abbas-jamalipour/)

BAHRAM JAVIDI

University of Connecticut, Storrs, CT USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/bahram-javidi/)

CECILE JUNG-KUBIAK

Jet Propulsion Laboratory, Pasadena, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/cecile-jung-kubiak/)

HULYA KIRKICI

University of South Alabama, Alabama, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/hulya-kirkici/)

GERMANO LAMBERT-TORRES

Gnarus Institute, Itajuba, Brazil

View Bio → (https://ieeeaccess.ieee.org/editorial-team/germano-lambert-torres/)

XIAOLI LI

Institute for Infocomm Research, Singapore

View Bio → (https://ieeeaccess.ieee.org/editorial-team/xiaoli-li/)

NIGEL LOVELL

UNSW Sydney, Kensington, Australia

View Bio → (https://ieeeaccess.ieee.org/editorial-team/nigel-lovell/)

IMRAN MEHDI

Jet Propulsion Laboratory, California, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/imran-mehdi/)

MICHAL MROZOWSKI

Gdansk University of Technology, Gdansk, Poland

View Bio → (https://ieeeaccess.ieee.org/editorial-team/michal-mrozowski/)

TORU NAMERIKAWA

Keio University, Yokohama, Japan

View Bio → (https://ieeeaccess.ieee.org/editorial-team/toru-namerikawa/)

MICHELE NAPPI

University of Salerno, Fisciano, Italy

View Bio → (https://ieeeaccess.ieee.org/editorial-team/michele-nappi/)

DALMA NOVAK

Octane Wireless, Hanover, Maryland, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/dalma-novak/)

ARNOLD (NEVILLE) PEARS

KTH Royal Institute of Technology, Stockholm, Sweden

**View Bio →
(https://ieeeaccess.ieee.org/editorial-team/arnold-neville-pears/)**

HUGO PROENÇA

University of Beira Interior, Covilhã, Portugal

**View Bio →
(https://ieeeaccess.ieee.org/editorial-team/hugo-proenca/)**

PETER SIEGEL

California Institute of Technology (CalTech), Pasadena, California, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/peter-siegel/)

GEORGIA TOURASSI

Oak Ridge National Laboratory (ORNL), Tennessee, USA

View Bio → (https://ieeeaccess.ieee.org/editorial-team/georgia-tourassi/)

Stay connected with IEEE *Access*! Follow us on social media.

(https://www.facebook.com/ieeeaccess)
(https://x.com/ieeeaccess)
(https://www.linkedin.com/company/ieee-access)
(https://bsky.app/profile/ieeeaccess.bsky.social)
(https://ieee-collabratec.ieee.org/app/community/6/IEEE-Access/activities)

Submit an Article ↗
(https://ieee.atyponrex.com/journal/ieee-access)

View Published Articles
(https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6287639)

(https://www.ieee.org/)

IEEE Access

COUNTRY

United States

Universities and research institutions in United States

Media Ranking in United States

SUBJECT AREA AND CATEGORY

Computer Science
- Computer Science (miscellaneous)

Engineering
- Engineering (miscellaneous)

Materials Science
- Materials Science (miscellaneous)

PUBLISHER

Institute of Electrical and Electronics Engineers Inc.

Institute of Electrical and Electronics Engineers, USA in Scimago Institutions Rankings

SJR 2024

0.849 Q1

H-INDEX

290

PUBLICATION TYPE

Journals

ISSN

21693536

COVERAGE

2013-2025

INFORMATION

Homepage

How to publish in this journal

ieeeaccess@ieee.org

SCOPE

IEEE Access® is a multidisciplinary, open access (OA), applications-oriented, all-electronic archival journal that continuously presents the results of original research or development across all of IEEE's fields of interest. IEEE Access will publish articles that are of high interest to readers, original, technically correct, and clearly presented. Supported by author publication charges (APC), its hallmarks are a rapid peer review and publication process with open access to all readers. Unlike IEEE's traditional Transactions or Journals, reviews are "binary", in that reviewers will either Accept or Reject an article in the form it is submitted in order to achieve rapid turnaround. Especially encouraged are submissions on: Multidisciplinary topics, or applications-oriented articles and negative results that do not fit within the scope of IEEE's traditional journals. Practical articles discussing new experiments or measurement techniques, interesting solutions to engineering. Development of new or improved fabrication or manufacturing techniques. Reviews or survey articles of new or evolving fields oriented to assist others in understanding the new area.

Join the conversation about this journal

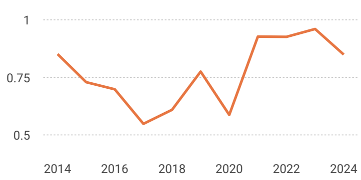
Quartiles

FIND SIMILAR JOURNALS

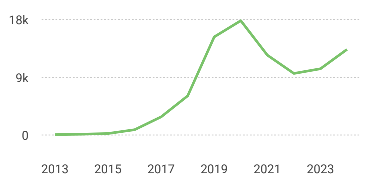
options

1	2	3	4	5
Computers and Electrical Engineering GBR	**Intelligent Automation and Soft Computing** USA	**Computer Systems Science and Engineering** GBR	**International Journal on Recent and Innovation Trends** IND	**International Journal of Computing and Digital** BHR
77% similarity	77% similarity	75% similarity	75% similarity	74% similarity

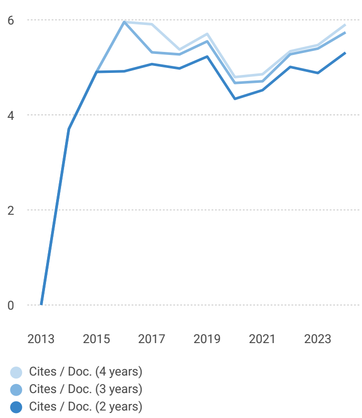
SJR



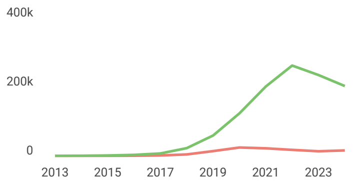
Total Documents



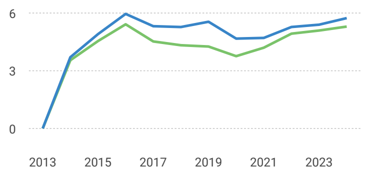
Citations per document



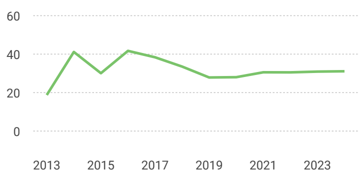
Total Cites Self-Cites



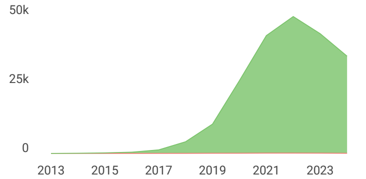
External Cites per Doc Cites per Doc



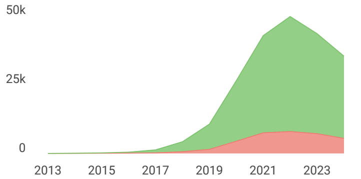
% International Collaboration



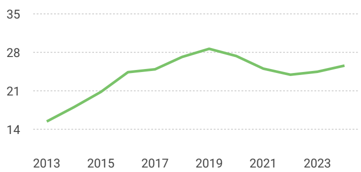
Citable documents Non-citable documents



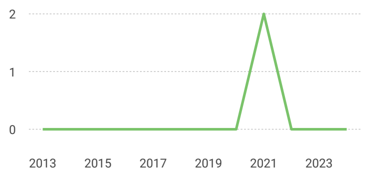
Cited documents Uncited documents



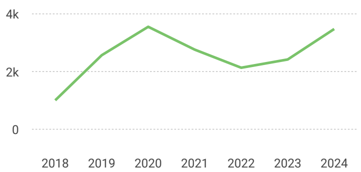
% Female Authors



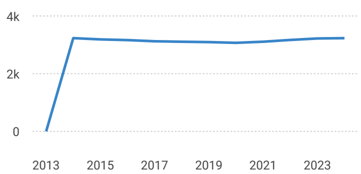
Documents cited by public policy (Overton)



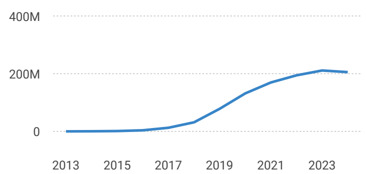
Documents related to SDGs (UN)

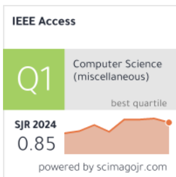


Estimated APC



Estimated financial value





← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scima

SCImago Graphica

Explore, visually communicate and make sense of data with our new data visualization tool.

Metrics based on Scopus® data as of March 2025

Loading comments...

Scopus Preview

Source details

IEEE Access

Open Access

Years currently covered by Scopus: from 2013 to 2025

Publisher: IEEE

E-ISSN: 2169-3536

Subject area: Engineering: General Engineering | Computer Science: General Computer Science | Materials Science: General Materials Science

Source type: Journal

View all documents > | Set document alert | Save to source list

CiteScore 2024
9.0

SJR 2024
0.849

SNIP 2024
1.504

CiteScore | CiteScore rank & trend | Scopus content coverage

Export content for category

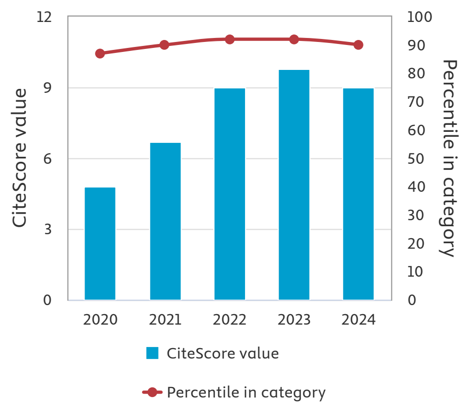
CiteScore rank

2024 | In category: General Engineering

#32 / 344 — IEEE Access — 9.0 — 90th percentile

Rank	Source title	CiteScore 2024	Percentile
#1	ACS Nano	24.2	99th percentile
#2	Computers in Industry	22.4	99th percentile
#3	Nano Convergence	21.0	99th percentile
#4	Technovation	19.5	98th percentile
#5	Engineering with Computers	18.6	98th percentile
#6	Advanced Science	18.2	98th percentile
#7	Renewable Energy	17.6	98th percentile
#8	Engineering	17.0	97th percentile
#9	Composites Science and Technology	16.8	97th percentile
#10	Expert Systems with Applications	15.0	97th percentile
#11	Computers and Industrial Engineering	13.2	96th percentile
#12	Alexandria Engineering Journal	12.9	96th percentile
#13	Journal of Engineering Education	12.6	96th percentile

CiteScore trend



Rank	Source title	CiteScore 2024	Percentile
#14	Engineered Science	12.5	96th percentile
#15	Journal of Environmental Chemical Engineering	12.5	95th percentile
#16	International Journal of Human Computer Studies	12.4	95th percentile
#17	Journal of Management in Engineering	12.3	95th percentile
#18	Ain Shams Engineering Journal	12.2	94th percentile
#19	Educational Technology and Society	12.0	94th percentile
#20	Cell Reports Physical Science	12.0	94th percentile
#21	Indonesian Journal of Science and Technology	11.6	94th percentile
#22	Journal of Science Education and Technology	10.8	93rd percentile
#23	Journal of Technology Transfer	10.6	93rd percentile
#24	IEEE Transactions on Circuits and Systems	10.6	93rd percentile
#25	Design Studies	10.5	92nd percentile
#26	Chaos, Solitons and Fractals	9.9	92nd percentile
#27	International Journal of Thermal Sciences	9.9	92nd percentile
#28	International Journal of Engineering Science	9.8	92nd percentile
#29	Journal of Industrial Integration and Management	9.7	91st percentile
#30	Philosophical transactions. Series A, Mathematical, physical, and engineering sciences	9.6	91st percentile
#31	Advances in Engineering Software	9.2	91st percentile
#32	IEEE Access	9.0	90th percentile
#33	Engineering Failure Analysis	8.8	90th percentile
#34	Journal of Engineering, Design and Technology	8.6	90th percentile
#35	Transportmetrica A: Transport Science	8.6	89th percentile
#36	Nanoscale Advances	8.6	89th percentile
#37	International Journal of Modelling and Simulation	8.5	89th percentile
#38	Computer Applications in Engineering Education	8.3	89th percentile

☆	Rank	Source title	CiteScore 2024	Percentile
☆	#39	European Journal of Engineering Education	8.1	88th percentile
☆	#40	Science China Technological Sciences	8.1	88th percentile
☆	#41	Concurrent Engineering Research and Applications	8.1	88th percentile
☆	#42	International Journal of Sustainable Engineering	8.1	87th percentile
☆	#43	Fractals	8.0	87th percentile
☆	#44	APL Materials	7.9	87th percentile
☆	#45	International Journal of Distributed Sensor Networks	7.4	87th percentile
☆	#46	Results in Engineering	7.3	86th percentile
☆	#47	International Journal of Innovation Science	7.2	86th percentile
☆	#48	International Journal of Technology and Design Education	7.2	86th percentile
☆	#49	IEEE Transactions on Learning Technologies	7.2	85th percentile
☆	#50	Precision Engineering	7.0	85th percentile
☆	#51	RILEM Technical Letters	7.0	85th percentile
☆	#52	IATSS Research	6.9	85th percentile
☆	#53	Nonlinear Engineering	6.8	84th percentile
☆	#54	Journal of Engineering and Technology Management - JET-M	6.7	84th percentile
☆	#55	Engineering Analysis with Boundary Elements	6.6	84th percentile
☆	#56	Development Engineering	6.6	83rd percentile
☆	#57	Journal of Central South University	6.6	83rd percentile
☆	#58	KONA Powder and Particle Journal	6.6	83rd percentile
☆	#59	Communications in Nonlinear Science and Numerical Simulation	6.6	82nd percentile
☆	#60	Discover Applied Sciences	6.5	82nd percentile
☆	#61	Journal of Zhejiang University: Science A	6.4	82nd percentile
☆	#62	Mining of Mineral Deposits	6.3	82nd percentile
☆	#63	Advances in Materials Science and Engineering	6.2	81st percentile

Rank	Source title	CiteScore 2024	Percentile
#64	Computers and Graphics	6.1	81st percentile
#65	International Journal for Numerical Methods in Engineering	6.1	81st percentile
#66	Australasian Journal of Engineering Education	6.0	80th percentile
#67	Journal of Risk Research	6.0	80th percentile
#68	Proceedings of the IEEE Real-Time and Embedded Technology and Applications Symposium, RTAS	5.9	80th percentile
#69	Acta Polytechnica Hungarica	5.8	80th percentile
#70	Computers and Fluids	5.6	79th percentile
#71	International Journal of Service Science, Management, Engineering, and Technology	5.6	79th percentile
#72	Applied Sciences (Switzerland)	5.5	79th percentile
#73	International Journal of Engineering Pedagogy	5.4	78th percentile
#74	Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences	5.4	78th percentile
#75	Polymer Engineering and Science	5.3	78th percentile
#76	Finite Elements in Analysis and Design	5.3	78th percentile
#77	Applied Science and Engineering Progress	5.3	77th percentile
#78	Computing in Science and Engineering	5.1	77th percentile
#79	ChemEngineering	4.9	77th percentile
#80	Mathematical Methods in the Applied Sciences	4.9	76th percentile
#81	Inventions	4.9	76th percentile
#82	Chaos	4.8	76th percentile
#83	Journal of Scientific Computing	4.8	76th percentile
#84	Theoretical and Computational Fluid Dynamics	4.8	75th percentile
#85	Applied Physics Express	4.7	75th percentile
#86	Journal of Biophotonics	4.7	75th percentile
#87	Smart Science	4.7	74th percentile
#88	International Journal of Online and Biomedical Engineering	4.7	74th percentile

Rank	Source title	CiteScore 2024	Percentile
#89	Journal of Engineering Design	4.6	74th percentile
#90	EMJ - Engineering Management Journal	4.5	73rd percentile
#91	Journal of Pre-College Engineering Education Research	4.5	73rd percentile
#92	Analytical Methods	4.5	73rd percentile
#93	International Journal of Agricultural and Biological Engineering	4.5	73rd percentile
#94	Ionics	4.5	72nd percentile
#95	Engineering Studies	4.4	72nd percentile
#96	Data-Centric Engineering	4.4	72nd percentile
#97	Cogent Engineering	4.4	71st percentile
#98	Recent Patents on Nanotechnology	4.3	71st percentile
#99	Proceedings of the IEEE International Conference on Requirements Engineering	4.2	71st percentile
#100	e-Prime - Advances in Electrical Engineering, Electronics and Energy	4.2	71st percentile
#101	Mining Science and Technology (Russian Federation)	4.2	70th percentile
#102	Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology	4.2	70th percentile
#103	Journal of Nonlinear Science	4.2	70th percentile
#104	Design Science	4.2	69th percentile
#105	Journal of Intelligent and Fuzzy Systems	4.2	69th percentile
#106	Engineering Reports	4.1	69th percentile
#107	International Journal of Engineering Transactions C: Aspects	4.0	69th percentile
#108	Revista Iberoamericana de Tecnologias del Aprendizaje	4.0	68th percentile
#109	International Journal of Engineering, Transactions A: Basics	3.9	68th percentile
#110	Journal of Thermal Science and Engineering Applications	3.9	68th percentile

Rank	Source title	CiteScore 2024	Percentile
#111	Proceedings of the ACM SIGACT-SIGMOD-SIGART Symposium on Principles of Database Systems	3.9	67th percentile
#112	International Journal of Engineering, Transactions B: Applications	3.8	67th percentile
#113	IEEE Radio Frequency Integrated Circuits Symposium, RFIC, Digest of Technical Papers	3.8	67th percentile
#114	Proceedings of the Workshop on Algorithm Engineering and Experiments	3.8	67th percentile
#115	AES: Journal of the Audio Engineering Society	3.7	66th percentile
#116	Journal of Engineering and Applied Science	3.7	66th percentile
#117	JOM	3.7	66th percentile
#118	International Review of Aerospace Engineering	3.7	65th percentile
#119	Proceedings -Design, Automation and Test in Europe, DATE	3.7	65th percentile
#120	International Journal of Design	3.6	65th percentile
#121	Nonlinear Analysis: Real World Applications	3.6	64th percentile
#122	Journal of the Brazilian Society of Mechanical Sciences and Engineering	3.5	64th percentile
#123	Proceedings of the International Symposium on Low Power Electronics and Design	3.5	64th percentile
#124	E-Informatica Software Engineering Journal	3.5	63rd percentile
#124	IEEE Technology and Society Magazine	3.5	63rd percentile
#126	International Journal of Mathematical, Engineering and Management Sciences	3.4	63rd percentile
#127	Scientia Iranica	3.4	63rd percentile
#128	Proceedings of the International Symposium on Power Semiconductor Devices and ICs	3.3	62nd percentile
#129	International Conference on Emerging Trends in Engineering and Technology, ICETET	3.3	62nd percentile
#130	Transport and Telecommunication	3.3	62nd percentile
#131	International Journal on Engineering Applications	3.3	62nd percentile
#132	Journal of Scheduling	3.2	61st percentile

☆	Rank	Source title	CiteScore 2024	Percentile
☆	#133	Applied Mathematics in Science and Engineering	3.2	61st percentile
☆	#133	IEEE Wireless Communications and Networking Conference, WCNC	3.2	61st percentile
☆	#135	International Journal of Intelligent Engineering and Systems	3.2	60th percentile
☆	#136	IEEE International Reliability Physics Symposium Proceedings	3.1	60th percentile
☆	#137	Forschung im Ingenieurwesen/Engineering Research	3.1	60th percentile
☆	#138	Special Topics and Reviews in Porous Media	3.1	60th percentile
☆	#139	Engineering Computations	3.1	59th percentile
☆	#140	Gongcheng Kexue Xuebao/Chinese Journal of Engineering	3.1	59th percentile
☆	#141	Applied Engineering Letters	3.1	59th percentile
☆	#141	Microgravity Science and Technology	3.1	59th percentile
☆	#143	Journal for the Measurement of Physical Behaviour	3.1	58th percentile
☆	#144	Proceedings - IEEE Computer Security Foundations Symposium	3.0	58th percentile
☆	#145	International Journal of Continuing Engineering Education and Life-Long Learning	3.0	57th percentile
☆	#146	Metrologia	3.0	57th percentile
☆	#147	International Journal of Technology Management	3.0	57th percentile
☆	#148	Journal of Engineering Research (Kuwait)	3.0	57th percentile
☆	#149	Engineering, Technology and Applied Science Research	2.9	56th percentile
☆	#150	Japanese Journal of Applied Physics, Part 2: Letters	2.9	56th percentile
☆	#151	International Journal of Technology	2.8	56th percentile
☆	#152	Research Technology Management	2.8	55th percentile
☆	#153	International Review of Applied Sciences and Engineering	2.8	55th percentile
☆	#154	Proceedings - Symposium on the High Performance Interconnects, Hot Interconnects	2.8	55th percentile

☆ Rank	Source title	CiteScore 2024	Percentile
#155	Bulletin of the Polish Academy of Sciences: Technical Sciences	2.7	55th percentile
#156	Engineering Journal	2.6	54th percentile
#157	International Journal of Applied Science and Engineering	2.6	54th percentile
#157	Journal of Engineering Mathematics	2.6	54th percentile
#159	Journal of Aerospace Technology and Management	2.5	53rd percentile
#160	Proceedings of the ACM/IEEE Joint Conference on Digital Libraries	2.5	53rd percentile
#161	Engineering and Applied Science Research	2.5	53rd percentile
#162	Journal of the Chinese Institute of Engineers, Transactions of the Chinese Institute of Engineers,Series A/Chung-kuo Kung Ch'eng Hsuch K'an	2.5	53rd percentile
#163	Engineering Letters	2.5	52nd percentile
#164	Optical Engineering	2.5	52nd percentile
#165	International Journal of Engineering Systems Modelling and Simulation	2.5	52nd percentile
#166	International Journal of Nanoscience and Nanotechnology	2.5	51st percentile
#166	Qinghua Daxue Xuebao/Journal of Tsinghua University	2.5	51st percentile
#168	Communications in Science and Technology	2.5	51st percentile
#169	IEEE Global Engineering Education Conference, EDUCON	2.4	51st percentile
#170	Journal of Applied Science and Engineering	2.4	50th percentile
#171	Modelling and Simulation in Engineering	2.4	50th percentile
#172	IIUM Engineering Journal	2.3	50th percentile
#173	International Journal on Electrical Engineering and Informatics	2.3	49th percentile
#174	Journal of Integrated Science and Technology	2.3	49th percentile
#175	Tehnicki Vjesnik	2.3	49th percentile
#176	Journal of Applied Engineering Science	2.3	48th percentile
#177	Ergonomics in Design	2.3	48th percentile

☆	Rank	Source title	CiteScore 2024	Percentile
☆	#178	Journal of the Chinese Society of Corrosion and Protection	2.2	48th percentile
☆	#179	Advances in Engineering Education	2.2	48th percentile
☆	#180	Applied Engineering in Agriculture	2.2	47th percentile
☆	#181	Gongcheng Kexue Yu Jishu/Advanced Engineering Sciences	2.2	47th percentile
☆	#182	Proceedings - IEEE International Conference on Mobile Data Management	2.2	47th percentile
☆	#183	Beijing Ligong Daxue Xuebao/Transaction of Beijing Institute of Technology	2.1	46th percentile
☆	#184	Advances in Science and Technology Research Journal	2.1	46th percentile
☆	#185	Nanoscience and Nanotechnology - Asia	2.1	46th percentile
☆	#186	Journal of Engineering Science and Technology	2.1	46th percentile
☆	#187	Finite Fields and their Applications	2.1	45th percentile
☆	#188	World Transactions on Engineering and Technology Education	2.1	45th percentile
☆	#189	Gazi University Journal of Science	2.1	45th percentile
☆	#190	EUREKA, Physics and Engineering	2.0	44th percentile
☆	#191	Journal of Integrated Design and Process Science	2.0	44th percentile
☆	#192	Journal of Engineering and Technological Sciences	2.0	44th percentile
☆	#193	Proceedings of the Estonian Academy of Sciences	2.0	44th percentile
☆	#194	International Journal of Engineering Education	2.0	43rd percentile
☆	#195	Tehnicki Glasnik	2.0	43rd percentile
☆	#196	International Journal of Engineering Research in Africa	2.0	43rd percentile
☆	#197	Frontiers in Heat and Mass Transfer	2.0	42nd percentile
☆	#197	Periodica Polytechnica Social and Management Sciences	2.0	42nd percentile
☆	#199	Proceedings of the Annual Hawaii International Conference on System Sciences	2.0	42nd percentile

☆	Rank	Source title	CiteScore 2024	Percentile
☆	#200	Yingyong Jichu yu Gongcheng Kexue Xuebao/ Journal of Basic Science and Engineering	1.9	42nd percentile
☆	#201	Strategic Design Research Journal	1.9	41st percentile
☆	#202	Engineering Research Express	1.9	41st percentile
☆	#203	Dongnan Daxue Xuebao (Ziran Kexue Ban)/ Journal of Southeast University (Natural Science Edition)	1.9	41st percentile
☆	#204	Networks and Heterogeneous Media	1.9	40th percentile
☆	#205	Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu	1.9	40th percentile
☆	#206	International Journal on Technical and Physical Problems of Engineering	1.9	40th percentile
☆	#207	International Journal of Thermodynamics	1.8	39th percentile
☆	#208	Journal of Engineering Education Transformations	1.8	39th percentile
☆	#209	International Review of Mechanical Engineering	1.8	39th percentile
☆	#210	Journal of Applied Research and Technology	1.8	39th percentile
☆	#211	Japan Journal of Industrial and Applied Mathematics	1.8	38th percentile
☆	#212	Journal of the Faculty of Engineering and Architecture of Gazi University	1.8	38th percentile
☆	#213	Hsi-An Chiao Tung Ta Hsueh/Journal of Xi'an Jiaotong University	1.8	38th percentile
☆	#214	International Journal of Engineering Trends and Technology	1.8	37th percentile
☆	#215	International Journal of Computational Materials Science and Surface Engineering	1.7	37th percentile
☆	#216	Latvian Journal of Physics and Technical Sciences	1.7	37th percentile
☆	#217	Journal of Integrated Coastal Zone Management	1.7	37th percentile
☆	#218	Harbin Gongye Daxue Xuebao/Journal of Harbin Institute of Technology	1.7	36th percentile
☆	#219	Recent Patents on Engineering	1.7	36th percentile
☆	#220	International Journal of Design and Nature and Ecodynamics	1.7	36th percentile

Rank	Source title	CiteScore 2024	Percentile
#221	African Journal of Research in Mathematics, Science and Technology Education	1.7	35th percentile
#222	Engineering Economist	1.7	35th percentile
#223	International Journal of Technology, Policy and Management	1.6	35th percentile
#224	Bioinspired, Biomimetic and Nanobiomaterials	1.6	35th percentile
#225	Revista Facultad de Ingenieria	1.6	34th percentile
#226	Advances in Technology Innovation	1.6	34th percentile
#227	AIUB Journal of Science and Engineering	1.6	34th percentile
#228	Iranian Journal of Materials Science and Engineering	1.6	33rd percentile
#229	International Journal on Advanced Science, Engineering and Information Technology	1.5	33rd percentile
#230	Zhejiang Daxue Xuebao (Gongxue Ban)/Journal of Zhejiang University (Engineering Science)	1.5	33rd percentile
#231	Indian Journal of Engineering and Materials Sciences	1.5	32nd percentile
#232	Acta Polytechnica	1.5	32nd percentile
#233	Jurnal Teknologi	1.5	32nd percentile
#234	Proceedings - Applied Imagery Pattern Recognition Workshop	1.5	32nd percentile
#235	Journal of Beijing Institute of Technology (English Edition)	1.5	31st percentile
#236	Xibei Gongye Daxue Xuebao/Journal of Northwestern Polytechnical University	1.4	31st percentile
#237	Engineering Transactions	1.4	31st percentile
#238	High Temperature	1.4	30th percentile
#239	Acta Scientiarum - Technology	1.4	30th percentile
#240	International Journal of Advanced Intelligence Paradigms	1.4	30th percentile
#241	Beijing Jiaotong Daxue Xuebao/Journal of Beijing Jiaotong University	1.4	30th percentile
#242	Journal of Technology Education	1.4	29th percentile
#243	International Journal of Computer Aided Engineering and Technology	1.4	29th percentile

Rank	Source title	CiteScore 2024	Percentile
#244	Proceedings of the Romanian Academy Series A - Mathematics Physics Technical Sciences Information Science	1.3	29th percentile
#245	Al-Khwarizmi Engineering Journal	1.3	28th percentile
#246	Beijing Gongye Daxue Xuebao / Journal of Beijing University of Technology	1.3	28th percentile
#247	Ingenieria e Investigacion	1.3	28th percentile
#248	El-Cezeri Journal of Science and Engineering	1.2	28th percentile
#249	High Temperature Material Processes	1.2	27th percentile
#250	Advances in Systems Science and Applications	1.2	27th percentile
#251	Conference Record - Industrial and Commercial Power Systems Technical Conference	1.2	27th percentile
#252	Journal of Studies in Science and Engineering	1.2	26th percentile
#253	Jiangsu Daxue Xuebao (Ziran Kexue Ban) / Journal of Jiangsu University (Natural Science Edition)	1.2	26th percentile
#254	Eurasian Physical Technical Journal	1.2	26th percentile
#255	DYNA (Colombia)	1.1	26th percentile
#256	Engineering Access	1.1	25th percentile
#257	Modeling and Simulation in Science, Engineering and Technology	1.1	25th percentile
#258	Herald of the Bauman Moscow State Technical University, Series Natural Sciences	1.1	25th percentile
#259	Yingyong Kexue Xuebao/Journal of Applied Sciences	1.1	24th percentile
#260	Journal of Optical Technology (A Translation of Opticheskii Zhurnal)	1.1	24th percentile
#261	International Journal of Reasoning-based Intelligent Systems	1.1	24th percentile
#262	PoliTO Springer Series	1.1	23rd percentile
#263	Engineering Review	1.1	23rd percentile
#264	Journal of Engineering Science and Technology Review	1.1	23rd percentile
#265	Huanan Ligong Daxue Xuebao/Journal of South China University of Technology (Natural Science)	1.1	23rd percentile

	Rank	Source title	CiteScore 2024	Percentile
☆	#266	Science and Global Security	1.1	22nd percentile
☆	#266	U.Porto Journal of Engineering	1.1	22nd percentile
☆	#268	Journal of Computing Science and Engineering	1.0	22nd percentile
☆	#269	Journal of Integrated Disaster Risk Management	1.0	21st percentile
☆	#270	Dongbei Daxue Xuebao/Journal of Northeastern University	1.0	21st percentile
☆	#271	ASEAN Engineering Journal	1.0	21st percentile
☆	#271	Journal of Computational Methods in Sciences and Engineering	1.0	21st percentile
☆	#273	Journal of Engineering Physics and Thermophysics	0.9	20th percentile
☆	#274	ZWF Zeitschrift fuer Wirtschaftlichen Fabrikbetrieb	0.9	20th percentile
☆	#275	Journal of Southeast University (English Edition)	0.9	20th percentile
☆	#276	Conference Proceedings of the Society for Experimental Mechanics Series	0.9	19th percentile
☆	#277	Measurement Techniques	0.9	19th percentile
☆	#278	International Journal of Services, Technology and Management	0.9	19th percentile
☆	#279	Ingenieria y Universidad	0.9	19th percentile
☆	#280	Proceedings of International Conference on Applied Innovation in IT	0.9	18th percentile
☆	#281	Acta Periodica Technologica	0.9	18th percentile
☆	#282	Wiadomosci Lekarskie	0.9	18th percentile
☆	#283	Ingeniare	0.8	17th percentile
☆	#284	Isi Bilimi Ve Teknigi Dergisi/ Journal of Thermal Science and Technology	0.8	17th percentile
☆	#285	Nanjing Li Gong Daxue Xuebao/Journal of Nanjing University of Science and Technology	0.8	17th percentile
☆	#286	International Journal of Systematic Innovation	0.8	17th percentile
☆	#287	Al-Qadisiyah Journal for Engineering Sciences	0.8	16th percentile
☆	#288	Inorganic Materials: Applied Research	0.8	16th percentile

Rank	Source title	CiteScore 2024	Percentile
#289	International Journal of Dynamical Systems and Differential Equations	0.8	16th percentile
#290	Asia-Pacific Journal of Science and Technology	0.8	15th percentile
#291	Journal of Engineering Technology	0.8	15th percentile
#292	Revista Politecnica	0.7	15th percentile
#293	ASEE Annual Conference and Exposition, Conference Proceedings	0.7	14th percentile
#294	Multiphase Science and Technology	0.7	14th percentile
#295	Proceedings - International Conference of the Chilean Computer Science Society, SCCC	0.7	14th percentile
#296	Journal of Engineering Research	0.7	14th percentile
#297	Lecture Notes in Computational Science and Engineering	0.7	13th percentile
#298	Digest of Technical Papers - SID International Symposium	0.7	13th percentile
#299	ARPN Journal of Engineering and Applied Sciences	0.7	13th percentile
#300	Shanghai Ligong Daxue Xuebao/Journal of University of Shanghai for Science and Technology	0.7	12th percentile
#301	Dalian Ligong Daxue Xuebao/Journal of Dalian University of Technology	0.7	12th percentile
#302	Indian Journal of Engineering	0.7	12th percentile
#303	Polytrauma	0.6	12th percentile
#304	HKIE Transactions Hong Kong Institution of Engineers	0.6	11th percentile
#305	SpringerBriefs in Applied Sciences and Technology	0.6	11th percentile
#306	Defence S and T Technical Bulletin	0.6	11th percentile
#307	Revista Internacional de Metodos Numericos para Calculo y Diseno en Ingenieria	0.6	10th percentile
#308	Pakistan Journal of Engineering and Applied Sciences	0.6	10th percentile
#309	Ingenieria (Colombia)	0.6	10th percentile
#310	Huadong Ligong Daxue Xuebao /Journal of East China University of Science and Technology	0.6	10th percentile

	Rank	Source title	CiteScore 2024	Percentile
☆	#311	Diyala Journal of Engineering Sciences	0.5	9th percentile
☆	#312	Acta Polytechnica CTU Proceedings	0.5	9th percentile
☆	#313	IEEE International Professional Communication Conference	0.5	9th percentile
☆	#314	Eurasia Proceedings of Science, Technology, Engineering and Mathematics	0.5	8th percentile
☆	#315	Mathematical and Computational Applications	0.5	8th percentile
☆	#316	International Journal of Science, Mathematics and Technology Learning	0.5	8th percentile
☆	#317	Journal of Technology, Management, and Applied Engineering	0.4	7th percentile
☆	#318	Journal of Harbin Institute of Technology (New Series)	0.4	7th percentile
☆	#319	NED University Journal of Research	0.4	7th percentile
☆	#320	Kufa Journal of Engineering	0.4	7th percentile
☆	#321	Nigerian Journal of Technology	0.4	6th percentile
☆	#322	STEAM-H: Science, Technology, Engineering, Agriculture, Mathematics and Health	0.4	6th percentile
☆	#323	Johns Hopkins APL Technical Digest (Applied Physics Laboratory)	0.4	6th percentile
☆	#324	IET Conference Proceedings	0.4	5th percentile
☆	#325	Suranaree Journal of Science and Technology	0.4	5th percentile
☆	#326	African Journal of Applied Research	0.4	5th percentile
☆	#327	Gaojishu Tongxin/Chinese High Technology Letters	0.3	5th percentile
☆	#328	International Symposium on Project Approaches in Engineering Education	0.3	4th percentile
☆	#329	Annals of Arid Zone	0.3	4th percentile
☆	#330	Journal of Technology	0.3	4th percentile
☆	#330	SPE Eastern Regional Meeting	0.3	4th percentile
☆	#332	Resource: Engineering and Technology for Sustainable World	0.3	3rd percentile
☆	#333	Mathematical Engineering	0.3	3rd percentile

Rank	Source title	CiteScore 2024	Percentile
#334	Transactions of the Japan Society for Computational Engineering and Science	0.2	3rd percentile
#335	VDI-Berichte	0.2	2nd percentile
#336	Advanced Topics in Science and Technology in China	0.2	2nd percentile
#337	Consulting-Specifying Engineer	0.1	2nd percentile
#338	Bulletin of Japan Association for Fire Science and Engineering	0.1	1st percentile
#338	International Symposium on Technology and Society, Proceedings	0.1	1st percentile
#340	SWE Magazine	0.0	1st percentile
#341	Proceedings - IEEE International Symposium on Distributed Simulation and Real-Time Applications, DS-RT	0.0	1st percentile
#342	Engineer	0.0	0th percentile
#343	Design Engineering (Toronto)	0.0	0th percentile
#343	Synthesis Lectures on Engineers, Technology, and Society	0.0	0th percentile