OpenVoice PD Monitor: A Novel, Privacy-Preserving Open-Source Mobile Application for Parkinson's Disease Diagnostic Indication

I. Summary of Main Application

1. Project Title
OpenVoice PD Monitor: A Novel, Privacy-Preserving Open-Source Mobile Application for Parkinson's Disease Diagnostic Indication

2. Executive Summary
Parkinson's Disease (PD) is a progressive neurodegenerative disorder requiring accurate, objective symptom diagnosis for effective management. Traditional clinical assessments are often sporadic and subjective, leading to delays in identification. Voice impairment, affecting up to 90% of PD patients, presents a promising, non-invasive digital biomarker.

The "OpenVoice PD Monitor" proposes the development of an innovative, open-source mobile application designed to leverage voice analysis to provide a preliminary diagnostic indication of PD for individuals, thereby acting as a Decision Support System (DSS) to guide them towards a clinician if needed. This project also aims to accelerate open scientific research. The application will enable users to record voice samples, which will undergo advanced Machine Learning (ML) and Deep Learning (DL) analysis with stringent privacy protection. Results will be presented via a personalized dashboard, allowing users to view their diagnostic indication and the confidence score of the assessment.

This project directly aligns with the NGI Zero Commons Fund's vision for an open, trustworthy, and human-centered internet. It creates a freely accessible "digital common" of tools and methodologies for health diagnosis. The project team will include a dedicated clinician neurologist with over 15 years of experience, ensuring clinical relevance and providing expert validation of the system's diagnostic indications.

3. Alignment with NGI Vision and Call for Proposals
- "OpenVoice PD Monitor" is fundamentally an R&D project that directly contributes to the Next Generation Internet Commons.
- **Contribution to Internet Commons:** It creates a new "common" for health data analysis, making voice-based PD diagnostic indication transparent and accessible, rather than confined to proprietary systems.
- **Open Source/Access:** All source code will be released under a recognized open-source license. All scientific outcomes will be published open access, fostering open science and reproducibility.
- **User Empowerment:** The application places users in control of their health data, providing accessible tools for self-assessment and contributing to a more human-centered internet.
- **European Dimension:** Developed with strict adherence to GDPR principles, the project

aims to benefit European citizens directly, fostering collaboration with European research and patient organizations.

4. Brief Technical Approach

The platform will utilize a comprehensive suite of ML (e.g., SVM, Random Forest, XGBoost, KNN, Naive Bayes) and DL methods (e.g., CNNs, LSTMs, ResNet, Transformers, FCNN) to analyze voice features (Jitter, Shimmer, HNR, PPE, MFCCs, spectral characteristics). The mobile application will be developed using Flutter, a cross-platform framework, ensuring broad accessibility for users on both iOS and Android devices. All raw audio recordings captured by the user's mobile device will be temporarily stored locally on the device in volatile memory only during feature extraction. Immediately upon recording completion, advanced audio feature extraction algorithms (using Python libraries such as Librosa and Praat integrated directly into the app or through a secure, embedded backend module) will process these recordings locally. The extracted features will then undergo anonymization techniques (pitch-shifting, time-scale modification, noise addition) locally to further ensure anonymity. This "on-the-fly" processing design approach significantly reduces privacy and ethical risks by ensuring sensitive data remains ephemeral, secure, and under user control always, aligning with both NGI Zero's commitment to privacy-first technology and GDPR compliance. Initial model development and validation will use the Kaggle Parkinson's Disease Voice Dataset (males~66%, females~33%, age: mean 64.4 years with standard deviation~9.24) [16]. Subsequently, a private test dataset, curated by the collaborating neurologist, will be used to assess the model's generalizability in a real-world clinical context.

5. Expected Impact and Value Proposition

The project is expected to deliver significant impact:

- **Human-Centric Impact:** Provides an accessible Decision Support System (DSS) for individuals to obtain a preliminary indication of PD, enhancing active participation in health management and guiding them towards professional clinical assessment if needed.
- **Scientific Impact:** It will foster an openly accessible voice application, accelerating PD research and leading to improved diagnostic tools.
- **Economic Impact:** Reduces the cost of preliminary PD assessment and encourages innovation in open digital health. By broadening the identification of PD patients, it enables earlier, more effective interventions and ultimately reduces the financial burden on the healthcare system.
- **NGI Strategic Impact:** Reinforces open internet principles by applying them to a critical public health domain, contributing to resilient and trustworthy digital commons.

6. Budget Summary (50,000 EUR)

The requested 50,000 EUR funding will be allocated as follows:

- **50% (25,000 EUR) for Salaries:** Supports a Lead ML Engineer/Researcher, a PhD Candidate, a Lead Engineer Professor, and a Clinician Neurologist for core R&D over a 1-year period.
- **10% (5,000 EUR) for Hardware/Computational Resources:** Allocated for physical hardware purchase and specialized software/tools.
- **20% (10,000 EUR) for Journal and Conference Publications:** Covers Open Access Article Processing Charges and conference dissemination fees.

- **20% (10,000 EUR) for Other Expenses:** Covers administrative costs, legal/ethical review, and minor unforeseen expenses.

II. Full Proposal

1. Introduction and Context

1.1. Introduction to Parkinson's Disease (PD) and Current Diagnostic Challenges
Vocal impairment, or dysphonia, is an early and highly prevalent symptom of PD, affecting up to 90% of patients, even in early stages [4]. Changes in voice stem from neurological damage impacting speech-related muscles. Specific acoustic features, such as variations in fundamental frequency (Jitter), amplitude (Shimmer), and the harmonics-to-noise ratio (HNR), have been strongly correlated with PD severity [5]. The non-invasive, low-cost, and repeatable nature of voice recording makes it an ideal candidate for providing a diagnostic indication of the disease. The ability to process voice data offers a unique opportunity to develop advanced diagnostic support tools.

1.2. The Promise of Voice as a Digital Biomarker
Vocal impairment, or dysphonia, is an early and highly prevalent symptom of PD, affecting up to 90% of patients, even in early stages [1]. Changes in voice stem from neurological damage impacting speech-related muscles. Specific acoustic features, such as variations in fundamental frequency (Jitter), amplitude (Shimmer), and the harmonics-to-noise ratio (HNR), have been strongly correlated with PD severity [1]. The non-invasive, low-cost, and repeatable nature of voice recording makes it an ideal candidate for providing a diagnostic indication of the disease. The ability to process voice data offers a unique opportunity to develop advanced diagnostic support tools.

1.3. Unmet Needs in PD Care and the Opportunity for Open Innovation
Despite advancements, significant unmet needs persist in PD care:

- **Lack of Objective, Timely Diagnostic Indication:** Assessments are often subjective and intermittent, making accurate and timely preliminary assessment challenging.
- **Limited Access:** Not all patients have access to specialized neurologists or diagnostic facilities, particularly in rural areas.
- **Data Privacy Concerns:** Existing solutions often rely on proprietary, closed systems, raising concerns about ownership and security of sensitive health data.
- **Fragmented Research Data:** Data from different studies are often incompatible or inaccessible, hindering collaborative research and the development of more robust ML/DL models.

Developing open-source solutions, grounded in Next Generation Internet (NGI) principles, offers a unique opportunity to address these challenges. An open-access platform prioritizing privacy can bridge these gaps, empower patients, and accelerate scientific progress, creating a digital public good.

1.4. Project Vision and Contribution to Next Generation Internet Commons

"OpenVoice PD Monitor" envisions a future where PD diagnostic indication is accessible, transparent, and human-centered. Our goal is to create a platform that not only offers preliminary diagnostic insights to users, but also actively contributes to building the "commons" of the open internet, as promoted by the NGI Zero Commons Fund. This is achieved through:

- **Open-Source Software:** All code, from frontend to ML models, will be open source, enabling full transparency, community auditing, and collaboration.
- **Open Data & AI:** We will publish an open-access toolkit for extracting and interpreting Parkinson's disease vocal biomarkers, facilitate voluntary anonymized contributions, and establish the foundation for a potential collaboratively generated voice-feature dataset to support future research.
- **User Autonomy:** Users will retain full control over their data, with clear consent mechanisms for any contribution of anonymized features to public datasets.
- **Trustworthiness & Resilience:** The transparent and open nature of the project, combined with privacy-preserving techniques, will build trust and ensure platform resilience.

By contributing in these areas, OpenVoice PD Monitor aims to show how open digital tools can help solve real healthcare challenges and create sustainable public benefits. The project brings together researchers, clinicians, and people living with Parkinson's disease to ensure the system is scientifically sound, clinically relevant, and centered on real-world needs [9].

2. The Project: Concept and Innovation

2.1. Core Functionality and User Journey

The "OpenVoice PD Monitor" will be a user-friendly mobile application designed for accessibility across various devices. The user journey is simple and intuitive:

1. **Voice Recording & On-the-Fly Feature Extraction:** Users will record short, standardized voice samples (e.g., sustained vowels, reading short sentences) directly via their mobile device's microphone. Crucially, raw audio data will be processed "on the fly" using Python libraries and tools) to extract relevant features; raw audio recordings will never be permanently stored or uploaded to servers. After features are extracted, the raw recordings will be automatically deleted from the device's memory.
2. **Privacy Protection & Anonymization:** Before any processing of the extracted features, these features will undergo advanced anonymization techniques (see Section 3.2), ensuring they cannot be linked to the user's identity.
3. **ML/DL Analysis for Diagnostic Indication:** The anonymized features will be used as input for the integrated ML/DL models to provide a preliminary diagnostic indication.
4. **Personalized Insights & Clinician Referral:** Users will access a personalized dashboard displaying their diagnostic indication (e.g., "Voice characteristics suggest a higher likelihood of PD, consider consulting a neurologist") and the confidence score of the assessment. This system acts as a Decision Support System (DSS) designed to provide a "warning" or "indication" that suggests a consultation with a clinician. This dashboard can be shared (with explicit user consent) with healthcare providers to facilitate further clinical assessment.

This detailed workflow is visually represented in Figure 1 below.

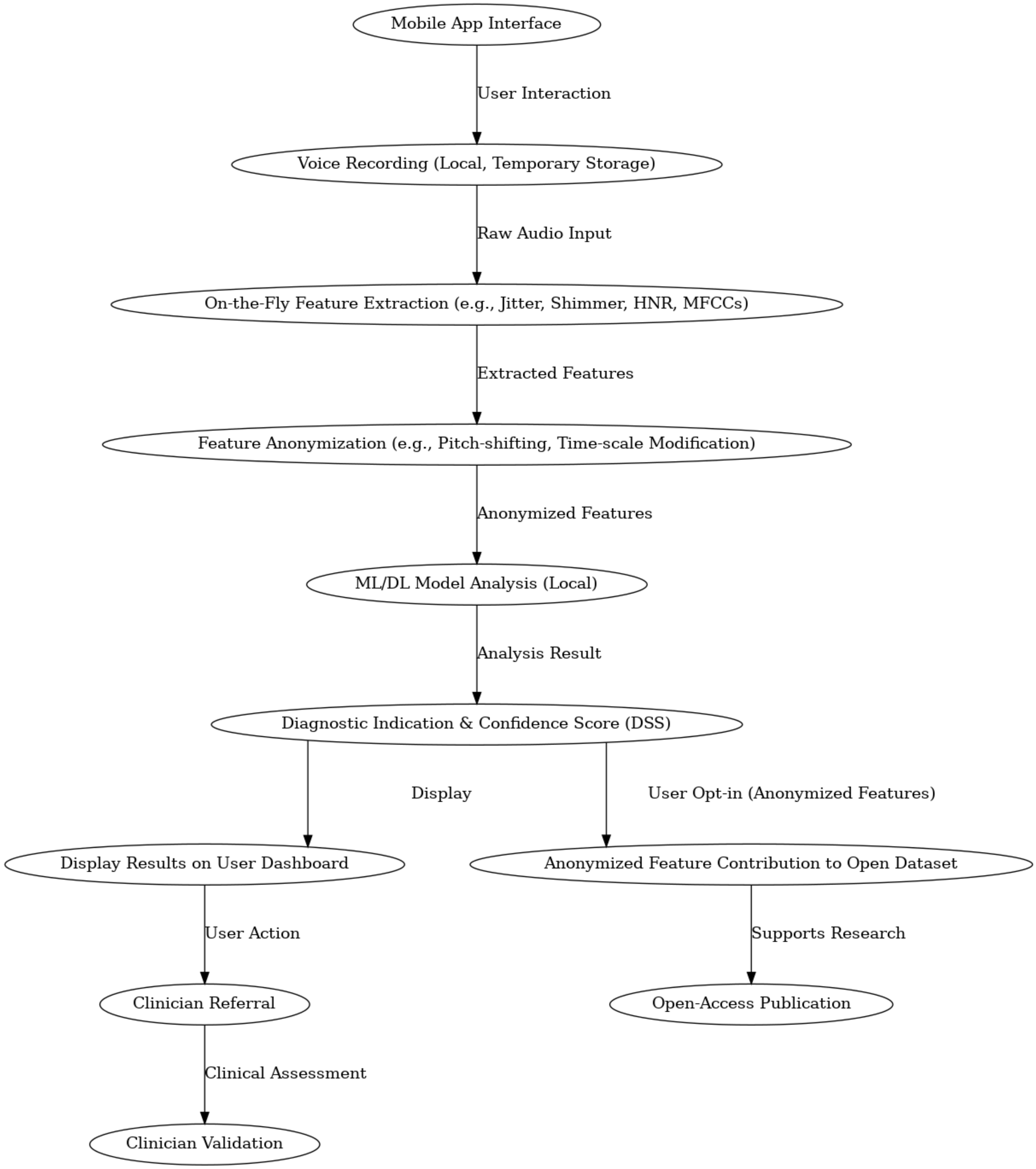

Figure 1: OpenVoice PD Monitor Application Workflow

2.2. Innovation and Differentiating Factors

While existing research and proprietary applications for voice analysis in PD exist, "OpenVoice PD Monitor" significantly differentiates itself through its commitment to NGI principles:

- **Pioneering Open Source/Open Science Approach:** Unlike closed, proprietary systems, "OpenVoice PD Monitor" will be fully open source, allowing for complete transparency, community auditing, and collaboration. This accelerates scientific progress and builds trust, making the approach more reliable and sustainable [6].
- **Privacy by Design with On-the-Fly Processing:** The integration of advanced anonymization techniques immediately after "on-the-fly" feature extraction, without saving raw audio data, ensures that the sensitivity of health data is proactively addressed from the very beginning, going beyond mere GDPR compliance. This design choice is critical for eligibility and feasibility, as it minimizes privacy risks inherent in handling sensitive biometric data.
- **Creation of Open Data Commons (Anonymized Features):** The toolkit will include modules for generating anonymized voice feature extracts, thereby establishing the essential infrastructure for the future development of a comprehensive public dataset. This approach mitigates fragmentation within Parkinson's research data and promises to serve as an invaluable resource for the global research community, advancing the principles of open science [7].
- **Focus on Accessible Diagnostic Indication:** OpenVoice PD Monitor is designed to provide an accurate, non-invasive diagnostic indication based on voice characteristics. This serves as a valuable preliminary assessment tool, particularly in contexts where access to specialized diagnostic facilities is limited.
- **European Dimension:** The project will be developed with European values of privacy, accessibility, and collaboration in mind, offering a model for digital health in Europe and beyond.

2.3. User Autonomy and Empowerment through Open Technology

At the core of "OpenVoice PD Monitor"'s philosophy is the principle of user empowerment. By providing a transparent and accessible tool, individuals and their caregivers can take an active role in seeking preliminary health assessments. Access to insights into their vocal health and diagnostic indications not only increases awareness but can also facilitate more informed discussions with healthcare providers. This approach aligns with NGI principles of enhancing user autonomy and reclaiming the public nature of the internet.

3. Technical Methodology and Implementation

3.1. Data Source and Feature Engineering

Initial development and evaluation of ML/DL models will rely on the widely used "Parkinson's Disease Data Set" [16] from Kaggle. This dataset comprises 195 voice recordings from 31 individuals (23 with PD, 8 healthy), with multiple recordings per patient, enabling robust diagnostic model development. The data includes 22 voice features, extracted using scientifically recognized methods. Key features include:

- **MDVP:Fo(Hz), MDVP:Fhi(Hz), MDVP:Flo(Hz):** Mean, maximum, and minimum fundamental frequency.

- **MDVP:Jitter(%), MDVP:Jitter(Abs), MDVP:RAP, MDVP:PPQ, Jitter:DDP:** Measures of variation in fundamental frequency (pitch perturbation), indicating vocal instability.
- **MDVP:Shimmer, MDVP:Shimmer(dB), Shimmer:APQ3, Shimmer:APQ5, MDVP:APQ, Shimmer:DDA:** Measures of variation in amplitude (amplitude perturbation), related to vocal instability and reduced loudness (hypophonia).
- **NHR (Noise-to-Harmonics Ratio), HNR (Harmonics-to-Noise Ratio):** Ratio of noise to harmonic components. Lower HNR or higher NHR suggests vocal harshness and breathiness [5].
- **RPDE (Recurrence Period Density Entropy), DFA (Detrended Fluctuation Analysis), spread1, spread2, PPE (Pitch Period Entropy):** Nonlinear features reflecting dynamic complexity and vocal stability [1].

The various voice measures within the dataset (e.g., jitter, shimmer, HNR) are established indicators of vocal impairment in PD, such as dysphonia, monotone speech, and hypophonia. These vocal changes are often among the early symptoms of the disease and are crucial for diagnostic classification. Beyond these, the integration of other advanced acoustic features, such as Mel-Frequency Cepstral Coefficients (MFCCs) and spectral-based features, will be explored to further enhance model performance [2]. New data from user voice recordings will be processed using established Python libraries and tools (e.g., Librosa, Praat, SciPy) to extract these features "on the fly" for immediate analysis.

3.2. Machine Learning & Deep Learning Architecture for PD Diagnostic Indication

"OpenVoice PD Monitor" will adopt a multi-layered ML/DL architecture for optimal voice analysis, leveraging both the interpretability of traditional models and the ability of DL networks to capture complex, non-linear patterns.

Comprehensive Range of Algorithms:

- **Traditional ML Algorithms:**
    - **Logistic Regression:** A simple but effective model for binary classification, providing a baseline [14].
    - **Support Vector Machines (SVMs):** Powerful for classification problems, especially with non-linear kernels, having demonstrated high accuracy in PD classification [2].
    - **Decision Trees & Random Forests:** Decision Trees provide interpretable models, while Random Forests, as an ensemble method, reduce overfitting and improve generalization [13].
    - **Gradient Boosting (e.g., XGBoost, LightGBM, AdaBoost):** Highly effective ensemble methods that have shown top performance in PD detection due to their ability to handle complex data relationships and reduce bias [17, 11].
    - **K-Nearest Neighbors (k-NN):** A simple, non-parametric algorithm based on feature similarity [13].
    - **Naive Bayes:** A probability-based algorithm, often used as an efficient baseline [13].
- **Deep Learning (DL) Algorithms:**
    - **Convolutional Neural Networks (CNNs):** Highly suitable for processing audio data, capable of extracting hierarchical features directly from the raw audio signals

or spectrograms [4].

- **Recurrent Neural Networks (RNNs) / Long Short-Term Memory (LSTMs):** Suitable for modeling temporal dependencies inherent in speech signals, crucial for analyzing voice characteristics for diagnostic indication [2].
- **Hybrid CNN-LSTM Architectures:** Combining the strengths of CNNs for spatial feature extraction and LSTMs for temporal modeling, these hybrid models have achieved high accuracies [2].
- **Residual Neural Networks (ResNet):** Effective in overcoming vanishing gradient problems in deep architectures, leading to exceptional performance. ResNet has shown high accuracy, precision, and F1-score for PD detection from acoustic attributes [14].
- **Transformers:** Originally for natural language processing, Transformers leverage attention mechanisms for advanced sequence modeling and have shown competitive accuracy in PD diagnosis, with reported accuracies of 97.92% using Wav2vec2.0 and 98.5% with Swin Transformer [2].
- **Fully Connected Neural Networks (FCNN):** For predicting PD severity based on Unified Parkinson's Disease Rating Scale (UPDRS) scores, FCNNs have demonstrated high training and testing accuracies [14].

Model selection and optimization will be guided by comprehensive performance metrics including accuracy, precision, recall, sensitivity, specificity, F1-score, and AUC-ROC [14, 2, 13, 18]. Cross-validation and rigorous hyperparameter tuning will be standard practices to ensure model robustness. The selected optimal models will then be adapted for providing a diagnostic indication, offering a clear assessment of the likelihood of PD based on vocal features.

3.3. Privacy-Preserving Methodology

Protecting user privacy is a foundational principle of 'OpenVoice PD Monitor'. The project will implement state-of-the-art audio transformation techniques to anonymize speaker identity while preserving the critical acoustic features necessary for PD diagnostic indication [4]. These methods include pitch-shifting, time-scale modification, timbre change, F0 alteration, and noise addition. This approach ensures that sensitive personal identifiers are removed at the source, mitigating concerns about data misuse, and promoting ethical data utilization in healthcare. Crucially, raw voice recordings will be processed "on the fly" to extract features and will not be saved or stored on any server. Only the extracted, anonymized features will be used for analysis.

The feasibility of adopting federated learning principles in future phases will be explored, where models are trained locally on user devices, and only aggregated model updates—not raw data—are shared. This aligns with NGI's emphasis on data sovereignty and privacy [2]. All data transmission and storage within the 'OpenVoice PD Monitor' ecosystem will adhere to robust security protocols, including encryption, to further safeguard user privacy and build trust, which is a core NGI value [5, 10].

3.4. Open-Source Development & Sustainability

The 'OpenVoice PD Monitor' codebase will be hosted on a public repository (e.g., GitHub) under a permissive open-source license (e.g., MIT, Apache 2.0) [1, 2]. This commitment to open-source development ensures transparency, enables community contributions, and facilitates independent security audits, which are critical for a health application. Comprehensive documentation will be provided for researchers, developers, and end-users, simplifying adoption, modification, and further research [1]. The project will actively foster an engaged community through open communication channels and collaborative development efforts to ensure long-term sustainability and continuous evolution of the application. The NGI Zero Commons Fund explicitly supports projects that contribute to new internet commons across the technology spectrum, from infrastructure to end-user applications, emphasizing a holistic, full-stack approach [25, 1]. By developing 'OpenVoice PD Monitor' as an open-source mobile application, the project directly contributes to this vision, creating a shared digital public good that can be studied, modified, and shared by anyone [10].

3.5. Expected Outcomes and Impact

- The 'OpenVoice PD Monitor' project is poised to deliver several significant outcomes and impacts, directly addressing the user's requirements and aligning with the NGI Zero Commons Fund's objectives.
- **Enhanced Remote PD Diagnostic Indication:** The primary outcome will be a highly accurate, non-invasive, and accessible open-source mobile application for providing a diagnostic indication of PD. This will address a critical unmet need in current PD management by providing individuals and clinicians with a timely, objective tool for preliminary assessment [1]. This diagnostic support capability can empower individuals to seek earlier medical attention and facilitate more informed discussions with their healthcare providers, potentially leading to earlier, definitive diagnosis and intervention. The Clinician Neurologist on the team will play a crucial role in validating the clinical relevance and accuracy of these indications.
- **Pioneering Privacy-Preserving AI in Healthcare:** The project will establish a robust framework for the ethical utilization of voice data in medical analyses. By implementing and validating advanced anonymization techniques and "on-the-fly" processing without saving raw audio, 'OpenVoice PD Monitor' will set a precedent for privacy-conscious digital health solutions, directly contributing to NGI's trustworthiness principles [14]. This demonstrates a responsible approach to AI development, acknowledging and addressing concerns about data privacy and bias in AI for healthcare, which are crucial for building public trust and ensuring equitable access to technology [10].
- **Contribution to Digital Commons:** All software and research findings will be released as open-source and open-access, respectively. This commitment will significantly contribute to the "new internet commons" by providing reusable technological building blocks and fostering collaborative innovation in health technology [1]. The project embodies the "quadruple helix" model of collaboration among the public sector, aligned companies, academia, and civil society, working together to restore the internet (and by extension, health systems) to a healthier state [1].
- **Advancing Open Science:** By employing highly discriminative features (or methodologies for generating them), validated open-source ML/DL models, and published research, the project will accelerate future advancements in neurodegenerative disease research. This open approach can help overcome limitations such as the scarcity and small size of current PD speech datasets and address potential demographic biases in existing data, fostering a more inclusive and robust research landscape [9, 10]. The project's proactive engagement with these data constraints through advanced ML/DL techniques, such as transfer learning and data augmentation, demonstrates a deep understanding of practical AI deployment in healthcare.

III. Budget Allocation

The total requested funding for the 'OpenVoice PD Monitor' project is 50,000 EUR, which aligns with the maximum amount for a first proposal to the NGI Zero Commons Fund [25, 2]. This budget is strategically allocated to ensure the successful execution of the project's research and development objectives over a 1-year period, while maximizing its value for money and strategic potential in line with NGI's evaluation criteria [2]. The allocation ensures expert human capital, robust dissemination, and necessary computational resources.

Total Requested Funding: 50,000 EUR

Salaries (50%): 25,000 EUR

- **Lead ML Engineer/Researcher (Konstantinos Bromis, Postdoctoral Researcher/Data Scientist/Software Engineer at the School of Electrical and Computer Engineering, National Technical University of Athens) (0.5 FTE for 6 months): 10,000 EUR**
  - This allocation provides for the direct purchase of physical hardware components necessary for high-performance computing to train complex deep learning models (e.g., ResNet, Transformers) on voice datasets. This includes the acquisition of dedicated GPUs, sufficient RAM, and high-speed storage, which are essential for timely progress and achieving optimal model performance [9, 10]. The hardware will be housed in a secure, controlled environment, ensuring direct control over computational resources and data.
- **PhD Candidate (Konstantinos Georgas, PhD Candidate in Medical Image Analysis with Artificial Intelligence in School of Electrical and Computer Engineering at the National Technical University of Athens (NTUA)) (0.5 FTE for 4 months): 10,000 EUR**
  - This allocation covers the expertise required for the design, development, and deployment of the 'OpenVoice PD Monitor' mobile application using Flutter. This includes ensuring a user-friendly and accessible interface, a robust and secure backend, and strict adherence to open-source best practices. This role is essential for delivering the functional prototype and ensuring the application's usability and open accessibility.
- **Lead Engineer (Professor George K. Matsopoulos, School of Electrical and Computer Engineering, National Technical University of Athens) (0.05 FTE for 12 months): 2,500 EUR**
  - This allocation supports the strategic oversight and technical guidance from a Lead Engineer Professor, ensuring the project's adherence to high engineering standards and providing expertise in complex system design and integration.
- **Clinician Neurologist (Alkinoos Athanasiou, Assistant Professor of Neurosurgery, 2nd University Neurosurgical Department, “Ippokrateio” General Hospital, School of Medicine, Faculty of Health Sciences, AUTH, Greece) (0.1 FTE for 6 months): 2,500 EUR**
  - This allocation supports the involvement of a qualified Clinician Neurologist who will provide essential clinical guidance, ensure the medical relevance of the diagnostic indications, and validate the system's output. Their expertise is crucial for bridging the gap between technical development and clinical utility, enhancing the project's credibility and impact.

This salary distribution ensures that the research (ML/DL), development (mobile application), and clinical validation aspects of the project are adequately resourced with expert personnel, fostering a functional prototype and robust scientific outcomes within the 1-year project duration.

Hardware/Computational Resources (20%): 10,000 EUR

- **Physical Hardware Purchase: 3,000 EUR**
    - This allocation provides for the direct purchase of physical hardware components necessary for high-performance computing to train complex deep learning models (e.g., ResNet, Transformers) on voice datasets. This includes the acquisition of dedicated GPUs, sufficient RAM, and high-speed storage, which are essential for timely progress and achieving optimal model performance [9, 10]. The hardware will be housed in a secure, controlled environment, ensuring direct control over computational resources and data.
- **Specialized Software Licenses/Tools (if necessary and open-source alternatives are not feasible): 2,000 EUR**
    - This contingency allocation is for any specialized software licenses or tools that may be required for advanced audio processing or machine learning frameworks, should fully open-source alternatives prove insufficient for specific tasks. Preference will always be given to open-source tools (e.g., Python, TensorFlow, PyTorch), aligning with the project's core open-source commitment.

This allocation ensures that the technical excellence and feasibility of the project are fully supported, providing the robust computational infrastructure necessary for developing and evaluating ML/DL models.

Journal and Conference Publications (15%): 7,500 EUR

- **Open Access Article Processing Charges (APCs) for 1 Journal Publication: 3,000 EUR**
    - This allocation is dedicated to covering the Article Processing Charges for publishing one research paper in a high-impact, open-access academic journal. Ensuring that scientific outcomes are published as open access is a hard eligibility criterion for NGI funding [2]. This budget ensures that the project's novel findings, particularly regarding privacy-preserving AI and advanced ML/DL applications in PD voice analysis, reach a wide academic audience and contribute significantly to the global knowledge commons.
- **Conference Registration & Dissemination Fees: 6,000 EUR**
    - This allocation supports the presentation of research findings at relevant academic conferences (e.g., in speech processing, AI in medicine, or open-source technology forums). Participation in such events maximizes the visibility and impact of the project within both the scientific and open-source communities, fostering broader adoption and collaboration [1].
- **Travel and Accommodation for Conferences: 1,000 EUR**
    - This allocation supports essential travel and accommodation costs for presenting research findings at key international conferences, maximizing the project's visibility and fostering direct collaboration within the scientific community.

This budget component directly addresses the NGI's requirement for open access scientific outcomes and contributes to the strategic relevance and impact of the project by ensuring wide dissemination of results.

Other Expenses (15%): 7,500 EUR

- **Administrative Costs: 5,000 EUR**
  - Covers general administrative overhead, project management software, communication tools, and minor office supplies.
- **Legal and Ethical Review: 2,500 EUR**
  - Allocation for external consultation to ensure full compliance with GDPR and other relevant ethical guidelines for health data, particularly concerning privacy-preserving techniques and potential future data contribution frameworks. This is crucial for building trust and ensuring the responsible deployment of the technology.
- **Contingency/Unforeseen Expenses: 2,500 EUR**
  - A buffer for unexpected costs or minor adjustments during the R&D phase, ensuring project flexibility and resilience.

This allocation ensures comprehensive support for the project's operational and ethical requirements, contributing to its overall robustness and long-term viability.

VI. Conclusions

The 'OpenVoice PD Monitor' project represents a timely and strategically aligned initiative poised to make significant contributions to both digital healthcare and the Next Generation Internet (NGI) ecosystem. By leveraging advanced machine learning and deep learning techniques for Parkinson's Disease voice analysis, the proposed open-source mobile application directly addresses a critical unmet need for accurate, privacy-preserving diagnostic indication of PD. This capability moves beyond subjective clinical assessments, offering a more objective and patient-centric approach to disease identification.

The project's commitment to open-source development and open-access dissemination of scientific outcomes is fundamental to its alignment with the NGI Zero Commons Fund's vision. By making the software and research findings freely available, 'OpenVoice PD Monitor' actively contributes to the "new internet commons," fostering collective action, transparency, and auditability in the sensitive domain of health data. This approach is crucial for building a trustworthy internet, particularly as artificial intelligence becomes more integrated into healthcare diagnostics. The explicit focus on privacy-preserving methodologies, such as audio transformation techniques, ensures that user autonomy and data security are paramount, setting a precedent for ethical AI applications in health.

Furthermore, the project's strategic approach to overcoming common challenges in medical AI, such as limited dataset size and potential biases, through the thoughtful application of advanced ML/DL techniques like transfer learning and data augmentation, underscores its academic rigor and practical feasibility. The proposed budget allocation is meticulously justified, ensuring that resources are directed towards expert personnel, impactful open-access publications, and robust computational infrastructure, maximizing the project's value for money and strategic potential.

In conclusion, 'OpenVoice PD Monitor' is more than a technical solution; it is a model for how human-centered, open, and trustworthy digital technologies can be developed to address pressing societal challenges. By empowering individuals with a secure and accessible tool for health diagnostic indication and contributing to a shared knowledge base, this project embodies the core principles of the NGI initiative, paving the way for a healthier and more equitable digital future.

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