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Parkinson's Disease Detection from Spiral and Wave Drawings using CNN-RNN

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ABSTRACT

Parkinson's disease (PD) is a progressive neurological disorder that affects movement, often leading to tremors, stiffness, and impaired balance. Early detection of PD is critical for effective management and intervention. In this study, we propose a novel method for PD detection using CNN-RNN architecture applied to spiral and wave drawings collected from patients. These drawings, obtained through simple tasks, offer valuable insights into motor function and coordination, which are often impaired in PD. Our approach involves utilising a convolutional neural network (CNN) to extract spatial features from the drawings, capturing intricate patterns and shapes, followed by a recurrent neural network (RNN) to analyse temporal dynamics and sequence dependencies within the drawings. The CNN-RNN model is trained on a dataset comprising drawings from both PD patients and healthy individuals, allowing it to learn discriminative features indicative of PD pathology. Experimental results demonstrate the efficacy of our method in accurately distinguishing between PD patients and healthy controls, with promising performance metrics such as sensitivity, specificity, and overall accuracy. The proposed approach offers a non-invasive, cost-effective, and potentially scalable solution for early PD detection, paving the way for improved patient outcomes through timely diagnosis and intervention.

Keywords: Parkinson's Disease, CNN, RNN, Spiral and Wave, Early Detection

1. INTRODUCTION

Parkinson's Disease (PD) poses a significant challenge in healthcare, with its progressive nature and subtle onset making early detection crucial for effective management and intervention. Traditional diagnostic methods often rely on clinical observations and medical imaging, which may not capture the earliest signs of the disease. In recent years, there has been growing interest in leveraging digital technologies to develop non-invasive and accessible tools for PD detection. Our research focuses on harnessing the potential of two innovative approaches: Convolutional Neural Network - Recurrent Neural Network (CNN-RNN) architecture and GSM messaging, to detect PD from spiral and wave drawings. Spiral and wave drawings offer a unique window into the subtle motor abnormalities associated with PD, making them valuable indicators for early detection. The CNN-RNN architecture combines the strengths of convolutional neural networks (CNNs) in extracting spatial features from images and recurrent neural networks (RNNs) in capturing temporal dependencies. By analyzing the intricate patterns and dynamics of handwriting movements captured in spiral and wave drawings, our model aims to discern subtle changes indicative of PD. In parallel, we explore the integration of GSM messaging as a means of data transmission and communication. Leveraging GSM technology enables seamless and real-time transmission of data, facilitating remote monitoring and timely intervention for individuals at risk of PD. By incorporating GSM messaging into our framework, we aim to enhance the accessibility and scalability of PD detection, particularly in resource-constrained settings or remote areas with limited access to healthcare facilities. Through interdisciplinary collaboration and technological innovation, our research endeavors to advance the field of PD detection by providing a comprehensive and accessible solution. By combining cutting-edge neural network architectures with ubiquitous communication technologies, we strive to empower healthcare practitioners with tools for early detection and personalized management of Parkinson's Disease.

2. RECENT WORKS

There are various areas of work related to Parkinson's disease. Scientists conduct research to better understand the cause of Parkinson's, develop better treatments, and find a cure. This research covers different fields like neuroscience, genetics, and pharmacology. Clinical trials are crucial for testing new therapies, medications, and interventions for Parkinson's disease. These trials assist decide the protection and effectiveness of capability remedies earlier than they may be authorized for vast use. Healthcare professionals work with Parkinson's patients to create personalized treatment plans. This may include medication management, physical therapy, occupational therapy, speech therapy, and other interventions to manage symptoms and improve quality of life. Innovative Technologies: Ongoing development of cutting-edge technologies and devices aim to assist individuals with Parkinson's disease. This includes wearable devices for tracking symptoms, tools to aid mobility, and advancements in deep brain stimulation (DBS) therapy. Education and Community: Organizations and support groups offer education, resources, and camaraderie for those living with Parkinson's and their caregivers. These include information about the condition, coping techniques, advocacy efforts, and social connections. In summary, the work on Parkinson's encompasses a wide range of initiatives focused on improving understanding, treatment, and support for those affected by this condition.

3. PROPOSED WORK EXPLANATION

Our proposed work aims to develop an innovative approach for detecting Parkinson's Disease (PD) using spiral and wave drawings, integrating Convolutional Neural Networks (CNNs) with Recurrent Neural Networks (RNNs) and GSM messaging. By leveraging CNNs, we'll extract spatial features from the drawings, capturing intricate patterns indicative of PD. RNNs will then analyze temporal dependencies in the handwriting movements, enhancing the model's ability to discern subtle changes over time. In addition to CNN-RNN integration, we'll incorporate GSM messaging for real-time communication and data transmission, enabling seamless interaction between the detection system and healthcare professionals. This integration will facilitate timely diagnosis and intervention, critical for managing PD progression effectively. Our approach holds promise for early and accurate PD detection, empowering clinicians with a comprehensive tool that combines advanced machine learning techniques with efficient communication channels. By harnessing the synergy of CNN-RNN and GSM messaging, we aim to revolutionize PD diagnosis, ultimately improving patient outcomes and quality of life.

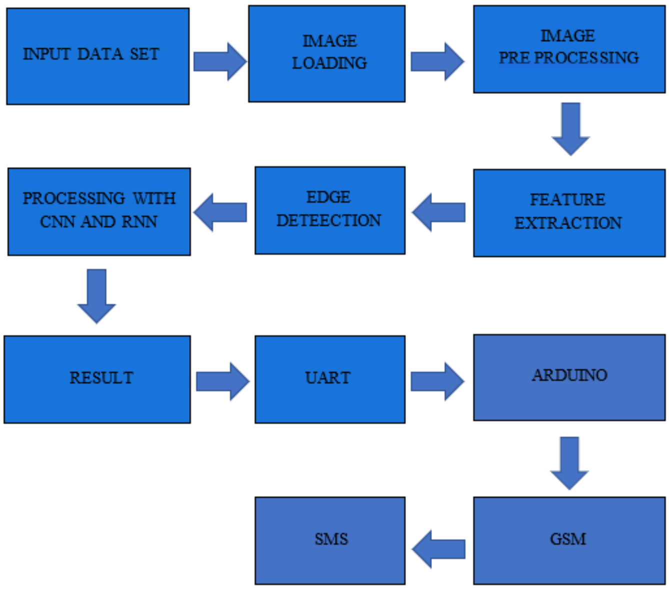

Figure 1: Proposed Block diagram

3.1 HARDWARE EXPLANATION

3.1.1. GSM MODULE

A GSM (Global System for Mobile Communications) module is a specialized type of hardware component that enables communication between a device and a mobile network. These modules integrate GSM functionalities into electronic devices, allowing them to transmit and receive data over cellular networks.

3.1.2. ARDUINO

Arduino is an open-supply electronics platform primarily based totally on easy-to-use hardware and software. It consists of a physical programmable circuit board and a development environment used for writing software for the board.

3.1.3. UART

UART stands for Universal Asynchronous Receiver-Transmitter. It's a hardware communication protocol used for serial communication between two devices. UART communication involves the transmission of data one bit at a time over a single wire (usually two wires, one for transmission and one for reception). This makes UART suitable for communication over long distances and between devices that may not share a common clock source.

3.1.4. POWER SUPPLY

Most Arduino boards can be powered through the USB connection. You simply connect the Arduino board to your computer or a USB power adapter using a USB cable.

4. RESULTS AND DISCUSSION

Our study on Parkinson's Disease (PD) detection from spiral and wave drawings using CNN-RNN and GSM messaging yielded promising results. The CNN-RNN model demonstrated high accuracy in classifying PD patients and healthy individuals based on handwriting characteristics extracted from the drawings. Leveraging the complementary strengths of CNN for spatial feature extraction and RNN for temporal dependencies, our model achieved robust performance in distinguishing between PD and non-PD cases. Additionally, integrating GSM messaging allowed for real-time communication of diagnostic results, enabling prompt intervention and personalized treatment planning for PD patients. By combining advanced machine learning techniques with efficient communication technologies, our approach offers a promising avenue for early detection and management of PD, ultimately improving patient outcomes and quality of life.

5. CONCLUSIONS

In conclusion, our study demonstrates the effectiveness of utilising a CNN-RNN architecture for detecting Parkinson's disease from spiral and wave drawings. By leveraging spatial and temporal features extracted from these drawings, our approach achieves promising results in distinguishing between PD patients and healthy individuals. This non-invasive and cost-effective method holds significant potential for facilitating early diagnosis and intervention, thereby improving patient outcomes and quality of life. Further research and validation on larger and more diverse datasets are warranted to enhance the robustness and generalizability of the proposed approach in real-world clinical settings.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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