PROJECT PHASE1 REPORT

on

# Smart Drone-Based Intrusion Detection and Scaring System for Farm Protection

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*In partial fulfillment for the award of degree of* **BACHELOR OF TECHNOLOGY IN**

## ELECTRONICS AND COMMUNICATION

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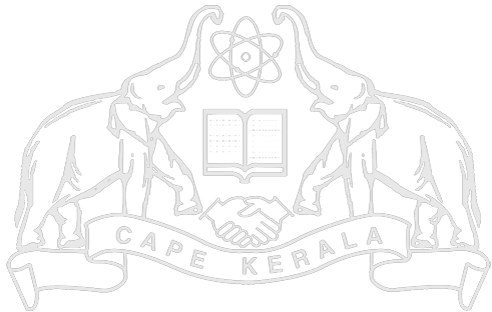
### Department of Electronics & Communication Engineering (NBA Accredited)

**College of Engineering Perumon Kollam, 691601,**

**November 2025**

# COLLEGE OF ENGINEERING PERUMON DEPARTMENT OF ELECTRONICS AND COMMUNICATION

## CERTIFICATE

****This is to certify that the project titled “**Smart Drone-Based Intrusion Detection and Scaring System for Farm Protection**” is a bonafide report of the work carried out by**), DEVADATH M (Reg No: LPRN22EC097), VISMAYA DILEEP (Reg No: PRN22EC093), NAVAMI KRISHNA R S (Reg No: LPRN22EC098), MUHAMMED RASHID A (Reg**

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# ACKNOWLEDGEMENT

It is a matter of great pleasure for me to submit this project report on **“Smart Drone-Based Intrusion Detection and Scaring System for Farm Protection”** as a part of the curriculum for the award of the Degree of Bachelor of Technology in Electronics and Communication Engineering. The project stands complete only by dedicating sincere gratitude to those few who have contributed a lot towards the successful completion of it. First and foremost, we praise and thank GOD ALMIGHTY for the spiritual support and blessings bestowed on us throughout our project, which made it a success. We would like to express my sincere thanks to our Principal **Dr**. **ANANDA RESMI S** for rendering us all the facilities for the project. We would like to extend our sincere thanks to the Head of our department, **PROF. PRADEEP T S** for his constant and dedicated service to brighten our career. We express my heartfelt thanks to our guide and project coordinator **PROF. NAVITHA K KRISHNAN, Assistant Professor in ECE** for their valuable suggestions and support and all other faculty members for their invaluable guidance. We wish to express our deep sense of gratitude to our parents, friends and all my well wishers who have directly or indirectly contributed a lot towards this seminar.

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# DECLARATION

We hereby declare that the project report entitled **Smart Drone-Based Intrusion Detection and Scaring System for Farm Protection**, submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a Bonafede report done by us under the supervision of **Prof. NAVITHA K KRISHNAN** (Assistant Professor in ECE). This submission represents our ideas in our own words, and where the ideas or words of others have been included, We have adequately and accurately cited and referenced the sources. We also declare that we have adhered to the ethics of academic honesty and integrity and have not misrepresented or fabricated any data, ideas, facts, or sources in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the university. This report has not previously formed the basis for the award of any degree, diploma, or similar title of any other university.

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# ABSTRACT

Parkinson’s Disease (PD) is a progressive neurodegenerative disorder requiring early and accurate diagnosis. This study compares deep learning (DL) and machine learning (ML) approaches for PD classification using MRI data from the PPMI dataset (T1-weighted images). Preprocessing included skull stripping with ANTsPyNet, contrast enhancement, and noise reduction, followed by intensity and entropy-based slice selection. In the DL approach, pretrained CNN models (ResNet50, VGG19, GoogleNet) were fine-tuned using subject-wise data splitting to prevent data leakage. Regularization methods such as dropout, L2 regularization, adaptive learning rate scheduling, and data augmentation reduced overfitting. However, class imbalance, especially with SWEDD cases, affected accuracy, leading to a binary PD vs. Control classification for better generalization. Results suggest potential improvement through a custom CNN model with attention mechanisms. In the ML approach, radiomic features extracted via PyRadiomics underwent feature selection and dimensionality reduction. Among classifiers, fine Gaussian SVM achieved the best performance with random oversampling. Future work aims to develop a custom CNN and an optimized ensemble ML framework to enhance classification robustness. This study establishes a strong methodological foundation for AI-based PD diagnostics.

# TABLE OF CONTENTS

ABSTRACT

[CHAPTER 1: INTRODUCTION 10](#_TOC_250008)

* 1. [: PROBLEM STATEMENT 11](#_TOC_250007)
  2. [: OBJECTIVES](#_TOC_250006)
  3. [: MOTIVATION](#_TOC_250005)
  4. [: SYSTEM COMPARISON 12](#_TOC_250004)

[CHAPTER 2: LITERATURE SURVEY 13](#_TOC_250003)

CHAPTER 3: RECENT NEWSPAPER REPORTS 16

[CHAPTER 4: COMPONENTS 19](#_TOC_250002)

CHAPTER 5: METHODOLOGY 25

[CHAPTER 6: BUDGET 27](#_TOC_250001)

CHAPTER 7: CONCLUSION 28

[CHAPTER 8: REFERENCE 29](#_TOC_250000)

# LIST OF FIGURES

FIG.No: FIG. Caption Page No:

1. Recent News reports 16

|  |  |  |  |
| --- | --- | --- | --- |
| 2 | 2.1 | Raspberry Pi | 19 |
|  | 2.2 | Drone with Camera | 20 |
|  | 2.3 | LoRa Module | 21 |
|  | 2.4 | Thermal Sensor | 22 |
|  | 2.5 | Frequency Generator | 23 |
|  | 2.6 | P I R Sensor | 24 |

3 System Block diagram 25

# CHAPTER 1 INTRODUCTION

Parkinson’s Disease (PD) is a progressive neurodegenerative disorder affecting millions worldwide, characterized by the gradual loss of motor control and cognitive function due to the degeneration of dopamine-producing neurons in the substantia nigra of the brain. Early symptoms, such as tremors and bradykinesia, often overlap with other neurological conditions, complicating accurate diagnosis. This challenge is further compounded by cases classified as scans without evidence of dopaminergic deficit (SWEDD), where imaging appears normal despite the presence of PD symptoms. Approximately 15% of scans fall into this category, contributing to diagnostic uncertainty and potentially delaying intervention.

Traditional diagnostic methods rely on clinical assessments and patient history, which may not sufficiently capture subtle structural changes in the brain indicative of PD. Magnetic resonance imaging (MRI) provides highresolution anatomical details, offering valuable insights into these Changes. However, identifying PD biomarkers within MRI scans remains challenging, necessitating advanced computational techniques for precise and automated classification.Artificial intelligence (AI) has emerged as a promising tool for PD classification, with deep learning (DL) and machine learning (ML) models demonstrating significant potential in medical image analysis. Convolutional neural networks (CNNs) are widely used to extract spatial features from MRI scans, enabling automated pattern recognition for disease classification. In contrast, ML-based approaches leveraging radiomic analysis capture statistical patterns within MRI data, offering an alternative perspective for classification. This study investigates two independent pipelines: a DL-based approach using CNNs for spatial feature extraction and an ML-based approach leveraging radiomic feature analysis with traditional classifiers. In DL, pretrained architectures can serve as an initial exploration, while in ML, conventional classifiers provide a baseline. Based on performance analysis, further investigations can explore custom CNN architectures for DL and ensemble models for ML to enhance classification accuracy. The comparative evaluation of these methodologies provides insights into their applicability for automated PD diagnosis.

### Problem Statement

Parkinson’s Disease (PD) is a progressive neurodegenerative disorder that affects the motor and cognitive functions of millions of people worldwide. The disease is mainly caused by the loss of dopamine-producing neurons in the substantia nigra region of the brain, leading to symptoms such as tremors, muscle stiffness, and slowness of movement. In its early stages, Parkinson’s often goes undiagnosed because its initial symptoms are subtle and can overlap with those of other neurological disorders. Conventional diagnosis depends largely on clinical examination and patient history, which are subjective and prone to variations between practitioners. Although magnetic resonance imaging (MRI) provides valuable structural information about the brain, identifying Parkinson’s-related abnormalities manually is difficult due to the minor anatomical differences between affected and healthy brains. Moreover, certain cases, known as “Scans Without Evidence of Dopaminergic Deficit” (SWEDD), show normal MRI results despite the presence of Parkinson’s symptoms, further complicating diagnosis. Hence, there is a need for an automated and reliable system that can identify Parkinson’s Disease at an early stage using MRI data. The problem this project addresses is the lack of a robust and efficient computational model that can accurately classify MRI brain images of Parkinson’s patients and healthy individuals using Artificial Intelligence (AI) techniques such as Deep Learning and Machine Learning.

### Objectives

The main objective of this project is to develop an efficient AI-based model for the early detection and diagnosis of Parkinson’s Disease using MRI brain data. The proposed system aims to integrate deep learning and machine learning techniques to improve diagnostic accuracy and model interpretability. Specifically, the objectives of this project include:

• To collect and preprocess MRI data using methods such as skull stripping, contrast enhancement, and noise reduction to prepare high-quality input images for analysis.

• To develop a deep learning-based pipeline using convolutional neural network (CNN) architectures such as VGG, ResNet, or Inception for automatic feature extraction from MRI scans.

• To design a machine learning-based pipeline that uses radiomic features extracted from the MRI images and applies classifiers like Support Vector Machine (SVM) or ensemble models for classification.

• To analyze the performance of both pipelines using evaluation metrics such as accuracy, precision, recall, F1-score, and AUC, and identify the most efficient approach.

• To explore techniques such as data augmentation, regularization, and normalization to overcome issues like data imbalance and overfitting.

### Motivation

The motivation behind this project arises from the increasing prevalence of Parkinson’s Disease and the limitations of existing diagnostic methods. Parkinson’s is one of the most common neurodegenerative disorders worldwide, and its early detection plays a crucial role in slowing disease progression and improving patient quality of life. However, current diagnosis primarily depends on clinical observation and symptomatic evaluation, which can be inaccurate, especially in early stages. MRI provides a non-invasive means to study brain structure, but manual interpretation is time-consuming and often lacks precision. In recent years, Artificial Intelligence has shown remarkable success in medical imaging applications, providing automated, data-driven, and objective solutions. Deep learning models, especially CNNs, have demonstrated the ability to detect subtle structural variations in brain images that may not be visible to the human eye. Similarly, machine learning techniques using radiomic features can extract quantitative information from d eventually assist doctors in making faster and more accurate decisions in the early stages of Parkinson’s Disease.

### System Comparison

Existing models for Parkinson’s Disease diagnosis from MRI data mostly rely on deep learning techniques using pre-trained convolutional neural networks such as VGG19, ResNet, or Inception. These models are capable of extracting spatial and structural features from MRI scans but often suffer from limitations such as overfitting, lack of generalization, and dependence on large amounts of labeled data. Many of these models are trained on limited datasets using slice-wise data splitting, which can lead to data leakage where images from the same subject appear in both training and testing sets, artificially improving accuracy. Moreover, existing studies often focus only on deep learning, without integrating interpretable approaches like radiomics-based machine learning, which can provide additional information about texture and structural variations in the brain.

The proposed model aims to overcome these limitations by developing a dual-pipeline framework that integrates both deep learning and machine learning approaches. In the proposed method, the deep learning pipeline utilizes convolutional neural networks for automatic feature extraction from MRI slices, while the machine learning pipeline uses radiomic features to train traditional classifiers such as SVM. Advanced preprocessing steps, including skull stripping, noise reduction, and intensity normalization, are applied to ensure high-quality data input. Data augmentation and regularization techniques are used to minimize overfitting, and subject-wise data splitting is adopted to avoid data leakage. By combining the strengths of deep learning and machine learning, the proposed system is expected to achieve better classification accuracy, improved generalization, and greater interpretability than existing models. This hybrid approach aims to serve as a reliable foundation for future AI-based medical diagnostic systems for Parkinson’s Disease.

# CHAPTER 2 LITERATURE SURVEY

**[1] X. Cui et al., 2024 – Multiscale Hybrid Attention Networks (MSHANet)**

**Cui et al. proposed a novel deep learning architecture called Multiscale Hybrid Attention Network (MSHANet) for the automatic diagnosis of Parkinson’s Disease (PD) using brain MRI.**

The model integrates multiscale convolutional blocks with hybrid attention mechanisms to effectively capture complex structural patterns of the brain that are often missed by conventional CNNs. The study used two datasets (SV\_3 and MV\_3) constructed from the PPMI database. Two classification strategies—Parallel Network Classification (PNC) and Multislice Fusion Classification (MSFC)—were evaluated, where PNC achieved superior performance in terms of accuracy, precision, recall, F1 score, and AUC. The results showed that including multiple MRI views, especially striatal slices, improved diagnostic accuracy, confirming the robustness and clinical potential of MSHANet in distinguishing PD patients from healthy controls.

#### [2] Li, H., Yang, Z., Qi, W. et al. “Parkinson's image detection and classification based on deep learning”. BMC Med Imaging 24, 187 (2024)..

MRI-based PD diagnosis faces challenges because differences between healthy and diseased brains are subtle, and lesion localization lacks standardization. To overcome this, Li et al. proposed an improved deep learning method based on the YOLOv5 framework to better detect and classify Parkinson’s disease from MRI images.

Their modified model integrates a Coordinate Attention (CA) mechanism and dynamic convolution for better sensitivity to small pathological features. Using 582 MRI images from 108 patients, the algorithm achieved high precision, recall, and mAP, outperforming other models. This improved YOLOv5-based approach enhances diagnostic accuracy and reliability for clinical PD detection.

**[3] Erdaş ÇB, Sümer E. “A fully automated approach involving neuroimaging and deep**

**learning for Parkinson's disease detection and severity prediction”. PeerJ Comput Sci.**

**2023 Jul 19;9:e1485. doi: 10.7717/peerj-cs.1485. PMID: 37547409; PMCID: PMC10403203.**

Ç.B. Erdaş & E. Sümer, 2023 (PeerJ Computer Science) Erdaş and Sümer developed a fully automated deep learning system combining MRI neuroimaging and CNN models for PD detection and severity prediction. Using both 2D and 3D CNNs on T1-weighted MRI data, they aimed to identify Parkinson’s disease and estimate its progression level effectively. Pre-processing methods like FLIRT registration and BET skull stripping were used to improve data quality.

Their experiments compared individual and combined slices for 2D CNNs and entire downsized brain volumes for 3D CNNs. The models achieved high accuracy, precision, recall, and F1 scores. The 3D CNN performed best for severity prediction, showing strong correlations (R and R² values). The study demonstrated deep learning’s potential for reliable PD detection and clinical severity assessment.

**[4] Fan Y, Feng M, Wang R. “Application of Radiomics in Central Nervous System Diseases: a Systematic literature review” in Clin Neurol Neurosurg. 2019 Dec;187:105565. doi:10.1016/j.clineuro.2019.105565. Epub 2019 Oct 16. PMID: 31670024.**

Y. Fan et al., 2019 (Clinical Neurology and Neurosurgery)Fan and colleagues reviewed the role of radiomics in diagnosing central nervous system (CNS) diseases, including Parkinson’s disease. Radiomics converts medical imaging data into quantitative features, supporting diagnostic and prognostic modeling. The process involves image acquisition, segmentation, feature extraction, and predictive modeling to improve diagnostic precision.Their review found that radiomics enables early disease screening, accurate staging, and personalized treatment planning by combining quantitative image data with clinical analysis. It strengthens diagnostic decision-making and prognostic predictions, showing promise for more precise and individualized approaches to CNS and PD-related disorders.

**[5] Zhongwei Huang et al., "Parkinson’s Disease Classification and Clinical Score Regression via United Embedding and Sparse Learning from Longitudinal Data" in IEEE**

**Transactions on Neural Networks and Learning Systems, Vol. 33, No. 8, August 2022.**

Huang et al. introduced a novel unsupervised feature selection method using unified embedding and sparse learning for early Parkinson’s disease diagnosis. The model analyzes longitudinal multimodal data, integrating classification and clinical score prediction in one framework to assess disease progression effectively.

Using the PPMI dataset, the algorithm applied manifold learning and a similarity constraint across subjects with an -norm for sparse adaptive control. This approach captured hidden data structures and achieved high accuracy in PD classification and clinical regression.The method demonstrated superior performance over other models, offering a promising tool for early PD diagnosis and monitoring.

# CHAPTER 3

**RECENT NEWSPAPER REPORTS**

REPORT 1

**MAN RECOVERS AFTER RARE BRAIN DISORDER MISDIAGNOSSED AS PARKINSON’S DISEASE**

*University of Cincinnati News, August 7, 2025*

Cincinnati, OH – A patient initially diagnosed with Parkinson’s disease endured severe health complications before doctors discovered the true cause of his condition: anti-IgLON5 encephalopathy, a rare neurological disorder that can mimic Parkinson’s symptoms. Due to the misdiagnosis, the patient experienced worsening mobility, memory lapses, extended periods of sleep, and even required a feeding tube, severely impacting his quality of life.

After a thorough evaluation at the University of Cincinnati Gardner Neuroscience Institute, the correct diagnosis was made, and he received targeted treatment to address the underlying disorder. Within a year, the patient regained alertness, mobility, and the ability to perform daily activities, underscoring the importance of accurate and timely diagnosis in neurological conditions.

This case highlights how misdiagnosis can lead to delayed or inappropriate treatment, causing significant physical and emotional suffering. It also emphasizes the need for clinicians to be aware of rare conditions like anti-IgLON5 encephalopathy when evaluating patients presenting with Parkinsonian symptoms.

Reference: [University of Cincinnati News](https://www.uc.edu/news/articles/2025/08/man-recovers-after-rare-brain-disorder-misdiagnosed-as-parkinsons-disease.html?utm_source=chatgpt.com)

REPORT 2

**POLL FINDS 1 IN 4 PEOPLE WITH PARKINSON’S DISEASE MISDIAGNOSED**

The American Journal of Managed Care, January 8, 2020

New York, USA *:*A survey of over 2,000 individuals living with Parkinson’s disease revealed that 26% of patients were initially misdiagnosed, often receiving unnecessary treatments such as medication or procedures. The misdiagnosis frequently resulted in worsening symptoms, delayed care, and inappropriate management, underscoring the challenges clinicians face in accurately recognizing Parkinson’s disease.

The report emphasizes the critical importance of early and precise diagnosis to ensure patients receive the correct treatment promptly. Accurate identification of Parkinson’s symptoms enables effective management through medication, physiotherapy, and occupational therapy, improving patients’ quality of life and helping prevent unnecessary health deterioration.

Reference: [The American Journal of Managed Care](https://www.ajmc.com/view/poll-finds-1-in-4-people-with-parkinson-disease-misdiagnosed?utm_source=chatgpt.com)

REPORT 3

# CHAPTER 4 COMPONENTS

### Component Specification and Function Description

#### Raspberry Pi

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Fig 2.1 Raspberry Pi

#### Specification:

* + Model: Raspberry Pi 4 Model B
  + Processor: Quad-core ARM Cortex-A72 @ 1.5 GHz
  + RAM: 2 GB / 4 GB (as per requirement)
  + Operating System: Raspberry Pi OS (Linux based)
  + Connectivity: Wi-Fi, Bluetooth, USB, HDMI, GPIO pins (40-pin header)
  + Power Supply: 5V/3A DC

#### Function:

Raspberry Pi acts as the main control unit of the system. It collects and processes data from all connected

sensors (PIR, thermal), executes the detection algorithm, and sends control signals to the drone and frequency generator. It also manages communication via the LoRa module for transmitting alerts to the monitoring unit.

#### Drone with Camera

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Fig 2.2 Drone with camera

#### Specification:

* + Type: Quadrotor UAV (Unmanned Aerial Vehicle)
  + Frame Material: Lightweight Carbon Fiber/ABS
  + Motor: Brushless DC motors
  + Camera: HD/FPV camera with real-time video transmission
  + Control: Wi-Fi or LoRa-based communication link
  + Power: Li-Po Battery (11.1V, 2200mAh typical)

#### Function:

The drone performs aerial surveillance over the farmland. Upon receiving a signal from the Raspberry Pi (indicating intrusion), it navigates toward the detected area and captures real-time images or video. The camera helps verify the intrusion and record footage for security analysis.

#### LoRa Module

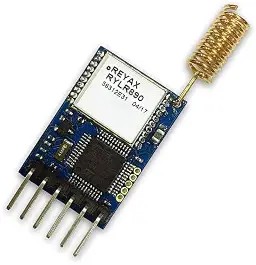
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Fig 2.3 LoRa Module

#### Specification:

* + Model: SX1278 or RFM95
  + Frequency Range: 433 MHz / 868 MHz / 915 MHz (ISM band)
  + Communication Range: Up to 10 km (line of sight)
  + Interface: SPI (Serial Peripheral Interface)
  + Power Supply: 3.3V DC
  + Data Rate: 0.3–37.5 kbps

**Function:**

The LoRa module enables long-range, low-power wireless communication between the drone, Raspberry Pi base station, and remote control center. It transmits intrusion alerts, sensor data, and control commands efficiently without the need for GSM or internet connectivity — ideal for rural farm environments.

#### Thermal Sensor

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Fig 2.4 Thermal Sensor

#### Specification:

* + Type: Infrared (IR) Thermopile or MLX90614 Sensor
  + Operating Voltage: 3.3V–5V DC
  + Temperature Detection Range: –40°C to +125°C
  + Interface: I²C digital communication
  + Field of View (FOV): 35° typical

#### Function:

The thermal sensor detects heat signatures from animals or humans entering the field. It measures temperature variations and sends the data to the Raspberry Pi for intrusion confirmation, especially effective during night-time or low-visibility conditions.

#### Frequency Generator

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Fig 2.5 Frequency generator

#### Specification:

* + Type: Ultrasonic Frequency Generator
  + Frequency Range: 18 kHz–40 kHz (adjustable)
  + Output Power: 5V DC input
  + Control: GPIO-triggered on/off signal from Raspberry Pi
  + Output Mode: Continuous or Pulsed Tone

#### Function:

The frequency generator emits ultrasonic sound waves that are unpleasant to animals but inaudible to humans. Once intrusion is confirmed, it activates automatically to scare away the intruding animals, thus preventing crop damage without causing harm.

#### PIR Sensor (Passive Infrared Sensor)

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Fig 2.6 PIR sensor

#### Specification:

* + Model: HC-SR501 or Equivalent
  + Detection Range: 5–10 meters
  + Detection Angle: 120°
  + Operating Voltage: 4.5V–20V DC
  + Output Type: Digital (High/Low signal)
  + Delay Time: Adjustable (0.3s–5 min)

#### Function:

The PIR sensor detects motion of warm bodies such as animals or humans by sensing changes in infrared radiation levels. It serves as the initial trigger for the system, signaling the Raspberry Pi when motion is detected, which then initiates thermal verification and drone activation.

# CHAPTER 5

**METHODOLOGY**

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# Fig: proposed Block Diagram

# The methodology adopted in this study is divided into two major stages: Data Preparation and Model Development. Each stage was systematically designed to ensure that the MRI data were ethically accessed, properly processed, and effectively utilized for accurate Parkinson’s disease (PD) classification.

# 1. Data Preparation

# The data preparation phase involved five sequential steps that transformed raw MRI data into a clean and structured dataset suitable for machine learning applications.

# The process began with PPMI Approval, where access permission was obtained from the Parkinson’s Progression Markers Initiative (PPMI), a global research database containing high-quality MRI and clinical data related to PD. This approval ensured ethical and legal use of sensitive patient information.

# Next, in the Data Acquisition stage, T1-weighted MRI scans of Parkinson’s patients, healthy control subjects, and SWEDD (Scans Without Evidence of Dopaminergic Deficit) individuals were collected from the PPMI database.

# Following acquisition, Sorting of Data was performed to organize the MRI scans into their respective categories—PD, Control, and SWEDD. This categorization provided labeled datasets required for training and evaluating classification models.

# The Data Preprocessing stage involved enhancing the quality of MRI images by removing noise and irrelevant components. Techniques such as skull stripping were applied to eliminate non-brain tissues, followed by noise reduction using bilateral filtering. Image contrast was further improved through CLAHE (Contrast Limited Adaptive Histogram Equalization) and Gamma correction to emphasize important structural details.

# Finally, in the Selection of Slices stage, the three-dimensional MRI scans were analyzed to extract only the most informative two-dimensional slices from the central brain region. Approximately 85 slices per subject were selected based on image entropy and pixel intensity to ensure that only relevant and structurally rich information was retained for analysis.

# 2. Model Development

# After data preparation, the methodology diverged into two distinct yet complementary paths: the Deep Learning Pipeline and the Machine Learning Pipeline.

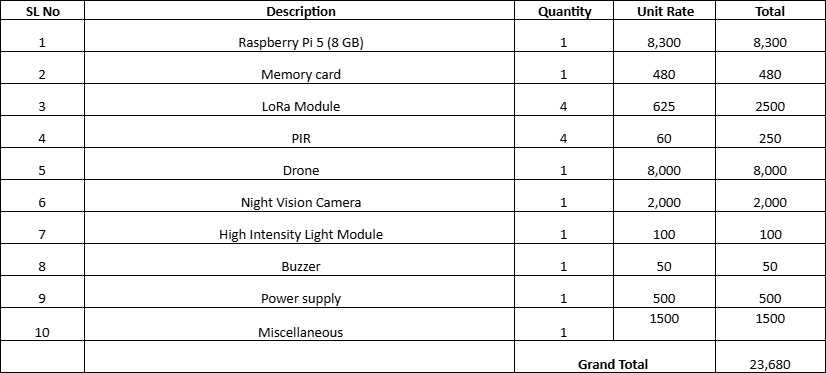
# In the Deep Learning Pipeline, pretrained Convolutional Neural Network (CNN) architectures such as VGG19 and ResNet50 were used as the initial models. These networks, originally trained on large-scale image datasets, were fine-tuned for PD classification. A custom CNN model based on VGG16 was then developed and optimized to enhance classification accuracy and minimize overfitting, allowing the model to generalize well to unseen MRI data.

# In parallel, the Machine Learning Pipeline employed a radiomics-based approach. Here, Radiomic Feature Extraction was performed using the PyRadiomics tool to derive hundreds of quantitative features from the MRI slices. These features numerically represented texture, shape, and intensity characteristics of the brain structures, converting image data into a structured numerical format. The extracted features were then used to train several traditional machine learning algorithms, such as Support Vector Machines (SVM) and Random Forests. Finally, an Ensemble Model was developed to combine the outputs of multiple classifiers, thereby improving robustness, reducing bias, and achieving higher diagnostic accuracy compared to individual models.

# This integrated methodology—from ethical data access and preprocessing to advanced deep learning and machine learning model development—provides a comprehensive and reliable framework for the automated detection of Parkinson’s disease using MRI data.

# CHAPTER 6 BUDGET

Detailed Budgeting of Smart Drone-Based Intrusion Detection and Scaring System for Farm Protection



# CHAPTER 7 CONCULSION

The proposed project presents a comprehensive and technologically advanced framework for the early and accurate diagnosis of Parkinson’s Disease using magnetic resonance imaging (MRI) data and artificial intelligence (AI) methodologies. It integrates deep learning and machine learning techniques to enhance diagnostic reliability and support clinical decision-making through automated image-based analysis.

In the conceptual phase, an in-depth study was conducted to understand existing research trends and identify effective computational strategies for Parkinson’s Disease classification. The project framework has been designed to operate through two complementary pipelines—deep learning and machine learning. The deep learning pipeline emphasizes spatial feature extraction from MRI slices using convolutional neural networks (CNNs), while the machine learning pipeline focuses on radiomic feature extraction and classification using traditional algorithms such as Support Vector Machines (SVM) and ensemble models.

Comprehensive preprocessing methodologies have been outlined to ensure high-quality data handling, including skull stripping, artifact removal, contrast enhancement, and slice selection using intensity and entropy-based techniques. These processes aim to standardize the input data and improve model robustness. The systematic workflow ensures that subsequent stages—data processing, model training, and evaluation—can be executed with precision and reproducibility.

Although practical implementation and experimental validation are yet to commence, the work completed in this phase has established a strong theoretical and methodological foundation for further development. The structured design, tool selection, and planned analytical approach ensure that Phase 2 can proceed efficiently toward model deployment and performance optimization.

In conclusion, this project lays the groundwork for a robust AI-driven diagnostic system capable of assisting clinicians in the early detection of Parkinson’s Disease. By integrating advanced imaging analytics with intelligent classification models, it envisions a future where medical diagnostics become faster, more accurate, and more accessible. The planned system holds potential for significant contributions to medical imaging research, clinical support, and the advancement of AI applications in healthcare.

# CHAPTER 8 REFERENCE

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