PRECISION FARMING: CNN-BASED SYSTEM FOR CROP AND WEED CLASSIFICATION AND DENSITY ANALYSIS

अत्याधुनिक खेती : फसल और खरपतवार वर्गीकरण एवं घनत्व मापन के लिए सीएनएन प्रणाली

A

Thesis

Submitted for the Award of the Ph.D. degree of

PACIFIC ACADEMY OF HIGHER EDUCATION AND RESEARCH UNIVERSITY

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PACIFIC ACADEMY OF HIGHER EDUCATION AND RESEARCH UNIVERSITY, UDAIPUR

2024

DECLARATION

I, **TAKMARE SACHIN BALAWANT S/O SHRI BALAWANT TAKMARE** resident of Flat no.102, Chestnut building, Cosmos Enclave, Ram Mandir Road, Kasarvadavali, Ghodbunder Road, Thane(W), Pin-400615, hereby declare that the research work incorporated in the present thesis entitled **"Precision Farming: CNN-Based System for Crop and Weed Classification and Density Analysis" (**अत्याधुनिक खेती : फसल और खरपतवार वर्गीकरण एवं घनत्व मापन के लिए सीएनएन प्रणाली) is my original work. This work (in part or in full) has not been submitted to any University for the award or a Degree or a Diploma. I have properly acknowledged the material collected from secondary sources wherever required.

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Professor

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Date: **Name and Designation of Supervisor**

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DATE: - **TAKMARE SACHIN BALAWANT**

DEDICATED TO
MY FAMILY, FRIENDS
AND WELL-WISHERS

PREFACE

This thesis presents a comprehensive study on the development of a CNN-based system for precision farming, specifically aimed at the classification of crops and weeds and the analysis of their density. Traditional farming practices often rely on manual methods for managing resources such as pesticides and fertilizers, leading to inefficiencies and environmental harm. The increasing global population and the emergence of herbicide-resistant weeds necessitate innovative solutions for sustainable agriculture.

Utilizing advancements in machine learning and computer vision, particularly Convolutional Neural Networks (CNNs), this research introduces an automated system capable of accurately identifying crop and weed species from image data. The system facilitates data-driven decisions for optimal fertilizer and pesticide application, thereby enhancing resource efficiency and reducing environmental impact.

The methodology involves data collection from various sources, preprocessing, and the development of multiple CNN models. The performance of these models is evaluated based on accuracy, precision, recall, and F1 score. The study's findings demonstrate the effectiveness of the proposed system in improving agricultural productivity and sustainability.

This research contributes to the field by providing a robust framework for precision farming, highlighting the practical implications of integrating advanced technologies in agriculture. Future research directions and potential improvements to the system are also discussed, aiming to further enhance the accuracy and applicability of the proposed approach.

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ABBREVIATIONS

CNN - Convolutional Neural Network

YOLO - You Only Look Once

ResNet50V2 - Residual Networks 50 Version 2

VGG - Visual Geometry Group

IoT - Internet of Things

GANs - Generative Adversarial Networks

mAP - mean Average Precision

AP - Average Precision

RPN - Region Proposal Network

RoI - Region of Interest

TP - True Positive

FP - False Positive

FN - False Negative

TN - True Negative

F1 Score - F1 Score (Harmonic Mean of Precision and Recall)

RGB - Red, Green, Blue

MS COCO - Microsoft Common Objects in Context

NMS - Non-Maximum Suppression

ReLU - Rectified Linear Unit

SGD - Stochastic Gradient Descent

AP@0.5 - Average Precision at IoU threshold 0.5

API - Application Programming Interface

SVM - Support Vector Machine

ML - Machine Learning

DL - Deep Learning

CR - Cyperus Rotundus

AB - Ammania Baccifera

TP - Trianthema Portulacastrum

DA - Digera Arvensis

CG - Calotropis Gigantea

BR - Brinjal

CO - Corn

ON - Onion

SO - Soybean

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