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***Abstract*—In the domain of research and development, our FYP project introduces an innovative mobile application that is tailored for business-to-business (B2B) users. Via the use of smart phone, users can seamlessly employ their device cameras to identify and classify diverse soil types and fish species that is locally found across Pakistan. In case of soil classification, our mobile app allows users with comprehensive insights into the identified soil's properties. It provides detailed information on the recommended fish species, accompanied by precise ingredient proportions details (fish hydrolysate). This amalgamation enhances protein levels within the specific soil, resulting in an optimal soil health. In the context of fish classification, our app will offer all the relevant details of the fish that includes fish health, freshness, and the presence of any potential diseases. Moreover, the app also instructs user with precise blending instructions, specifying the optimal combination of fish species, other ingredients, and suitable soil types for achieving the best outcomes. With modern technologies and intelligent techniques, our project achieves great success in the domain of both agriculture and aquaculture.**

***Index Terms*—Artificial Intelligence, Deep Learning, Computer Vision, Agriculture, Aquaculture, Economical.**

I. Introduction

In recent years, Artificial Intelligence (AI) has improved significantly due to many developments and advancements in the field. Many mobile applications are being built in the domain of AI that are accessible through our trusty smart phones. The usability of AI is further extended by techniques such as Deep learning (DL) and Computer Vision (CV), which happens to be our domain of research and development. Deep learning and computer vision are two cutting-edge fields of artificial intelligence that have found extensive applications in various real-life scenarios, transforming industries and enhancing our everyday experiences. These technologies have demonstrated remarkable capabilities in recognizing patterns, extracting meaningful information from visual data, and making intelligent decisions based on visual inputs. In our project, we will be focusing on the intersection of modern available technological prowess and the vital sectors of agriculture and aquaculture in Pakistan by harnessing the extended techniques AI has to offer. The backbone of Pakistan's economy is agriculture, and as time progresses, the agricultural system of Pakistan calls for an innovative solution that can bridge the gap between technology and farming. This need forms the backdrop for our project. Picture a mobile application that uses the power of smart phone's camera to revolutionize two critical aspects of Fish Hydrolysate [1]: soil classification and fish assessment. Fish hydrolysate, a nutrient-rich liquid or powder produced from fish waste and byproducts, serves as a valuable organic fertilizer and soil conditioner, enhancing plant growth and soil health. We aim to leverage its potential to improve agricultural activities on poor soil. This application is specifically designed for business-to-business (B2B) users, opening up a plethora of possibilities in the agricultural landscape of Pakistan. When the app is being used for soil classification, it becomes a knowledgeable ally for farmers and soil inspectors. Along with identification of soil, the app offers great insight into each soil type's unique properties. Moreover, the app also offers recommendation of the most compatible fish species for a given soil. The application also provides the user with precise instructions on the incorporation of fish hydrolysate, a strategic move to boost soil protein levels and enhance overall soil health. Moving on to the next use case of our project, which is fish classification [2][3]. The dataset that will be used to train the model for fish classification will be collected locally (commonly found in the fish markets of Karachi), just like the soil dataset. The application will provide extensive information about the fish under scrutiny, including detailed health assessments [4][5], freshness checks, and disease detection [6][7]. The application will also guide the user on the ideal combination of fish species, additional ingredients, and compatible soil types to achieve optimal results. With this technologically innovative project, we aim to practically create a farming companion. The application will simplify the complexities of agriculture while automating the Fish Hydrolysate procedure. With just a single tap on the screen, users can access a realm of agricultural insights, making their farming endeavors smarter, more efficient, and undoubtedly more accessible. The core of our project is to promote intelligent and sustainable agricultural practices. With our project, this goal is well within reach. In the following Fig 01, we can observe how agriculture and aquaculture are interlinked with each other.

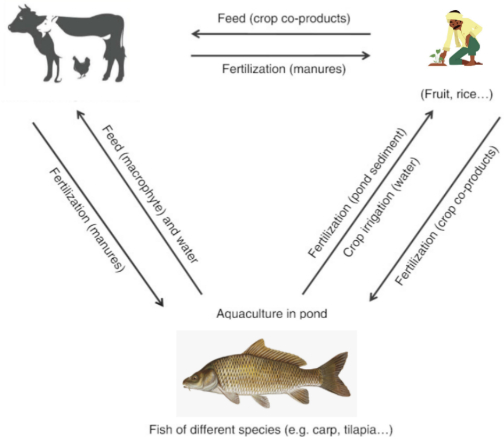

Fig. 1. Integrated agriculture–aquaculture systems flow diagram

II. Literature Review

In recent years, the fusion of artificial intelligence (AI) with agriculture, often referred to as "AgriTech," has gained significant attention in research and practical applications. This is further enhanced when such techniques are met with traditional practices of aquaculture. Via the use of such AI techniques, many aspects of agriculture (e.g., aquaculture and agricultural soil management) are revolutionized. DL has been very important in enhancing agriculture process via image recognition and speech recognition (LeCun et al., 2015; Schmidhuber, 2015). DL's has the ability to find complex patterns in data through neural networks with multiple layers has opened new avenues for agricultural innovation (Goodfellow et al., 2016). In the context of aquaculture, DL models have been used to classify fish species based on images (Deng et al., 2013). Via the use of Convolutional Neural Networks (CNNs), which has emerged as a potent tool for this purpose, accurate species identification is provided (Krizhevsky et al., 2012). Additionally, DL assists in monitoring fish health, assessing freshness, and detecting diseases, ensuring the well-being of aquatic populations (Esteva et al., 2017). Machines are enabled to interpret visual information via the use of computer vision (Szeliski, 2010). As of late, both DL and CV are converging in order to extract more benefits the AI technology has to offer in the fields of agriculture and aquaculture. Combining these technologies will empower the development of comprehensive aquaculture management systems, optimizing fish farming practices and enhancing soil health (Redmon et al., 2018). Motivated by the various work presented above by the researchers, we propose to develop an application that uses the above-mentioned AI techniques to simplify the process of Fish Hydrolysate. The proposed method is novel because it seamlessly integrates modern available technology with traditional practices of agriculture and aquaculture in order to achieve an economical and feasible goal.

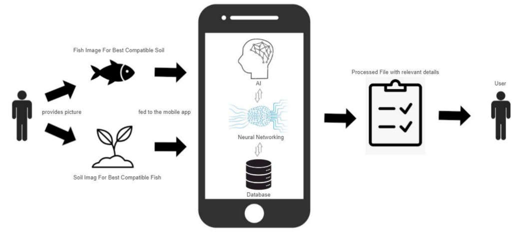

Fig. 2. Considered scenario for the proposed work

III. Description (Rationale) Of the Proposed Work

In this work, we consider the problem of classifying different kinds of fishes and soil that are best compatible with each other. Creating a fish fertilizer for a soil is a practice that is commonly found in the agriculture sector of Pakistan. However, as of yet, poor procedure is followed that is inefficient with currently available resources. With our mobile application, we can make better use of available resources that will in result yield significantly better result. The heart of our project lies in the utilization of locally sourced datasets, that is collected from the city of Karachi. These datasets form the backbone of our classification system, ensuring that the app is finely tuned to the specific soil and fish varieties found in our region. In this project work, we consider a soil or fish that needs to be classified in order for the process of fish hydrolysate to proceed, and propose a novel method to automate such procedure via the use of AI present within our mobile application. Figure.02 shows a considered scenario for this work that contains a visualized workflow of our automated system. The user provides the system the image of fish or soil which is then processed by our application and finally the processed file is provided back to the user with all the relevant details. We will be doing transfer learning with ResNet V0 model on our dataset after dividing it in 70of the last 5 layers (may change during experimentation) in order to further increase the accuracy of feature extraction of our image dataset. This methodology can potentially result in accuracy that is greater than 94with all the relevant information of the object present in the image via fetching information from database. Fig.02 briefly visualizes the basic workflow and how different components of the system work with each other.

IV. Research Project Objectives

The main objective of this research project is to build, automate, and ease the procedure of Fish hydrolysate (creation of fish fertilizer for enhancing the nutrient level of soil). The main objectives are as follows.

1) **Soil Classification:** Develop a robust soil classification system that utilizes the mobile app's camera to accurately identify and classify various soil types commonly found in Pakistan. The system will provide detailed information about each soil type, including its properties, composition, and suitability for specific agricultural purposes. It will also tell the user the most compatible

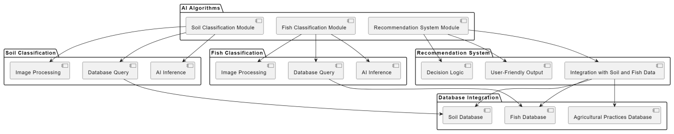

Fig. 3. Proposed Work Components

fish (required for protein enrichment) for that particular soil.

2) **Fish Classification:** Implement a comprehensive fish classification module within the mobile app. Users will be able to capture images of locally found fish species, and the app will classify them with high accuracy. The classification will include extensive details about the fish. The app will also tell the most compatible soil (for the creation of fish fertilizer) for that particular fish and vice versa.
3) **Data Collection:** We gathered extensive datasets of soil samples and fish species from the local Karachi market. These datasets will serve as the foundation for training and testing the deep learning algorithms used in the classification processes.
4) **Algorithm Development:** Deep learning algorithms, such as ResNet V0 (may change), will be used for both soil and fish classification. This will be further fine-tuned to achieve a classification accuracy of nearly 95
5) **User Interface:** Design an intuitive and user-friendly interface for the mobile app to ensure ease of use for B2B users. The app will provide a friendly experience for capturing images and receiving classification results.
6) **Database Integration:** Create a centralized database that stores information about various soil types, fish species, and their compatibility. When soil or fish is classified, the app will retrieve relevant data from the database and display it to the user.
7) **Recommendation System:** Implement a recommendation system that suggests the most compatible fish species for a given soil type and vice versa.
8) **Health Assessment:** Develop a health assessment system for fish that evaluates their condition and detects any potential diseases. Users will receive detailed information about the health status of the classified fish.

V. Research Design

Our research design comprises several distinct phases, each contributing to the development of our AI-driven mobile application that leverages cutting-edge technologies, including advanced AI algorithms, machine learning, and computer vision. The system will utilize real-time data acquisitions from smartphones' hardware and use their computing capabilities to facilitate storage, analysis, and more. The project will consist of the following phases:

TABLE I
Objectives and Their Approach Mapping

Objective	Approach for Achieving the Objective
1	Use Fine-Tuned Transfer Learning on locally collected soil image dataset
2	Using Fine-Tuned Transfer Learning on locally collected fish image dataset
3	Gather local soil and fish datasets from Karachi, preprocess and augment the data for training deep learning models
4	Implement ResNet V0 (may change) with transfer learning and fine-tuning for both soil and fish classification, achieving an accuracy of nearly 95%.
5	Develop an intuitive interface (via mobile development platforms) for easy image capture, resulting in a seamless user experience.
6	Create a centralized database (e.g., SupaBase or MongoDB) to store soil and fish information. Then integrate it with the mobile app for real-time data retrieval.
7	Implement a recommendation system based on soil-fish compatibility, enhancing user decision-making.
8	Develop a fish health assessment system for disease detection and health evaluation via training on the available dataset.

TABLE II
Objective Phases and Tasks Mapping

Objectives	Phases	Tasks
1	Comprehensive literature survey	Perform a comprehensive literature survey to further develop strong intuition about the state-of-the-art research methods in automating the traditional Fish Hydrolysate procedure.
2, 3 & 7	Data Collection	1. Visit the local fish market for images. 2. Visit different sites to get more insight into different kinds of soil. 3. Train and preprocess images for state-of-the-art deep learning algorithms.
4, 5 & 7	Feature extraction and Deep Learning Model	1. Extract features from the image dataset, extracting patterns found in soil and fishes. 2. Train the deep learning model further by providing extracted features from the dataset.
4	Model Tuning	Train the model by considering different hyperparameters. Avoid model overfitting and underfitting issues by doing training several times.
5 & 6	Evaluation	Validate and test the model, checking performance using a confusion matrix along with other validation checks, e.g., F1 score.
7 & 8	Develop a Product and mobile application and write-up	1. Transform the model into the product and develop the mobile application. 2. Write project progress reports. 3. Publish work in conferences and/or journals.

A. Phase 1: Comprehensive Literature Review

We conduct a comprehensive literature survey from multiple resources to determine the state-of-the-art techniques in the field. We will study various deep learning techniques within the domain of artificial intelligence. Additionally, we will explore research materials that cover the amalgamation of practices in both agriculture and aquaculture.

B. Phase 2: Data Collection

We visited the local fish market in Karachi to collect the dataset by taking pictures. The same procedure also extended to the collection of datasets for soil locally found in Pakistan. Our aim was to collect a local sourced dataset.

C. Phase 3: Data-pre-processing (Feature Extraction)

After dataset collection, we extract features (patterns) from the images (of fish and soil). This involves cleaning, organizing, and preparing the data for analysis. For soil data, we will extract relevant features related to soil composition and texture. For fish data, we will focus on fish attributes such as size, color, and shape as mentioned before.

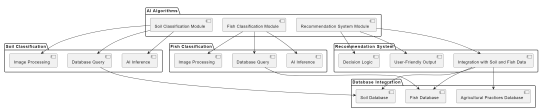

Fig. 4. Proposed Work Components

D. Phase 4: Deep Learning Model

This is a crucial phase in our FYP life cycle. Here, we leverage deep learning techniques along with transfer learning and fine-tuning strategies. We will train our model using the prepared datasets to achieve high accuracy in classifying soil types and fish species. Our aim is to surpass a 90

E. Phase 5: Mobile Application Development

After training our model, we move on to app development. Our app will be user-friendly and compatible with business-to-business (B2B) use. The deep learning model will work at the backend, taking care of the classification procedure.

F. Phase 6: Integration and Testing

To ensure the application's functionality, it will be rigorously tested on real-time local data (Karachi). This will provide valuable feedback for refinement.

G. Phase 7: Evaluation

We will evaluate the model using confusion matrices and other validation techniques. We will plot some abnormal curves to analyze the performance of a model. Any shortcomings will be addressed, and optimization strategies will be implemented.

H. Phase 8: Writing-up and Documentation

Throughout the project, we plan to maintain comprehensive documentation of our methodologies, data, code, and results. This documentation will further serve as the basis for journal articles, conference papers, and project reports, sharing our findings and contributions with the scientific community.

VI. Research Methodology

A. Methodology

As discussed in the preceding section, we will use deep learning for classification. We have described the previous section's approach, task, and phases. Here, we aim to discuss the experimental setup (on-site testing), deep learning model (training and testing phases), and evaluation criteria for the performance of our system.

1) Data Collection: As mentioned earlier in the document, we visited various sites in Karachi to collect an image dataset for the classification of fish and soil. The data collection process adhered to standardized methods and protocols to ensure accuracy and consistency.

2) Feature Extraction: After data collection, our focus will be shifted to feature extraction to allow effective classification. Features related to soil composition, texture, and nutrient content will be extracted for soil classification. In the case of fish classification, features such as fish morphology, coloration, and scale patterns will be extracted. The collected data will be preprocessed to enhance its suitability for deep learning algorithms. Figure 3 provides a visual representation of the backend for fish and soil classification.

3) Deep Learning Model: Through our current research, we aim to integrate different models for each respective stage and determine which model works best for each phase. Although the current shortlisted algorithms we have considered include ResNet V0, GoogleNet, and EfficientNet, we aim to configure models based on how accurately they perform on the respective stage of the process rather than determining immediately before testing.

4) Evaluation: We will apply test data containing abnormalities to the trained model and assess the performance by plotting confusion matrices among other forms of accuracy detection. Moreover, we aim to plot several abnormality graphs which will show anomalies in the Classification.

VII. Results and Findings

A. Training and Validation Accuracy:

Training and validation accuracy with respect to epochs for the current fish species on the proposed model is plotted in Fig. 7. Results of applying the model on the dataset and plotting a traditional confusion matrix of the predictions.

B. Confusion Matrix:

The confusion matrix is a visual snapshot of our classification model's prowess. In this scenario, it illustrates the accuracy of fish species classification. Each diagonal cell is boldly saturated, showcasing the model's adeptness in correctly identifying fish species. Minimal shading in the off-diagonal cells indicates low occurrences of misclassifications—False Positives and False Negatives.

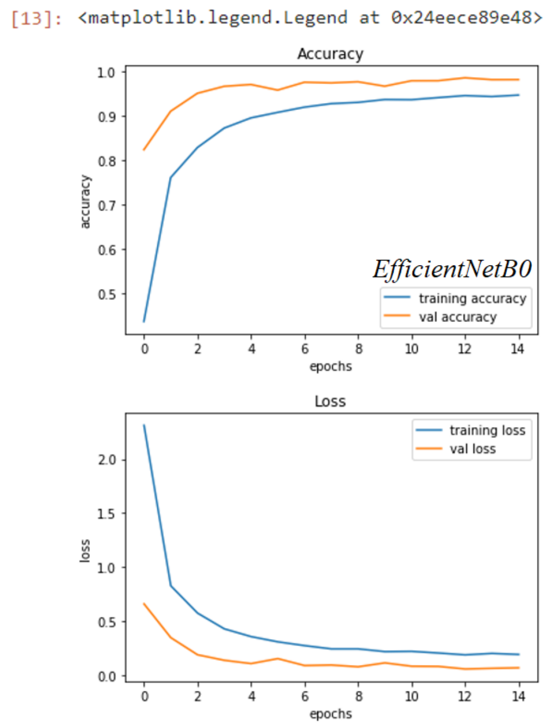

Fig. 5. Training Validation Accuracy Per Epoch-EfficientNetB0

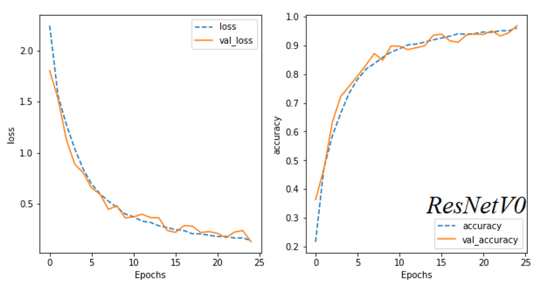

Fig. 6. Training Validation Accuracy Per Epoch-ResNetV0

VIII. Project Outcomes and Deliverables

In conclusion, we aim to leverage cutting-edge technology that follows industry-leading norms and legal criteria. The AI-driven fish fertilizer model, along with a gadget to determine the best fish for a particular soil, intends to be a groundbreaking solution in agriculture. We envision favorable end-user feedback, a user-friendly exterior, and thorough documentation. The expected outcomes include:

a) AI-Based Model for Fish Classification
b) Recommendations for the Best Fish Fertilizer for Specific Soil
c) Compatibility Assessment with Different Fish Species
d) Detection of Diseases in Fish through Computer Vision

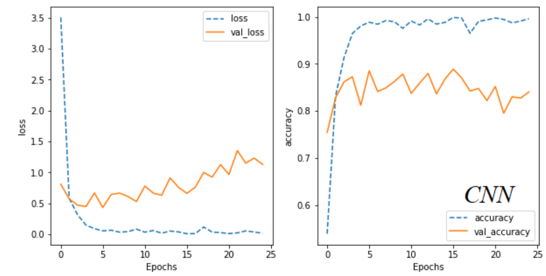

Fig. 7. Training Validation Accuracy Per Epoch-Base CNN

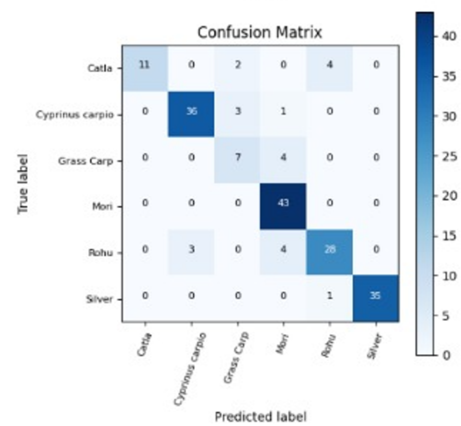

Fig. 8. Confusion Matrix

IX. Utilization

- Improved suggestions for soil and fertilizer can increase agricultural yields, addressing issues with global food security.
- Promotes environmentally friendly fish farming by assuring fish compatibility and disease avoidance.
- By suggesting appropriate fish and fertilizer combinations for various soil types, it aids in the expansion of agriculture into previously unsuitable locations.
- Increases revenue for companies by lowering input costs and reducing losses from disease or bad soil management.
- By ensuring the safety and quality of agricultural and aquacultural goods, promotes international trade.

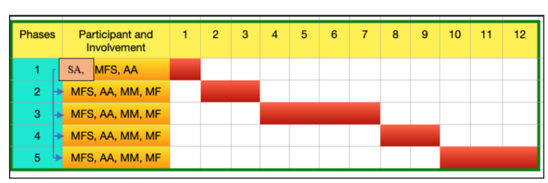

Fig. 9. PROJECT TIMELINE MAPPED WITH THE TEAM ROLES AND PHASES

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