IMAGE PROCESSING AND FRUIT DETECTION FOR A FARMER'S ASSISTANT

A PROJECT REPORT

Submitted by

Prakhar Nagar (21BAI10221)

Sobhan Shreeraj Sa (21BAI10228)

Aman Preet Singh (21BAI10232)

Shikhar Gupta (21BAI10347)

Jagdish Bhatt (21BAI10467)

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MADHYA PRADESH - 466114

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MADHYA PRADESH – 466114

BONAFIDE CERTIFICATE

Certified that this project report titled **"IMAGE PROCESSING AND FRUIT DETECTION FOR A FARMER'S ASSISTANT"** is the bonafide work of "**Prakhar Nagar**(21BAI10221), **Sobhan Shreeraj Sa**(21BAI10228), **Aman Preet Singh**(21BAI10232), **Shikhar Gupta**(21BAI10347) and **Jagdish Bhatt**(21BAI10467)**"** who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported at this time does not form part of any other project/research work based on which a degree or award was conferred on an earlier occasion on this or any other candidate.

PROGRAM CHAIR	**PROJECT GUIDE**
Dr. Suthir Sriram,	Dr. Pradeep Kumar Mishra
Program Chair - Division of AI & ML	Assistant Professor
School of Computer Science and Engineering	School of Computer Science and Engineering
VIT BHOPAL UNIVERSITY	VIT BHOPAL UNIVERSITY

The Project Exhibition II Examination is held on _______________

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ABSTRACT

This paper presents the development, testing, training, and working of detection of fruit/vegetable harvest for KHESA.

KHESA is a Farmer's Assistant envisioned by our team. The skeletal design and operational plan were laid out in Phase I of our project. This paper focuses on Phase II of the development process, albeit, illumination about the progress achieved in the initial phase is also provided.

In our project we use an image-based machine learning model trained and tested using Google's Teachable platform. The model is then further integrated into an android application. The mobile application is a simple one-window interface which shows the accuracy levels with which a particular harvest is identified. The average time it took for our model integrated into the mobile application to identify a crop successfully was 12.4s. On-field tests were also conducted to identify the accuracy with which KHESA would be able to operate in terms of the recognition and identification procedure. The On-field test was conducted on ripened white cauliflower harvest. The spotting and recognition success rates were 73% for the best fit crop conditions. The crop identification function is a primary function of our project as a whole i.e., KHESA. This function gives headway to other functional elements of the machine which can be developed in upcoming phases.

PROJECT DESCRIPTION AND OUTLINE

Introduction

We had developed a 3-D model for KHESA that gave us an insight into how the physical adaptation would look. The visual perspective ignites an imagination about how the machine would work. But in order to make it work indeed, we needed to develop the functions. The primary of those functions is the working of the camera, which in turn has led us into developing a system to identify the fruit/vegetable harvest in real-time.

Motivation for the work

Agriculture is the major factor on which India's financial situation depends. In the Indian farming system, most farming is done on a small scale. A smaller area means less room for error. This is because the margin of the profit/loss is also less. So giving the small scale Indian farmer with a solution that enables sustainable agriculture would go a long way to help our nation as a whole. For this very purpose, we formulated the idea of KHESA in Phase I. Now we have started to implement the idea and the vision by kickstarting the development with crop recognition.

We took a Machine Learning approach towards our problem. We collected images of different classes of vegetables and finalized a dataset. The dataset was then used to create a ML model. This model was then integrated into an android application which incorporated TFLite. This app is what can be further gelled with other functions to get our Farmer Assistant working.

Problem Statement

In the first phase, we tried to achieve the basic requirements for our project like installing a feature that would inform farmers about the weather, and created a prototype model expected to be cost efficient & easy to use in accordance with the field types.

In this phase, we are looking forward to developing a program as a feature to the app that would be able to perform processing of images for the same in detecting fruits and vegetables. Also, we need to change the model in accordance with the requirements of the applications which we have provided in our app.

Objective of the work

We need to have a system that can identify the target vegetable to be harvested for our model KHESA. Also, accurate input must be rendered to the computer system. The accuracy factor is absolutely critical to the success and performance of the system as a whole. This is because if identification is carried out efficiently, then and only then, can the forthcoming tasks be carried out in a precise manner.

Organization of the project

This Phase II of the project can be organized into the following modules:

1. Dataset Collection
2. Model Training(using Teachable by Google)
3. Integration to Android app(incorporating TFLite)
4. Testing Model in Real Time

Summary

To summarize this chapter, we shed light on the struggles of small-scale farmers all over the Indian subcontinent. These struggles gave us the motivation to come up with the idea of KHESA. After the Farmer Assistant idea was visualized in the form of a 3-D model, the need to work towards making the contraption functional was obvious. Thus, the team worked towards developing the primary function i.e. identification through image processing. For this purpose, we used a Machine Learning model integrated into an android application. We tested the model in real-time and on-field as well.

RELATED WORK INVESTIGATION

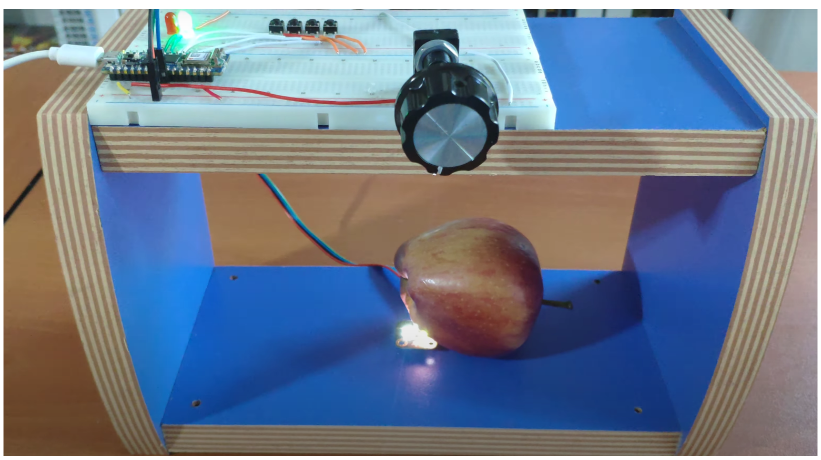
Introduction

In order to fully comprehend and analyze the best approach for the identification process we need to find a method that:

1. Identifies with accuracy
2. Is suitable for On-Field application
3. Is relatively Quick

Method 1

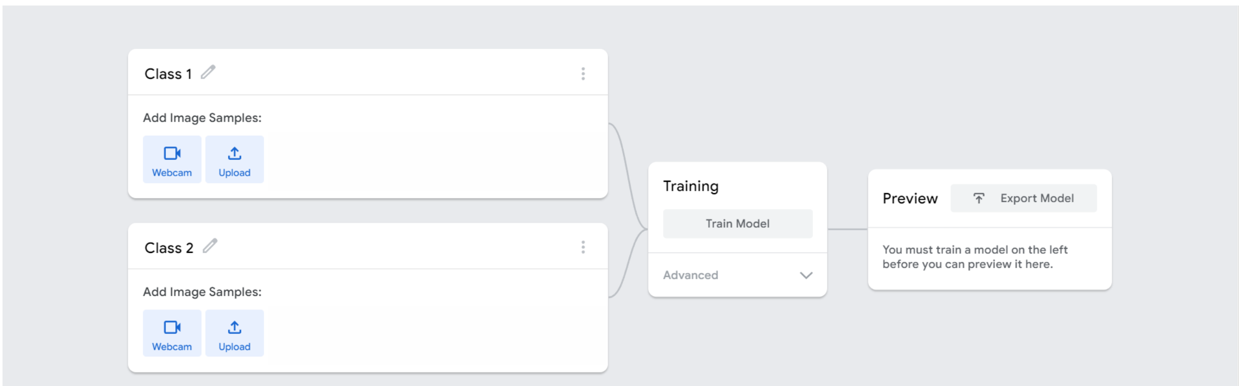
The first approach that we explored was “Detection by Colour”. This approach is incorporated to collate spectral color data of varying fruits and vegetables and then interpret it with a neural network model.



This approach involved using a fixed color background and placing the subject in an aptly lit environment was really important.

Method 2

The second approach we came across was "Machine Learning". This approach involved training a ML model to a given dataset. This model could then be coded into the system or included within a mobile app.



The model can be trained and improved over the course of a time period.

Pros/Cons

Upon weighing the advantages and disadvantages of the above mentioned methods, we settled for Method 2 owing to the following reasons:

1. Machine Learning method does not need a particular or fixed background for the imagery input opposed to Method 1. Thus, it would only be right to choose it for on-field agricultural tasks.
2. The Machine Learning method was found to be operating efficiently in low-light conditions as well, which was an impediment when it came to "Detection using Color".

Summary

In essence, Method 2 was chosen as there are lesser constraints involved. Lesser constraints imply increased efficiency. Method 1 would work perfectly well for lab work conditions. But the requirements for our project call for the facilities offered by Method 2.

REQUIREMENT ARTIFACTS

Introduction

Our project is envisioned to be operated entirely on the data given through a camera. For our operation to be success, our main concern involves around a foolproof camera, a trusted platform to develop Android-based application and a scope for our model to perform training & testing.

Hardware and Software requirements

Primary hardware requirements are as follows:

1. **RGB-D camera:** A device capable of performing 2D or 3D image mapping of an extensive area.
2. **Frame for the camera:** A convenient light-weight frame able to hold the camera steadily as well as easily glide to let the camera function properly.
3. **Raspberry Pi:** A small single-board computer model that essentially help the camera to perform.

Primary Software requirements are as follows:

1. **Image Segregation software:** That would help breaking image data from the camera into segments to identify the crops.
2. **TensorFlow setup:** An open-source library that would help to connect to the main hardware setup through Raspberry Pi.

Specific Project Requirements

1. Datasets Requirement

Our project is engaged around machine learning which involves training and testing our model. This requires us to have enough datasets to receive maximum success rate.

Most of our datasets were collected from Kaggle. Kaggle is an online community that provides open ML project datasets.

2. Functions Requirement:

For training & testing of our model, we took help of Teachables. Teachables, provided by Google, is a tool that hosts a ML model which makes it easier to train & test datasets.

We used Android Studio to develop the application using JAVA & XML language, integrated with the help of TFLite.

Summary

We lack primary requirements for our project which would have gathered us with more efficient results. However, we perform our model training & testing with substitutes. We used a mobile phone with a 50MP camera to carry out the crop recognition process and Android Studio platform for integrating our software which was run on a standard computer system.

DESIGN METHODOLOGY

Methodology and Goal

We identified the problem through an amalgamation of observation and experience. The experience includes on-field presence in an agricultural surrounding. The observational review incorporates the presence of 20 people tending to a small piece of soybean field near to our university campus. Following on from this identification, we conducted a literature review of experiments performed to resolve similar issues. The major inferences were drawn from ecoRobotix Weeding Robot and Virgo Root AI. Keeping our objectives of sustainable and profitable farming for small scale farmers in mind, we arrived upon the idea of a remotely operated machine that does the work of a labor and an advisor simultaneously.

Functional Module Design

These designs were part of the progress made in Phase I of our project.

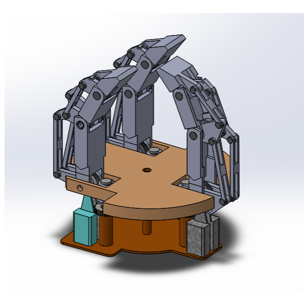


Fig 1.1

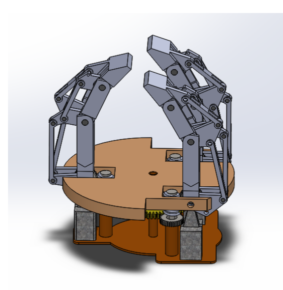


Fig 1.2

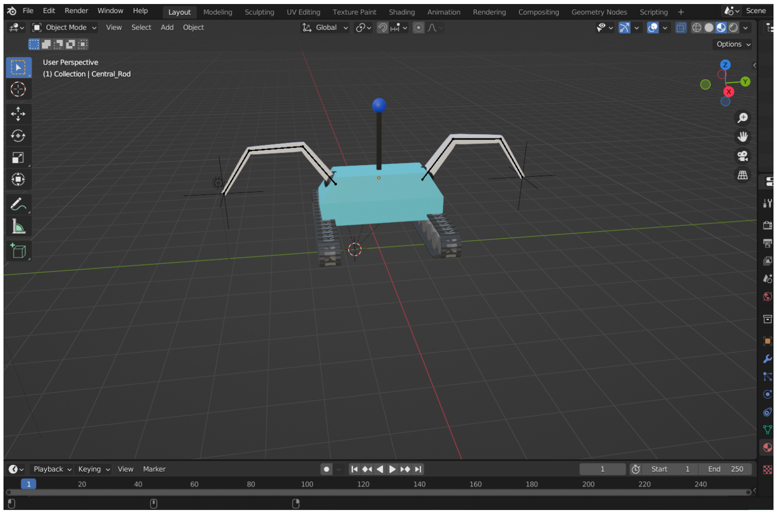


Fig 2

Fig 1.1 displays the gripper to be attached to the mechanical arms. Fig 1.2 is the same from a different orientation. Further, Fig 2 displays the overall skeletal model of KHESA.

Fig 1.1 and 1.2 were built using Tinkercad(online platform) while Fig 2 is made through Blender(Open Source Software).

Software Architectural Designs

These designs are all part of Phase II of our project.

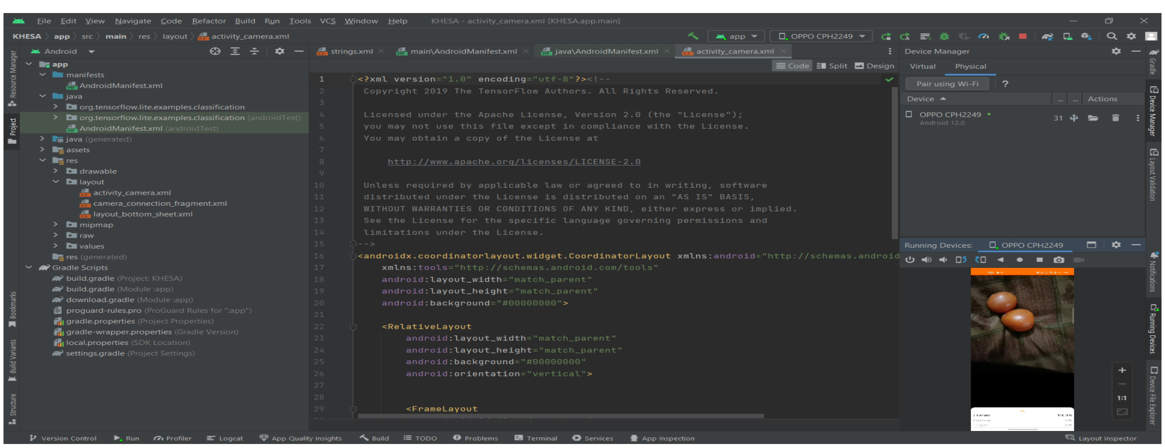


Fig 3

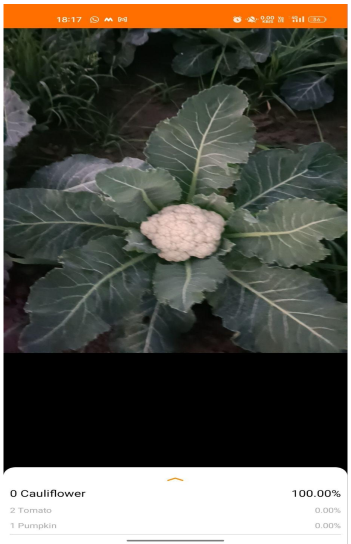


Fig 4.1

Fig 4.2

Fig 3 shows the code being run on Android Studio. Fig 4.1 and 4.2 display the implementation via screenshots from the android device used.

Summary

The above mentioned designs give shape to the project. The 3-D Models give an insight about how the physical device would look like and the application tells us about the successful implementation of the main activity i.e. identifying harvest.

PROJECT OUTCOME AND APPLICABILITY

Outline

Our Farming Assistant can now successfully identify crops in a field. As an outcome, KHESA has entered its development stage. This provides a “raw material” for integrating other functions such as cutting, pruning and separating ripe and unripe harvest.

Regarding the learning outcome, we, as a group were enlightened about the working of a Machine Learning model and its benefits. We learned to test and train an image-based Machine Learning Model. We also learned about integrating the model into an android app.

Key Implementations and Applicability

1. As a stand alone vegetable/fruit identifier
2. As a primary characteristic of the Farmer’s Assistant.
3. As a feature that can be integrated into other projects(for e.g. Object Identifier for the visually impaired)

Inferences

We can draw the following Inferences from the progress made in this project:

1. A 3D model can provide with a precise perception about the physical model.
2. Crop identification requires a large dataset of at least 1000 samples per class owing to the visual similarities among various sets of vegetables and fruits.
3. A well trained Machine Learning model is the most effective way for developing object identification systems.

CONCLUSION

Outline

So far, we have successfully designed the digital prototype model and developed the key function required to operate the Farming Assistant's apparatus. The assistant would be of service to the Indian small-scale farmer in the domain of weeding, harvesting and weather warning. The project may further expand into areas such as soil sample collection and microdose fertilizer application.

Limitations of the System

1. The coding process of Sensors and IoT is still a hurdle not crossed in our project. This problem will be tackled with time in the near future.
2. Lack of Funds was also a hindrance in developing a fully operational and functional model.

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