Mango Sizing Application Using Image Processing

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Abstract - A mobile-based Mango Sizing Application using an Image Processing was developed to address the challenges of manual fruit grading methods in the agricultural industry. Traditional manual grading is time-consuming and often inconsistent due to human subjectivity. This application automates mango grading based on size, color, and weight using image processing and linear regression models. The application captures mango images, processes them to extract relevant features, and classifies them into predefined size grades. Evaluated using ISO 25010 software quality standards, the application scored high in functionality, efficiency, usability, maintainability, and security. The proposed solution offers a reliable, fast, and consistent method for mango classification, providing a practical alternative to traditional methods.

Keywords—Image processing, mango sizing, grading, ISO 25010, linear regression, mobile application.

I. INTRODUCTION

Fruit grading, particularly mango sizing, plays a critical role in determining quality and market value. Conventionally, mangoes are graded manually based on size, weight, and color—often using subjective techniques that are time-consuming and prone to inconsistency [1]. With increasing demand for automation and precision in agriculture, the need for an intelligent and efficient mango grading application becomes essential.

To address this, a mobile-based Mango Sizing Application using Image Processing was developed. This application leverages image processing and linear regression to automatically grade mangoes based on visual and measurable attributes. The proposed solution improves grading consistency, reduces labor effort, and minimizes the time required for post-harvest sorting.

The application was evaluated using ISO 25010 software quality standards including performance efficiency, functional suitability, usability, maintainability, and security. The positive results validate the application reliability and usability in real-world agricultural contexts.

II. METHODOLOGY

A. **Application Overview**

Our Mango Sizing Application—affectionately called *Mangrade*—was built using Cordova and Android Studio to make it accessible on smartphones. It's designed to be user-friendly: users simply snap a photo of a mango, and the app does the rest. Behind the scenes, it analyzes the image to detect key features like color and pixel dimensions. Using a linear regression model, the app then estimates the mango's weight and automatically classifies it into size categories such as Grade A, B, or C.

B**. Image Processing and Feature Extraction**

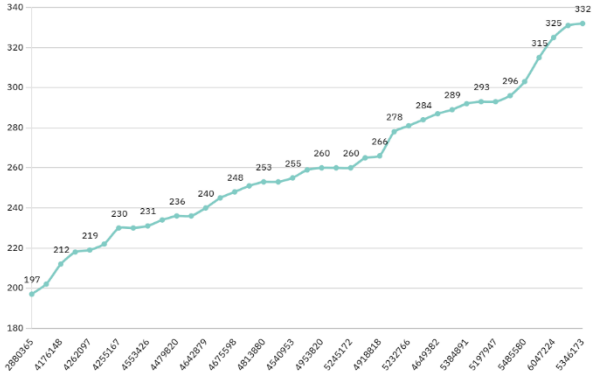
Once a mango image is captured, it goes through a series of processing steps. First, the image is preprocessed and segmented to isolate the mango from the background. Then, the system extracts important visual features like size and color. These values are used in a linear regression model to estimate the weight based on pixel data. Finally, the app uses these metrics to determine the appropriate size grade for the mango—quickly and accurately.

C. **Application Architecture and Design**

To ensure the system was well-structured and efficient, we designed it using various UML diagrams, including use case, class, sequence, and deployment diagrams. Development followed a prototype-based, iterative approach—starting with careful planning and analysis, moving through thoughtful design, and culminating in hands-on implementation. Each phase helped shape an app that's not just functional, but also reliable and adaptable.

Correlation between number of mango pixels and weight of the mango.

Using the linear regression formula where x stands for number of pixels and y stands for weight, b is equals to 623575.6412312514 and a is equals to 15840.766343909603 the weight of the mango can be predicted.



$$a = \frac{[(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)]}{[n(\Sigma x^2) - (\Sigma x)^2]}$$

$$b = \frac{[n(\Sigma xy) - (\Sigma x)(\Sigma y)]}{[n(\Sigma x^2) - (\Sigma x)^2]}$$

The Mango Sizing App takes a photo of a mango on a black background and uses color filtering to count how many pixels make up the mango. It filters out the black background and keeps only the mango area. This pixel count is then matched with the mango's actual weight during training. Using linear regression, the app learns to predict the weight of new mangoes just by analyzing their image—making the process quick, accurate, and automatic.

D. Evaluation Criteria

Application quality was assessed using ISO 25010 standards:

- **Performance Efficiency**: Response time and resource utilization.
- **Functional Suitability**: Accuracy and completeness of grading functions.
- **Usability**: Ease of use and user satisfaction.
- **Maintainability**: Application modularity and ease of updates.
- **Security**: Protection against unauthorized access and data integrity.

Figure 1. Complete Setup and Home Page of the Application

the application includes an android phone or smartphone which where the apps could be installed. The android phone or smartphone serves as the server to the user as he or she install and use the application. A home page that has different kind of process to grade mango such as train mango and scan mango.

Figure 2. View of Train Mango

presents the picture to view the train mango process of the application wherein the user can input the weight of a certain mango then can take a picture of it and it will automatically count the pixels of a certain mango and you can save it just to store the data.

Figure 3. View of Scan Mango

shows the picture of viewing the scan mango process of the application wherein the user can capture image and it will automatically detect the weight, number of pixels and the quality of each mango.

III. RESULTS AND DISCUSSION

This contains the findings, analysis, and interpretation of the gathered data.

Table 1 - Level of Performance Efficiency of Mango Sizing Application using Image Processing Application

Category	n	Mean	Description
Degree to which the response and processing times and throughput rates of a product or a system, when performing its function, meet requirements.	30	4.97	Highly Efficient
Degree to which the amounts in types of resources used by the system, when performing its functions, meet requirements.	30	4.9	Highly Efficient
Degree to which the maximum Limits of a system parameter Meet requirements.	30	4.97	Highly Efficient
Grand Mean		4.95	Highly Efficient

Table 1 presents the level of Performance Efficiency of the application; the respondents evaluated the application as highly efficient with a mean score 4.95. The results demonstrate that the Mango Grading Application is highly efficient across all evaluated criteria. The application is able to process mango images in real time, providing consistent grading based on predefined quality parameters such as size and weight.

Table 2 - Level of Functional Suitability of Mango Sizing Application Using Image Processing Application

Category	n	Mean	Description
Degree to which the set of function covers all the specified task and user objectives	30	4.83	Highly Functional
Degree to which a system Provides the correct results with the needed degree of precision	30	4.97	Highly Functional
Degree to which function facilitate the accomplishment of specified task and objectives.	30	4.9	Highly Functional
Grand Mean		4.9	Highly Functional

As shown in Table 2, the Mango Sizing Application using Image Processing Application was evaluated as highly functional with a grand mean score of 4.9. This indicates that the application effectively served its purpose and offering accurate and precise results while facilitating the grading process for mangoes.

Table 3 - Level of Usability of a Mango Sizing Application Using Image Processing Application

Category	n	Mean	Description
Degree to which users can recognize whether a system is appropriate for their needs	30	4.93	Highly Usable
Degree to which a system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, freedom risk and satisfaction in a specified context of use.	30	4.6	Highly Usable
Degree to which the system has that attributes that make it easy to operate and control	30	4.67	Highly Usable
Degree to which the system protects users against making errors	30	4.87	Highly Usable
Degree to which a user interface enables pleasing and satisfying interaction for the user.	30	4.8	Highly Usable
Degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve specified goal in a specified context of use.	30	4.57	Highly Usable
Grand mean		4.74	Highly Usable

As shown in Table 3, the respondents evaluated the application as highly Usable with a mean score 4.74.

The usability evaluation indicates that the Mango Sizing Application is highly usable across multiple criteria. The application offers intuitive navigation and operational simplicity, which enhances user satisfaction and productivity. Features like error prevention and pleasing interface design contribute significantly to its overall usability.

Table 4 presents the level of Maintainability of the system; the respondents evaluated the system as highly Maintainable with a mean score 4.67. This implies that the application is designed for easy maintenance, allowing efficient updates, modification, and repairs when necessary. Key factor such as modular design, comprehensive documentation, and adaptability

to technological changes make the system easy to update and repair.

Table 4 - Level of Maintainability of a Sizing Grading Application Using Image Processing Application

Category	n	Mean	Description
Degree to which the system is composed of discrete of components such that a change to one component has minimal impact on other components	30	4.83	Highly Maintainable
Degree to which the system can Be used as an asset in more than one system, on in building other assets	30	4.83	Highly Maintainable
Degree of effectiveness and Efficiency with which it is possible to assess the impact on a system of an intended change to one or more of its parts, to diagnose of a product for deficiencies or causes of failures, or to identify parts to be modified	30	4.27	Highly Maintainable
Degree to which the system can be effectively and efficiently modified without introducing defects degrading existing product quality	30	4.67	Highly Maintainable
Degree of effectiveness and Efficiency with which test criteria can be established for a system and tests can be performed to determine whether those criteria have been met	30	4.77	Highly Maintainable
Grand mean		4.67	Highly Maintainable

Table 5- Level of Security of a Mango Sizing Application Using Image Processing System

Category	n	Mean	Description
Degree to which a product or system ensures that data are accessible only to those authorized to have access.	30	4.93	Highly Secured
Degree to which a system, product or component ensures that the state of its system and data are protected from unauthorized modification or deletion either by malicious action or computer error.	30	4.57	Highly Secured
Degree to which actions or events that can be proven to have taken place so that the events or actions cannot be repudiated later.	30	4.67	Highly Secured
Degree to which the actions of an entity can be traced uniquely to the entity.	30	4.8	Highly Secured
Degree to which the identity of a subject or resource can be proved to be the one claimed.	30	4.87	Highly Secured
Degree to which the system sustains operations while under attack from a malicious actor.	30	4.7	Highly Secured
Grand Mean		4.76	Highly Secured

Table 5 presents the level of Security of the system. As shown in Table 5, the respondents evaluated the system as highly Secured with a mean score 4.76. This indicate that the system secure ensures adequate protection of mango's data, and maintain system integrity during operation.

The application was evaluated by 30 respondents: 10 IT faculty, 10 mango farmers, and 10 retailers. Results show:

Performance Efficiency: Mean score 4.95 (Highly Efficient)
Functional Suitability: Mean score 4.9 (Highly Functional)
Usability: Mean score 4.74 (Highly Usable)
Maintainability: Mean score 4.67 (Highly Maintainable)
Security: Mean score 4.76 (Highly Secured)

These results indicate the system's excellent performance in all software quality dimensions, making it a viable tool for mango farmers and retailers.

IV. CONCLUSION AND FUTURE WORK

The Mango Sizing Application provides an automated and accurate solution for grading mangoes based on visual attributes. It significantly improves grading consistency and reduces manual effort, supporting agricultural productivity and quality control.

Future enhancements may include integrating advanced machine learning techniques for defect detection and extending the application to other fruit types. Incorporating distance detection features and improving image preprocessing will further boost the system's accuracy and usability.

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