A novel intelligent mobile application using human-centered AR: A case study in orange inspection

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Abstract. *The growing interest in Augmented Reality (AR) technologies is increasing due to their recent use by several productive industry sectors. Also, by Industry 4.0, one of the pillars is AR and artificial intelligence (AI) to support human-machine collaboration. Human-Centered AI is an emerging research area focusing on providing interactive solutions to support human activities. This paper presents an innovative mobile application (App) composed of an AR interface connected to an AI to assist a user in interactive decision-making in the orange inspection.*

1. Introduction

The advances of Agriculture 4.0 increase food production and reduce losses from advances in pests and diseases [de Oliveira and Corrêa 2020]. AR is an important tool in this context [Bottani and Vignali 2019]. This technique can be replicated in agricultural activities, for example, in livestock farms[Caria et al. 2019]. In the context of fruits citrus, the cultivation of these fruits generates a global GDP of US$ 6.5 billion [Neves and Trombin 2017]. In addition, diseases such as black spots, citrus canker, and greening damage the fruit and reduce production due to premature drop from the trees[Fundecitrus 2021]. Thus, it is necessary to create a tool in this context.

In the literature, some works use Unmanned Aerial Vehicles (UAV) to carry out inspections in plantations [Velusamy et al. 2022]. But, these methods may contain flaws as the diseases may be present in the fruit on a side other than the UAV camera. Thus, user interaction at the time of the inspection is essential because he takes the action of rotating the fruit for inspection with the mobile device (MD). Therefore, in this work, we present the development of the intelligent App AR with Human-Machine interaction. A tool to assist citricultures in the inspection of diseases in orange plantations. Also, whereas the usage of Human-Centered AI in agriculture is still little explored, work helps to understand the needs among the domains that compose this area, including Human-Computer Interaction and Artificial Intelligence.

2. Theoretical References and Related Work

AR is a technology that allows the superposition of 3D virtual objects in a 3D real environment, with our perspective of reality [Azuma 1997]. In agriculture, MD's with AR and AI can help farmers in many ways [Yang et al. 2021]. In this context, the work proposes to provide information to the user about diseases in oranges.

Human-Centered AI (HCAI) is defined by systems that are continually being optimized due to human action [Shneiderman 2020]. This method can be important in agriculture because they reach more precise levels, combining intelligent information for decision-making [Holzinger et al. 2022]. Given this, we propose presenting two AR objects in the App interface so the user can decide which model best represents the inspected image. Thus the user has autonomy in decision-making when inspecting the oranges.

3. Proposed System

For the development of the system, the central usability guides are adopted for the creation of the interface [Nielsen 2006], as well as in the context of mobile applications using AR [Labrie and Cheng 2020]. With this, we can guarantee that the App meets the minimum requirements for a good field operation and has a very intuitive interface for use. Furthermore, the solution must present the information to the user within a response time acceptable by human standards.

Figure 1-A shows the App development process that happens as follows: A MD collects the image of the orange; The App performs the detection and classification of the received image with the AI model. The ARCore framework waits for AI classification; The APP presents in the UI the AR objects according to the AI classification. Thus, the user decides which AR object corresponds to the inspected image to save the data. The AI Models are available in [Ferreira da Silva et al. 2022]. The first model is responsible for detection, and the second for classifying oranges. Also, all processing happens at the edge of the device.

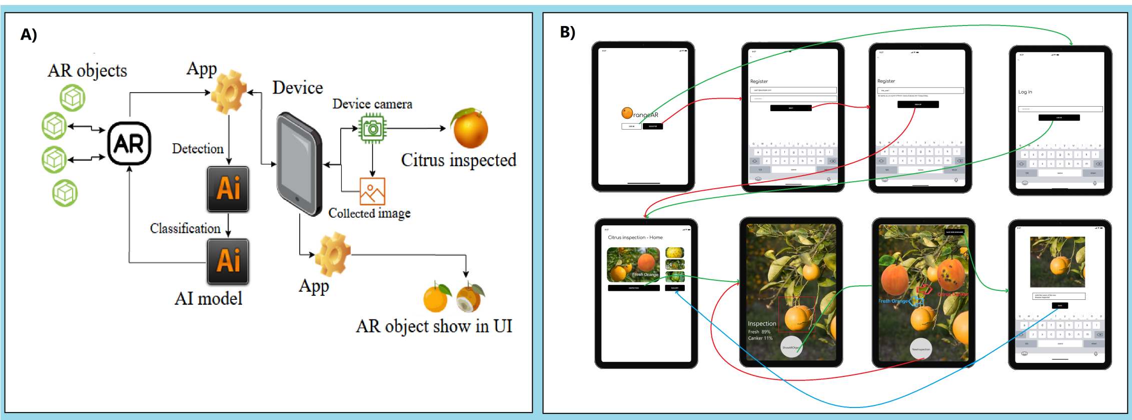

Figure 1. Proposed System (A) and UI Design (B)

Figure 1-B shows the navigation flow in App UI. Whereas users do not need the training to use an App, we build a simple interface to make test this proposed work. First, the user can perform login or registration. On the home screen, the user can inspect or view the collected images in the gallery. If the user decides to inspect, with one touch on ”ShowARObject” button, the AR object shows in UI. Also, we can save the image as a new disease in the MD.

4. Results

To develop this app, we used flutter and executed it in a Samsung Galaxy Tab S6 Lite. Although flutter not a native Android language, it performed well in this context, following

Nielsen's heuristic usability guide. We performed 30 executions following steps: Identify the disease in the fruit; Press the "ShowARObject" button and Preview the AR object on the device screen. Figure 2 shows some predictions made by the AI and the corresponding AR object.

Thus, the average time for each AR object to render on the device screen is approximately 1.5 seconds. This value is the difference between tapping the button "ShowARObject" and the moment in which the object appears on the AR screen.

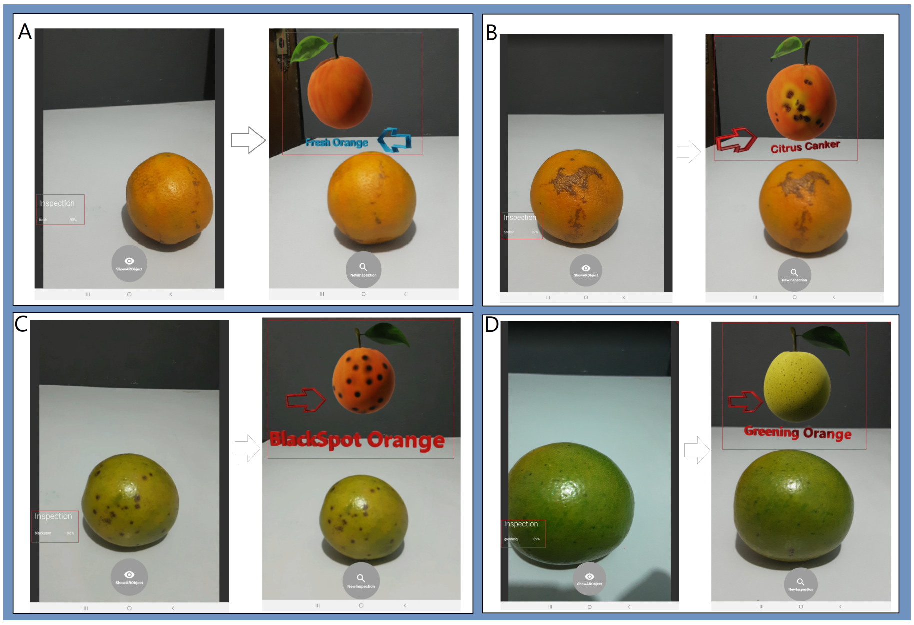

Figure 2. Inspection IA and AR: A) Fresh; B) Canker; C) BlackSpot; D) Greening.

We guarantee to test the device in airplane mode, and only with this App running. So, according to Status Visibility, the App respond in an acceptable user perception time interval. Regarding the correspondence between the system and the real world, we put standard texts and icons. Step necessary to the user does not have difficulties using the App. There is also the control and freedom to go back, undo or cancel action in the App. Finally, the user decides to save or discard the image collected. Action that becomes possible due to the use of the human-centered AR tool.

5. Conclusion

In this work, we propose a new way to apply AR with Human-Machine interaction in a smart MD to inspect oranges. This App shows the importance of user interaction with the App and the fruit for the inspection of oranges. Considering that the inspection must be carried out on the entire surface of the fruit, the user needs to rotate the orange at the inspection time. This way, the system puts the user experience at the center, interacting with the MD.

Finally, this intelligent AR App with Human-Machine interaction integrated into the MD allows an interactive and intelligent citrus inspection. Thus, helping citrus growers in the task of inspecting oranges, having the user as a component for the entire functioning of the whole system.

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