Product Requirements

PlantAR: An Interactive Learning Tool

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Brief problem statement

Current science education often relies on static images in textbooks to teach students about complex biological structures like plants. This method can fail to engage students and does not provide an intuitive, 3D, interactive understanding of how different parts of a plant function and relate to one another.

This project aims to solve this problem by developing an Augmented Reality (AR) application for mobile devices. The app will allow elementary and middle school students to explore detailed, interactive 3D models of various plants. By pointing their device at a target image, a model will appear that they can rotate, zoom into, and tap on to learn about specific parts (e.g., roots, stem, leaves, flower). This immersive and hands-on approach will make learning more engaging, memorable, and effective.

System requirements

- **Mobile Device:** A smartphone or tablet with iOS (ARKit compatible) or Android (ARCore compatible). The device must have a camera.
- **Development Platform:** Unity Game Engine (version 2021.3 LTS or later).
- **AR Framework:** AR Foundation, ARKit, ARCore.
- **Third-Party Assets:** 3D plant models (sourced or created), target images for tracking.
- **Deployment:** Application will be deployed as a standalone .apk (Android) or .ipa (iOS) file for testing.

Users profile

The primary users are **elementary and middle school students** (ages 8-14).

- **Reading Level:** 3rd to 8th grade. Text must be simple, clear, and concise.
- **Technical Proficiency:** Assumed to be novice users of mobile apps but familiar with basic touch gestures (tap, swipe, pinch).

- **Characteristics:** Curious, visual learners, with relatively short attention spans. The application must be highly engaging, intuitive, and easy to use without instruction.
- **Accessibility Needs:** The application should be designed with accessibility in mind (e.g., high color contrast, scalable text, clear audio descriptions if implemented later) to accommodate diverse learners.

Users – Teachers (elementary and middle school educators)

- **Role:** Teachers integrate PlantAR into classroom instruction to support lesson plans on plant biology.
- **Needs:** Ability to **preview models and descriptions** before class, select appropriate plant models, and guide group exploration.
- **Technical Proficiency:** Comfortable with mobile apps and digital teaching tools, but prefer simple setup.
- **Characteristics:** Time-constrained, focused on tools that are reliable, accurate, and quick to deploy in a classroom setting.
- **Accessibility Needs:** Clear content editing workflow so they can adapt text to student reading levels or add lesson-specific notes.

List of Features

- **F1:** Image Tracking. The app will recognize a predefined physical target image.
- **F2:** 3D Model Rendering. A 3D model of a plant will be rendered and locked onto the target image.
- **F3:** Model Manipulation. Users will be able to rotate and zoom the 3D model using touch gestures.
- **F4:** Interactive Parts. Users can tap on specific parts of the plant model (root, stem, leaf, flower).
- **F5:** Information Display. A pop-up panel will display the name and a brief description of a tapped plant part.
- **F6:** Plant Selection. A simple menu to select from multiple available plants (for future versions beyond MVP).

Functional requirements (user stories)

No.	User Story Name	Description	Priority
R1	View Plant Model	As a student, I want to point my phone's camera at a target image so that a 3D model of a plant appears in the real world.	1

R2	Rotate Model	As a student, I want to drag my finger on the screen so that I can rotate the plant model to see it from all angles.	1
R3	Zoom Model	As a student, I want to use a pinching gesture on the screen so that I can zoom in and out on the plant model to see fine details.	1
R4	Identify Plant Part	As a student, I want to tap on a specific part of the plant (e.g., a leaf) so that a text label appears showing its name (e.g., "Leaf").	1
R5	Learn About Part	As a student, after tapping a plant part, I want to see a simple, one-sentence description of its function (e.g., "The leaf uses sunlight to make food for the plant.")	1
R6	Clear Information	As a student, I want to tap elsewhere on the screen or a "close" button so that the information pop-up disappears.	2
R7	Stable Model	As a student, I want the model to stay firmly locked to the target image without jittering or drifting away.	2
R8	Multiple Plants	As a teacher, I want to have a set of different target images that each trigger a different plant model (e.g., sunflower, tomato plant).	3
R9	Teacher Preview Mode	As a teacher, I want to preview the plant models and their descriptions beforehand so I can integrate them into my lesson plans.	3

Non-Functional Requirements

- NF1: Usability
    - The application shall be learnable by a child in the target age group within 2 minutes of use without a tutorial.
    - The touch gestures for rotation and zoom shall be responsive, with less than 100ms latency.
- NF2: Performance
    - The application shall maintain a frame rate of at least 30 frames per second (FPS) on supported mid-range devices to ensure a smooth AR experience and prevent motion sickness.

- NF3: Compatibility
    - The application shall run on iOS devices supporting ARKit 4.0+ (e.g., iPhone 8 and later) and Android devices supporting ARCore 1.0+ (as defined by the Google ARCore supported devices list).
- NF4: Accuracy
    - The biological information (names and descriptions of plant parts) presented in the application shall be factually accurate and age-appropriate, as verified by the sponsor (Dr. Ludi).
- NF5: Accessibility
    - The application's text shall adhere to WCAG 2.0 Level AA guidelines for contrast ratio (at least 4.5:1 for normal text).
    - The application shall be navigable using its core features without reliance on color alone as the sole method of conveying information.
- NF6: Sponsor Requirement (Maintainability)
    - The codebase shall be well-documented with comments to allow for future expansion by other developers.
    - A clear README.md must provide setup instructions (Unity/AR Foundation), steps for adding/replacing 3D models, and updating biological content without altering core code.
    - Documentation should be structured so future developers or technically inclined teachers can easily expand and maintain the application

Sponsor Requirements

I have read and approve the material in this document. If there is no external sponsor, the TA or instructor will sign it for accuracy/scope.

Dr. Stephanie Ludi (she/her)

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