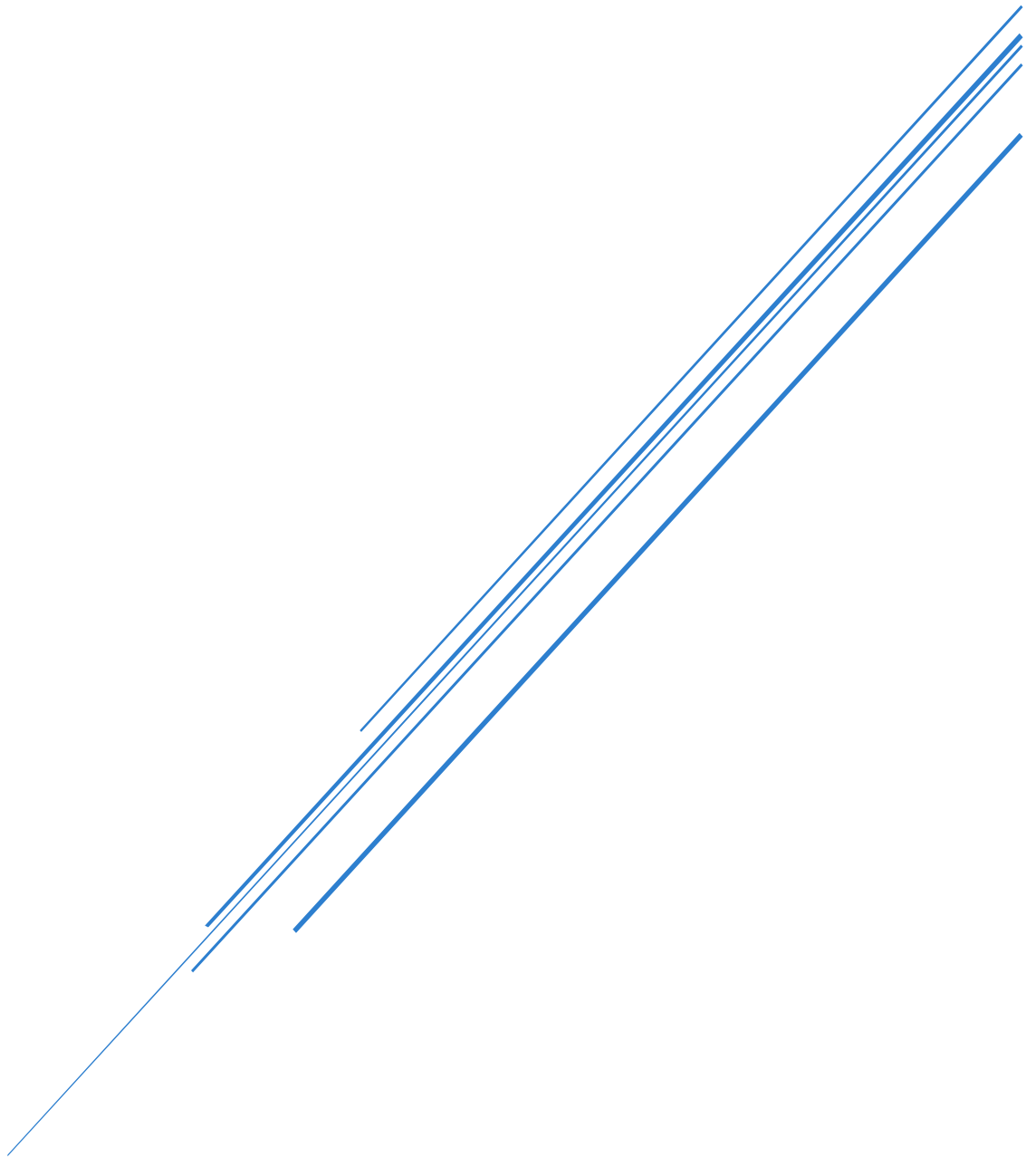


AR ASSIGNMENT REPORT

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Introduction

Additional features

Beyond the core requirements, several other features were implemented to improve user interaction. Custom image markers were designed specifically for each tracking point, providing unique visual identities that align with the University of Lincoln's branding. Animations were integrated into marker detection responses, creating dynamic feedback when targets are recognised. A placeable 3D object feature was developed with progressive scaling animation upon instantiation. This object incorporates two interactive states: an idle state with continuous rotation, and a selected state that reverses the rotation's direction and applies a colour transformation, demonstrating advanced user interaction handling and real-time object manipulation within the AR environment.

AI usage

AI tools were used at various stages of development, mainly for debugging scripts and understanding AR-specific error messages. As this was my first time working with augmented reality, I struggled with concepts like image scoring and marker detection. Several of my custom markers either wouldn't detect properly or broke the tracking code entirely. The tools helped me understand what made a good marker, like contrast, feature points, and pattern complexity. The tools also guided me through fixing the issues. This support was particularly valuable for navigating error messages. All AI suggestions were tested and modified to fit my specific implementation before being used in the final application.

Development

Project Foundation

Most of the application was developed across four workshops that introduced core AR concepts. Workshop 1 established the foundational Unity project with an AR framework. Providing a template configured for Android deployment. The initial setup included a sample scene and a simulated environment to test during run-time. Workshop 2 focused on image target detection and tracking, introducing the Reference Image Library and the AR Tracked Image Manager component. These tools are scalable and easily allow developers to add more images when needed. Workshop 3 covered plane detection and object instantiation using the AR Plane Manager and AR Raycast Manager components. Workshop 4 assisted with user interface implementation, including UI canvas setup. This workshop also expanded on the previous one, providing an extended version of the PlaceObjectsOnPlane script. Now, the user can place an object and interact with it. For the application, I just made the user be able to count or delete the objects to showcase interactivity.

Custom Marker Implementation

Three custom image markers were designed to represent different aspects of the University of Lincoln experience. The first marker showcased the University of Lincoln Logo was provided by the workshop, and tells a little fun fact about the university's opening. The second marker showcased the Computer Science Society, for which I sourced the official CSS logo as a committee member and mentions how we raised money for charity and secured the Society of

the Year award during the 24/25 academic year. The final marker was a picture of the apple found hanging in the INB atrium, and mentions how Lincoln is the most affordable student city according to Natwest (“Student Living Index 2025 | Student Living Costs | NatWest,” n.d.). Each marker required careful consideration of image quality and feature detection. Initial attempts, specifically with the CSS logo, resulted in poor detection reliability, with some markers not tracking correctly or breaking the detection code entirely. Through testing and refinement, I learned that markers needed high contrast, distinct feature points, and sufficient pattern complexity, which the original CSS logo lacked. I iteratively refined each marker by adjusting these variables and achieved more reliable tracking performance.

Placeable Object with Interactions

The star placement system demonstrates spatial interaction within the AR environment. Users tap onto detected ground planes to instantiate a green star at the selected point. Upon instantiation, the star executes a growth animation by interpolating its scale from zero to full over approximately 0.3 seconds using Unity’s `transform.localScale`, `Time.deltaTime` and coroutines. Once placed, the star enters an idle state with continuous clockwise rotation. The model changes when interacted with; the star becomes red and rotates continuously counterclockwise instead.

Collectable Badge System

A progression tracking system rewards users for discovering unique markers. When a marker is detected for the first time, the application awards the user with a badge (visualised by the markers, for example: the CSS got a coin, the apple got a green gem, and the official university of Lincoln logo got a red heart). The progress is tracked with a counter displayed in the top-right. To prevent duplicate rewards, I implemented a tracking mechanism using a list of strings that checks for any duplicates before awarding badges. This gamification element encourages exploration and provides clear completion criteria, enhancing user experience during the open days.

Design

Interaction Model

The application employs a tap-based interaction model consistent with previously established AR applications. Norman (2013) emphasises that effective design guides user behaviour without explicit instruction. The star placement system utilises tap gestures for both instantiation and selection, following common AR conventions. This design choice reduces cognitive load by avoiding gesture complexity. Users instinctively understand that tapping places objects and tapping again selects them. The growth animation upon instantiation serves two purposes: it confirms successful interaction and draws visual attention to the newly created object. This feedback mechanism aligns with Nielsen’s visibility of system status heuristic (Nielsen, 1994), ensuring users receive immediate confirmation of their actions.

The dual-state rotation system provides continuous feedback that distinguishes the idle from the selected state. Clockwise rotation, along with the slight raising and lowering of the star, in the idle state, creates a subtle motion that signals the object is interactive rather than static. Upon selection, the counterclockwise rotation and colour change from green to red provides

unmistakable feedback that the system has registered user input. The collaborative effort of these feedbacks accommodates different user attention patterns and ensures accessibility across varying lighting conditions where colour alone might prove insignificant.

Colour Psychology

The colour choices throughout the interface draw upon established conventions commonly found in interactive design. The delete button employs red, a colour universally associated with destructive actions, warnings, and irreversibility (Bellizzi and Hite, 1992). This leverages users' existing colour association from other software contexts, reducing the learning curve and preventing accidental deletions. The counts button's green colouring aligns with positive actions. Green typically signals progression, confirmation, or safe actions in interface design.

The fun fact panels employ distinct colours for each marker category: purple for the Computer Science Society, as this is their main colour, green for Lincoln city affordability information, typically associated with money, and yellow for the university content. This colour-coding creates a visual distinction that helps users associate specific facts with their corresponding markers, which helps support memory retention. Dunser and Billingham (2011) note that colour differentiation in AR interfaces reduces confusion when multiple virtual elements coexist in the same physical space.

The tooltip panel shifts to blue when all badges are collected, signalling achievement and finality. Blue is typically associated with being calm, trusted and completed (Labrecque and Milne, 2012) which makes it appropriate for success states, differentiating the completion message from ongoing task instructions in the grey tooltip panel.

Spatial UI

The application's control layout reflects conventions in mobile AR interfaces where spatial constraints demand careful consideration. The persistent tooltip at the top of the screen provides contextual guidance without obscuring the camera's view, which is commonly the primary interaction space in AR applications. This follows Billingham and Dunser's (2012) recommendation that AR interfaces minimise occlusion of the physical environment while maintaining information accessibility.

The decision to implement the persistent tooltip, rather than a dismissible tutorial, reflects an understanding of AR's cognitive demands. Users must simultaneously process physical environments, virtual augmentations, and interface controls. A persistent tooltip reduces memory load by guiding the user exactly when needed, eliminating the need to recall dismissed tutorial information. The tooltip is dynamic and changes from "Scan unique markers" to "all badges collected", demonstrating progressive disclosure. The badge collection mechanic draws inspiration from Pokemon GO's location-based collection system (Niantic, 2016), where spatial exploration is rewarded with collectables. However, unlike Pokemon GO's GPS-based approach, this application uses marker-based AR to create tighter associations between physical objects and digital content, which research suggests improves educational retention in museum contexts (Yoon et al., 2012).

The separation of the delete and remove info buttons addresses the users' different needs: delete removes a selected, placed star. In contrast, the remove info button dismisses the fun facts panel that appears when the user scans a marker. This functional separation prevents the ambiguity that could arise with a "Clear" button instead. However, future iterations of the

application would benefit from spacing the two buttons further apart, perhaps by placing the Count button in the middle, as the "Delete" and "Remove Info" buttons can still be quite ambiguous.

Educational Content Integration

The fun fact system balances entertainment with education, addressing the application's core objective of teaching visitors about the University of Lincoln. By embedding information directly into the marker detection events, the application creates meaningful associations between physical locations and contextual knowledge. This spatial anchoring of information leverages one of AR's unique traits: connecting digital content to physical places in ways that support memory formation and contextual learning (Dunleavy et al., 2009). The removable nature of the fun fact panel respects user agency, allowing visitors to clear information once read without disrupting ongoing AR interactions with placed objects or markers.

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