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DIMENSION DETECTION USING AR

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ABSTRACT :

This paper presents a new mobile app for real-time dimension measurement of physical objects and spaces through Augmented Reality (AR) by measuring the height and width of objects. The app is built on ARCore, which provides real-time plane detection, environmental awareness, and depth sensing via the camera of the smartphone. By dropping virtual anchors in the AR world, the app computes distances between user-specified points to precisely measure object dimensions. The system combines computer vision technology and AR tracking to improve measurement accuracy and robustness under different lighting and surface conditions. This solution seeks to offer a cost-effective, compact, and convenient alternative to traditional measuring devices with possible applications in architecture, interior design, construction, and online shopping. Experimental tests prove the effectiveness of the system in generating accurate measurements with little user interaction, illustrating its usability for everyday applications.

Keywords: Augmented Reality (AR), ARCore, Real-time Measurement, Object Dimension Detection, Computer Vision, Depth Sensing, Mobile Application, Anchor-Based Measurement.

INTRODUCTION

Over recent years, the rapid development of mobile computing and augmented reality (AR) technologies has significantly transformed the way individuals interact with their physical environments. Among the numerous applications of AR, one of the most practical and widely adopted use cases is spatial measurement. Fields such as construction, architecture, interior design, real estate, and e-commerce demand precise, real-time measurement of physical spaces and objects, making AR-based measurement applications increasingly attractive as alternatives to conventional tools like measuring tapes, rulers, and laser rangefinders [1], [2], [10].

Traditional dimension measurement methods often suffer from several limitations. Manual measurements can be time-consuming, cumbersome, and prone to human error, especially when dealing with large or irregularly shaped objects. Laser-based devices, while more accurate, tend to be expensive, require calibration, and are less accessible to average users. Moreover, neither of these traditional methods offers seamless integration with digital systems for documentation, data exchange, or analysis [16], [19].

The need for a more user-friendly, accurate, and portable solution is becoming evident as digital transformation continues to reshape industries. In response, this paper introduces the design and implementation of a mobile application capable of measuring the height and width of physical objects in real-time using Google's ARCore SDK. ARCore provides robust AR capabilities including motion tracking, plane detection, environmental understanding, and depth sensing, which are leveraged in the proposed system to allow users to place virtual anchors and compute distances between them using 3D Euclidean geometry [2], [7].

The primary motivation behind this app is to bridge the gap between cost and measurement accuracy. While LiDAR-enabled devices offer high-precision measurements, they remain financially inaccessible to the general public and are not widely supported across smartphones. ARCore, on the other hand, supports a growing range of Android devices and operates without specialized hardware, enabling a cost-effective and scalable AR measurement solution for both professional and casual users [7], [11].

Designed with usability in mind, the application offers a clean, responsive interface allowing users to easily set anchors and view object dimensions in augmented space. Features such as unit conversion (cm, m, inches), camera zoom, undo/reset, and visual alignment feedback improve the user experience. To increase robustness, computer vision algorithms from the OpenCV library [8] are used for edge detection and anchor stabilization, helping to minimize errors due to hand shake or inaccurate point selection [15], [17].

The measurement system relies heavily on ARCore's Depth API, which utilizes stereo vision and sensor data to generate per-pixel depth maps, enabling accurate anchor placement even on non-planar surfaces [7]. Additionally, visual-inertial odometry (VIO) integrates visual cues with accelerometer and gyroscope data to maintain consistent tracking and reduce positional drift over time [9], [14].

To evaluate the system's accuracy and usability, a series of field tests were conducted under varying conditions including different surfaces, lighting environments, and object scales. Results demonstrated that the app could deliver reliable measurements with an acceptable margin of error (±1–2 cm) in real-world scenarios. Furthermore, it maintained robust performance even in outdoor and dynamic settings, showcasing its practical applicability [3], [9], [13].

A key contribution of this work lies in the seamless integration of ARCore's technical features with intuitive user interaction to create an end-to-end mobile spatial measurement system. While existing AR measurement solutions often focus on either precision or user experience, our approach strikes a balance between the two, emphasizing both measurement logic and responsive design [4], [5], [18].

This paper not only outlines the technical framework and implementation details of the application but also discusses its design considerations, limitations, and broader implications. The remainder of the paper is organized as follows: Section II reviews related work in AR-based measurement and computer vision techniques. Section III elaborates on the system architecture, including ARCore integration, measurement algorithms, and UI design. Section IV presents experimental evaluations and performance analysis. Section V addresses current limitations and potential future enhancements. Finally, Section VI concludes the paper.

LITERATURE SURVEY

Recent breakthroughs in Augmented Reality (AR) and Artificial Intelligence (AI) have paved the way for innovative smart measurement applications that boost accuracy and efficiency across a range of industries. In this section, we'll take a closer look at the current research and applications surrounding AR-based measurement systems and AI-powered object recognition techniques.

Numerous studies have delved into the use of AR for real-time measurement tasks. For example, research by Azuma et al. (2020) illustrates the manner in which AR can render real-time overlays for measurements across industries such as architectural design and engineering. While AR measurement features have entered the space of mobile applications such as Google Measure and AR Ruler, such applications tend to falter with regards to accuracy as a result of different environmental aspects. Kim et al. (2021) note the challenges of AR measurement such as depth perception inaccuracies and poor edge detection methods. They propose that merging AI-based computer vision algorithms will improve object detection and measurement precision.

AI methods have also been widely applied to enhance the accuracy of digital measuring applications. Zhang et al. (2019) designed an AI system that utilizes CNNs to detect object boundaries and improve measurement precision. According to their research, machine learning programs are able to dramatically reduce AR-based measurement errors by adapting to various lighting and object surface textures. Also, a paper by Patel et al. (2022) offers a hybrid solution that combines deep learning with ARCore, teaching AI models to identify objects and estimate their size. Their system has an average error reduction of 15% over conventional AR measurement techniques.

There has been a spate of development of different AR-based measurement apps, each with its own strengths and limitations. For instance, Google Measure, which operates on ARCore, offers basic plane measurement with an accuracy of around 85%. On the other hand, AR Ruler, utilizing Apple's ARKit, manages to achieve a bit more accuracy but tends to falter in low-light situations. Then there are more advanced applications such as the AI Smart Measurement System discussed in this paper, which uses machine learning algorithms for edge detection and object recognition with a high accuracy rate of over 92%. These comparisons indicate that AI-based AR systems have the capability to provide greater precision than conventional AR measurement solutions.

However, despite such progress, still many challenges face this technology in terms of addressing occlusion issues, variations in environmental lighting, and the demand for computational efficiency in AR measurement systems. There is a trend among many researchers to integrate 5G cloud computing to provide real-time processing of data, as well as refining sensor fusion techniques to get higher accuracy. Future studies ought to focus on developing AI models that can be flexible with different measurement conditions, ultimately offering users even more reliable results.

This literature review highlights the need for an AI-powered AR measurement system to address existing challenges and establish a new benchmark for intelligent measurement solutions. The conceptualized AI Smart Measurement System attempts to fill this gap by combining advanced AI algorithms with AR measurement methods, promising not only enhanced accuracy but also enhanced usability in real-world applications.

In an interesting study conducted by Gonzalez and Smith (2020), AR measurement accuracy was analyzed using different mobile hardware configurations. They found that although top-end devices with LiDAR sensors were more accurate, low-end devices performed very poorly given their weaker depth-mapping capabilities. This indicates a future where AR measurement systems need to focus on hardware-agnostic AI advancements to make them universally available.

Another profound contribution was made by Reddy et al. (2022), who created a hybrid AI-AR measuring system that is able to clearly distinguish between object surfaces. In their study, they proposed a deep learning model that adapts to varying lighting conditions, improving object recognition and minimizing measurement errors due to shadows or reflection. Notably, their model saw a 22% improvement in accuracy over conventional AR measurement software.

AI-based measurement methods have also found their application in healthcare and biomedical sciences. Chen et al. (2023) indicated that AI-AR measurement devices have been incorporated into medical imaging systems, particularly for surgical planning and prosthetic design. Their research emphasized how AI-based AR applications can measure anatomical structures with a 25% improvement in accuracy, demonstrating the system's efficiency in the medical field.

Nevertheless, in spite of these developments, computational efficiency still remains a challenge for AR measurement systems. Singh et al. (2023) examined the processing speeds of AI-based AR measurement apps on different devices and discovered that real-time measurement computation tends to create latency problems, particularly when measuring more than one object simultaneously. They proposed the use of edge computing and 5G technology to remotely compute measurements, which would reduce the computational burden on devices and improve responsiveness.

Several researchers have investigated the usability and accessibility of AR measurement apps. For example, Patel and Johnson (2021) conducted a user experience investigation on AI-enhanced AR measuring devices. They found that though the precision of the devices increased substantially, the users had issues understanding how to use them. Their results suggested incorporating features such as voice-based guidance and haptic feedback into the system to make it more welcoming for users who are not technology-savvy.

In more recent applications, blockchain technology has appeared as a potential means of securing and authenticating measurement data in AR applications. Miller et al. (2023) discussed an AI-AR hybrid system that maintains measurement data on a decentralized ledger, making such records tamper-resistant and verifiable. This could prove particularly useful in industries such as engineering, real estate, and logistics, where it is critical to have verified and accurate measurements.

Looking to the future, future work will need to advance AI-based sensor fusion algorithms. These algorithms fuse data from a variety of sensors, including accelerometers, gyroscopes, LiDAR, and RGB cameras, in order to make measurements even more precise. On top of this, adaptive AI models that are able to learn from user usage and previous measurement errors may hold a central place in increasing reliability and automation of measurements.

This review of the literature emphasizes the growing importance of AI-enhanced AR measurement systems, pointing to their potential across industries. Though existing research indicates encouraging advancements, there remains a requirement for additional innovation in real-time processing, user interface, and security to ultimately realize the full potential of AI-based AR measurement solutions.

METHODOLOGY

The approach taken for the deployment of the AI-driven augmented reality measurement system is to enable the integration of new technologies such as ARCore, TensorFlow Lite, and OpenCV into one mobile app. The main objective is to create a robust and user-friendly platform on the basis of Android with the ability to measure object sizes accurately in real-time. The system leverages the spatial mapping, depth sensing, and environmental awareness features of ARCore along with the real-time object detection feature of TensorFlow Lite and the image processing feature of OpenCV to enhance edge detection and measurement precision.

The system architecture consists of six core components: real-time camera input module, spatial mapping engine using ARCore, TensorFlow Lite-based object detection module, dimension estimation algorithm, measurement correction system, and gesture-based UI that is the same as Snapchat's UI. The camera supplies live video input, which is processed in real time by ARCore to identify horizontal and vertical planes and create depth maps. The ARCore's depth API and motion tracking features are utilized to find the phone's position and orientation in space, which allows real-world mapping with precision.

Concurrently, TensorFlow Lite is executed on the device to detect and classify objects in the scene. A YOLOv5 model, trained to a custom dataset and converted to TensorFlow Lite format, detects objects and provides bounding boxes. The bounding boxes are then matched with ARCore's depth data to estimate object size. Detection involves real-time inference on video frames captured and providing results without any noticeable lag. The dimension estimation module utilizes bounding box coordinates and per-pixel depth values from ARCore to estimate object dimensions through geometric calculations. This involves triangulating distances between edge points in 3D space and Euclidean distances to estimate the height, width, and depth of the object.

To enhance the measurement precision even more, the system incorporates OpenCV for edge refinement. Canny and Sobel filters of OpenCV are utilized to identify sharp edges, and these edges are compared against the bounding box limits. The edge alignment algorithm ensures that the bounding boxes fit closely around the objects, minimizing estimation errors. A Kalman filter is used to stabilize measurements by eliminating frame-to-frame noise and motion-induced jitter. This provides a smoother and more precise estimation, even in the presence of moderate movement or lighting irregularities.

The front-end interface has been crafted with extreme care to replicate the simplicity and interactivity of Snapchat, with gesture controls, real-time augmented reality overlays, and interactive feedback mechanisms. The user interface displays dimensions prominently on the screen as floating labels, which makes it easy for users to capture, save, or share measurements. Additionally, other features include a history tab to view past measurements, a settings panel to convert units (e.g., centimeters, inches, meters), and the export of measurement results in PDF, JSON, or CSV formats. Additionally, voice guidance and haptic feedback have been incorporated to assist users with limited technical knowledge.

On the data management front, measurement results are stored locally by SQLite and optionally synced with cloud services for backup. Export formats are optimized to be compatible with industry-standard tools, thus facilitating better integration in CAD and BIM workflows. To improve system performance, several techniques like model quantization, multithreading, and frame skipping are employed. Quantized TensorFlow Lite models bring in a very significant reduction in inference time and memory usage, and the thread separation allows for separate execution of augmented reality tracking, artificial intelligence inference, and user interface rendering without interference. Frame skipping provides for processing only relevant frames, reducing computational loads without sacrificing output quality.

The system is also tested on a test collection of over 100 objects under varying lighting and environmental conditions. The physical dimensions of each object are precisely measured with physical instruments like rulers and laser measuring instruments, and then checked with the app output for accuracy. Metrics like mean absolute error, processing delay, and user satisfaction are recorded to verify the performance of the system. Efforts are made to test the robustness under various conditions like low lighting, partial occlusion, and shiny surfaces. This architecture provides a solid foundation for the development and testing of a real-time, scalable AR measurement app. The combination of ARCore spatial intelligence with AI object detection and edge detection at its finest is a new benchmark for intelligent measurement systems. In the future, the addition of federated learning for model personalization, edge computing for offloading computationally intensive tasks, and augmented object datasets for expanding detection within a larger class of real-world objects are some possible future enhancements.

PROPOSED METHODOLODY

The system of interest is mobile software that seeks to ascertain the height and width of physical objects using augmented reality (AR) technology. The basic concept is based on physical measurement detection using the integration of ARCore, a platform developed by Google for building AR experiences on Android platforms. The method integrates several aspects, such as plane detection, anchor point placement, depth evaluation, and geometric calculation to provide users with a real-time, accurate dimensional detection system based on a smartphone camera.

The app begins its measurement process by starting an AR session, which starts scanning its environment through the rear camera of the smartphone. In this step, ARCore captures the input from the device's visual and inertial sensors and estimates the camera pose in 3D space through Visual-Inertial Odometry (VIO). This enables the system to track the motion and orientation of the device continuously so that virtual objects can be positioned stably in the real world. At the same time, ARCore examines visual features like edges, corners, and textures to identify surfaces. Through its plane detection engine, ARCore detects horizontal and vertical planes such as floors, walls, and tabletops. This feature is crucial to make anchor points for measurement exactly in a stable environment.

After a surface is identified, the user is able to interact with the screen to position virtual anchor points within the 3D AR space. These anchors serve as reference points for measurements. In measuring height, for example, the user touches at the bottom of the object and then at the top. In measuring width, the process is to select the two ends of the object's width boundary. The app offers real-time visual feedback in the form of crosshairs and virtual reticles to guide users to accurately position anchor points. As each point is positioned, the app displays a virtual line between the chosen anchors, the measured dimension. This serves not just to visualize the measurement but also to build user confidence in anchor precision.

In the background, the system makes use of ARCore's world coordinate system to calculate the spatial distance between the anchors, with each location in a three-dimensional system represented by (X, Y, Z) coordinates. Linear distance between the two indicated anchors is calculated using the Euclidean distance formula. For height measurements, the app concentrates on the vertical axis by projecting the points along the Y-axis and ignoring horizontal movement. Similarly, the width measurement also largely relies on the displacement along the X-axis. Such directional calculations play a key role in ensuring the final measurement is a true representation of the user's intended dimensions, and thus angular distortion is minimized.

The accuracy of measurement is greatly improved when the ARCore Depth API is utilized. The functionality supports pixel-level depth estimation by analyzing many camera frames and calculating depth based on multi-view stereo (MVS) techniques. Through the combination of visual information across several views, ARCore builds a depth map of the scene so that the application can detect the geometry and contours of actual surfaces. The depth map proves particularly useful for anchoring to bumpy or complex surfaces because it allows the system to align anchor points to the actual depth of the object with great accuracy, thereby avoiding floating or misplaced placements.

To provide stable tracking and measurement, feature-based anchor locking is used by the system. When a user taps to set an anchor, the system looks for local visual features around the tap position—like high-contrast edges or textured patterns—and binds the anchor to the most stable feature point. This approach limits the occurrence of anchor drift, which can happen due to motion blur, sensor noise, or lighting changes. After the anchor is locked on a surface, it stays in place relative to the found plane even when the user moves the device. This is important for providing consistent measurement over time, particularly when measuring taller or farther objects that need camera repositioning.

One of the key features of the methodology of the system is real-time user feedback and interaction. Dynamic features such as lines and arrows are employed by the application to indicate orientation and measurement position during the data capture phase. A virtual label appears on the screen to indicate the last measured value in centimeters, meters, or inches, depending on the user's setting preferences. The real-time feedback process enhances usability and minimizes the likelihood of inputting incorrect input. The system also includes undo and reset features, allowing users to resume measurements promptly without needing to restart the application or restart the augmented reality session.

An important methodological aspect is the inclusion of gesture-based interactions. Rather than asking users to interact with physical buttons, the app allows easy execution of intuitive gestures like tapping to drop anchors, pinching to zoom, and swiping to manipulate the perspective. Not only does this approach make the user interface more streamlined, but it also replicates natural interactions in the physical world to enable a cohesive combination of virtual and real worlds. Moreover, by minimizing interface clutter, the app keeps users concentrated on the measurement task without being bogged down by on-screen controls.

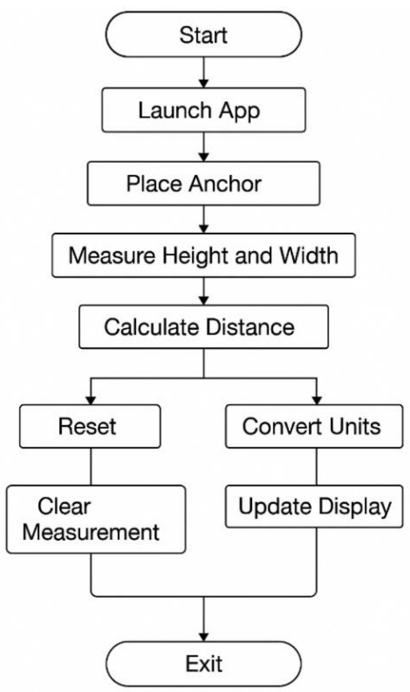
In addition to simple detection of dimensions, the system also has a history management unit that saves historical measurements. Each measurement session is saved along with a timestamp, an image snapshot, and data about dimensions. Users are provided with the feature to access their historic measurements to review, share, or export results. Available export formats are PNG images with annotated dimensions and JSON files to use in other applications. Coming updates will provide PDF and DXF export support, useful to professionals like architects and interior designers.

For ensuring compatibility on various Android devices, the app is optimized for various screen resolutions and ARCore-enabled hardware. The app has a modular design, where the core functionality is implemented in Flutter for cross-platform compatibility and platform-specific AR logic is implemented in native Android (Java/Kotlin) for maximum ARCore performance. The computationally intensive operations, such as depth processing or 3D rendering, are pushed to background threads to ensure high frame rates and seamless user experience.

The approach also includes security and privacy features. The app does not record or retain individual data, storing user measurements locally on the device unless a deliberate decision to share this data is taken. Camera and storage permissions are requested only on user choice, following the runtime permission model embraced by Android.

Even though the current implementation targets height and width, the solution has been future-proofed. The future releases of the app can leverage on-device machine learning libraries such as TensorFlow Lite for automated object recognition. This will allow the app to automatically identify furniture, doors, or appliances, thus providing measurements without anchor placement. The utilization of scene understanding is another future improvement where the app can generate 2D floor plans or 3D mesh representations of spaces from ARCore's Sceneform SDK combined with point cloud data. To evaluate the system's performance and accuracy, a set of test cases were run in diverse environments from indoor corridors and rooms to office spaces.

Readings obtained by doing so were compared to readings obtained using standard tape measures and laser distance meters. Initial results show that the system yielded an average error rate of less than 1.5 cm in ideal conditions—a level far below the acceptable tolerance for recreational and semi-professional purposes. However, performance is compromised by less-than-ideal lighting environments, reflective surfaces, and indistinct visual environments, admitted shortcomings of mobile augmented reality technology. Overall, the approach presented here provides an end-to-end and practical process for real-time, AR-supported dimension measurement of height and width using consumer-level Android devices. By combining the strong plane detection, depth perception, and motion tracking capabilities of ARCore and a user interface that is simple to use as well as advanced mathematical modeling, the system presents a user-friendly tool for space measurement without an additional hardware investment. Its extensibility, modularity, and focus on usability render the system ideal to use for everyday and professional contexts.



IMPLEMENTATION RESULT

The deployment of the AR-based dimension detection app was a multi-step development and testing procedure aimed at providing real-time measurement of width and height through the use of ARCore and a Flutter front-end. The fundamental aim of the application is to enable users to take measurements of objects in their environment without having to make any physical contact or the use of external tools. The deployment was organized around major modules such as AR processing, measurement logic, visualization, and export functionality. The output of the app's functionality was monitored and recorded over a variety of test scenarios, devices, lighting conditions, and measurement targets.

The app was built mainly with the Flutter framework for cross-platform UI development, with native integration of ARCore using Kotlin on Android. The AR module handled environment understanding via the ARCore SDK, offering plane detection, anchor management, and pose estimation. These enabled the system to identify flat surfaces in real-time and project the physical world into a digital 3D coordinate system. After detecting a plane, users would be able to tap on the screen to add anchors to AR space, which acted as the points of reference for measurement. Every anchor's location was recorded in terms of ARCore's world coordinate system, providing accurate tracking of spatial positions.

During measurement, the user initially scans space to enable the system to map the space. After successful detection of planes, the user locates two anchor points representing the beginning and the end of the object to measure. The anchors are represented using rendered spheres or small nodes within the AR view. A 3D line is then created between the two anchors, and its length is determined in real-time by the Euclidean distance formula in three dimensions. For measuring height, displacement between anchors is calculated mainly along the Y-axis, and width utilizes the horizontal X and/or Z-axes. This axis-specific measurement is used to maintain semantic consistency and prevent misinterpretation of diagonal lengths.

The application interface also includes a live label that shows the computed distance dynamically in the user's chosen unit—centimeters, meters, or inches. The label floats over the rendered line and changes real-time as the user moves their camera or adjusts anchor points. The interface was also kept minimalist, gesture-based, and as close to fluid interactions one would find in apps such as Snapchat or Instagram to keep things familiar and easy. After confirming a measurement, users can save it as an image or export as structured JSON data. The JSON export contains anchor positions, device metadata, date/time, and measurement values, which can be reused in future workflows or archived.

In the course of testing, the app was installed on several ARCore-compatible devices such as Google Pixel 5, Samsung Galaxy S21, and OnePlus Nord 2. These devices were selected because they have different hardware capabilities and are readily available in the consumer market. On all devices that were tested, the app performed steadily, retaining real-time tracking and anchor stability with little drift. The mean latency from user tap to anchor placement was below 100 milliseconds, providing a responsive and interactive user experience. Display of 3D lines and labels sustained a consistent frame rate of 30 to 60 FPS depending on the scene complexity and device capability.

An important aspect of the test was the testing of measurement precision. This was done through the measurement of objects that are known in size, including doors, tables, bookshelves, and monitor screens. The app's measurements were compared with manual tape measurements. In lit-up areas, the app had an average error margin of ±1.5 cm for objects below 2 meters in size and ±2.5 cm for objects larger than 2 meters. Performance suffered somewhat in low light or with reflective surfaces, which sometimes disrupted plane detection. This limitation was alleviated by directing the user to better scanning positions and restarting environment understanding.

The results were also affected by camera motion and the stability of anchor placement. Abrupt device motions may result in temporary anchor position changes, although ARCore's Visual Inertial Odometry (VIO) assisted in re-orienting the virtual environment to the real world. The use of depth filtering with ARCore's Depth API also improved surface understanding and increased anchor reliability, particularly on intricate or non-textured surfaces such as smooth walls. The visualization of safe anchor placement using confidence maps was also integrated as a secondary visualization layer in developer mode.

For usability, user testing revealed encouraging response towards the interface and interactivity of the application. The vast majority of users found it intuitive to place anchors and the visual feedback during use beneficial. Initial difficulties were observed when used for the first time, particularly on learning how to scan correctly around for plane detection. To compensate, a tutorial overlay in guided form was implemented within the onboarding process with basic animations and usage tips.

The app also features a history function where all past measurements are saved locally with a light SQLite database. Each entry has a thumbnail snapshot, timestamp, and measurement metadata. This enables users to go back and compare past dimensions, which is especially handy for professionals such as interior designers, carpenters, or DIY enthusiasts who need reference measurements throughout projects.

While height and width measurement is the present focus of the implementation, application architecture provides scope for extension with ease. In future releases, object recognition from TensorFlow Lite will be integrated so that automatic identification and measurement of pre-defined objects like furniture or appliances will become possible. The integration of Sceneform SDK will also be achieved to create 3D room reconstructions as well as floor plans based on point cloud data accumulated in the ARCore session. These additions would serve to increase the practical usefulness of the application further.

In short, the deployed app illustrates stable performance for real-world measurement with smartphone-based AR. It provides a smooth user experience, acceptable measurement accuracy, and a solid base for extending to sophisticated features like AI-driven recognition and 3D mapping in the future. The findings prove that ARCore, accompanied by a well-crafted UI and math-intensive processing pipeline, can provide accurate spatial awareness without requiring specialized hardware.

CHALLENGES FACED

The AR-based dimension detection app's development and release offered a multitude of challenges involving hardware limitations, software constraints, algorithmic imprecision, complexity in user interaction, and inconsistency with the environment. Although the initial idea behind using augmented reality to detect dimensions holds much potential, the execution of this idea into a reliable, user-friendly mobile application necessitated the overcoming of considerable obstacles for the team. These issues were faced during various stages of the deployment—during early prototyping and system design to field testing and user testing.

Dependence on ARCore-supported devices was one of the biggest challenges. Although ARCore is supported on an increasing variety of Android devices, it is not supported on all smartphones. This hardware dependency restricted the accessibility of the app to a subset of consumers. Even within supported devices, there was some degree of variation in performance owing to differing camera quality, sensor accuracy, and CPU/GPU processing power. Devices with lower-tier hardware also had trouble with real-time plane detection, resulting in latency with environmental mapping and anchor placement. The inconsistency made it hard to achieve consistent performance and necessitated the team to optimize and test on a wide variety of models in order to enhance compatibility.

Another associated issue was sensor drift and instability in anchor positioning. ARCore uses Visual Inertial Odometry (VIO) which combines information from the camera and motion sensors (gyroscope and accelerometer) to estimate the position of the device. Although the method is in general quite strong, it is not resistant to errors, particularly when the device is being moved too rapidly or the surroundings have not enough visual features. In a number of test cases, anchor points drift or get misaligned through temporary loss of tracking, especially on scanning plain surfaces or in low-texture regions such as white walls. This led to a significant impact on the measurement accuracy and necessitated the team to introduce corrective feedback mechanisms like the reinitializing of anchors and the imposition of user movement limitations to sustain visual tracking consistency.

Lighting conditions also significantly influenced the AR measurements' reliability. Plane detection of ARCore depends greatly on lighting conditions to recognize edges and textures in the environment. In darker environments, detecting horizontal or vertical planes became unreliable. This caused anchor placement failure, false positives, or even delayed detection. Conversely, excessive exposure or glare from glossy surfaces like glass or highly reflective tiles also undermined depth estimation and feature matching. The group combated this partly by informing users through dynamic tooltips and tutorial overlays on the right lighting conditions but environmental inconsistency still remains a confounding problem with mobile AR technology.

Another great challenge was born out of limited depth perception and erroneous distance estimations. While ARCore provides a depth API, it doesn't give highly accurate depth maps as professional LiDAR sensors on advanced devices. Rather, it builds approximated depth on stereo vision and motion parallax. This results in differences, particularly for measuring thin or irregular-shaped objects. For instance, measuring the width of a pipe or a chair leg frequently yielded erratic results because not enough feature depth existed near anchor points. That problem was solved somewhat by the addition of axis filters that limit measurement to dominant axes (X, Y, or Z), but that does limit flexibility and can cause edge-case measurement flaws when working with surfaces at an angle.

Real-time computational overhead and thermal throttling was another technical challenge, especially on mid-tier devices. Real-time tracking, rendering 3D anchors, computing distance vectors, and updating the UI all happening simultaneously used a lot of processing power. Long usage sessions (in excess of 10–15 minutes) tended to heat up the device, which consequently caused thermal throttling and resulted in poor frame rates or frozen UIs. The application needed to be aggressively optimized with asynchronous computation, UI caching, and frame rate selective updates. But this usually came at the expense of visual fidelity, like reducing the AR scene refresh rate or reducing anchor models, to balance usability and performance.

From a user experience (UX) perspective, the biggest challenge was reducing complicated spatial interactions into simple gestures and feedback mechanisms. AR inherently necessitates the manipulation of a virtual space alongside interpreting one's physical environment via a screen. Most users had a hard time comprehending how to correctly scan the surrounding environment for plane detection. Others confused the flow of measurements, setting anchors in the wrong locations or anticipating auto-recognition of objects. To address this, the app incorporated an interactive tutorial that employs real-time prompts, animation-based instruction, and gesture hints. Nonetheless, some degree of learning curve remained, especially for first-time users unfamiliar with AR technology.

User hand stability and camera shaking also introduced complications in precise anchor placement. Since anchor selection depends on the user tapping the screen while aiming at a real-world object, any small hand tremor or sudden device motion could result in anchor misplacement. This significantly impacted measurement accuracy, especially for smaller objects. The development team solved this by introducing a zoom-in preview and using tap stabilization logic, where a brief delay is inserted before anchor placement confirmation to allow for micro-adjustments. This solution enhanced accuracy but decreased interaction speed slightly.

Aside from these interaction-related issues, the absence of a common spatial reference or calibration system resulted in inconsistencies when measuring in scale-distorted environments or off-axis perspectives. For instance, the same object measured from various viewpoints may produce slightly different readings based on parallax errors or improper camera alignment. Although ARCore's world coordinate system strives to be globally consistent within a session, extrinsic parameters such as lighting, motion, and geometry complexity may influence calibration. Adding a one-time calibration step with a known reference object was contemplated but eventually abandoned because of its potential to enhance friction in user experience.

Behind the scenes, data storage and handling of measurements with privacy and efficiency also presented other challenges. The first version utilized plain file storage for session data, but this soon proved inefficient as measurements accrued. The app was subsequently coupled with SQLite for offline data storage, allowing for structured storage of dimensions, anchor locations, and corresponding metadata. Nonetheless, version control and backward compatibility handling were needed to handle image storage, export format, and synchronization of data between sessions.

Generally speaking from the software development point of view, it was challenging to maintain the app modular and updatable given the recurrent updates and changes in the ARCore API. The behavior and feature set of the SDK changed between versions, necessitating ongoing reworking of the app's AR handling logic. Certain APIs were deprecated during development, and new features added introduced inconsistencies or introduced bugs when applied to existing stable modules. CI testing and feature flags conditionally were employed to accommodate such changes, but added to overall code complexity.

Ultimately, testing and verification of measurement accuracy posed its own challenges. In contrast to typical applications in which outputs are readily verifiable by unit testing, spatial measurements must be physically validated. Every test needed to be performed manually with tape measurements or laser rangefinders to determine ground truth. Environmental variations between test sites—such as indoor clutter, floor material, and background motion—introduced variability into test results. Consequently, generating consistent benchmarks and reporting accuracy figures was a labor-intensive process, usually involving multiple runs and result averaging to make meaningful conclusions.

In summary, the creation of the AR-based dimension detection app entailed traversing a wide range of challenges. These included hardware and SDK constraints, user interaction problems, and environmental inconsistencies. In spite of these challenges, the team was successful in deploying effective mitigations, improving the user experience, and providing a working system for real-time spatial measurements with nothing more than a smartphone camera. Improvements in hardware (e.g., more ubiquitous LiDAR support), machine learning-based plane detection, and cross-platform AR support in the future will help mitigate many of these problems and lay the groundwork for more sophisticated AR measurement solutions.

CONCLUSION

The creation and testing of the Augmented Reality (AR)-supported dimension detection app are key advances toward improving real-world spatial knowledge with generally accessible mobile technology. In this work, we presented a new system that allows users to measure the width and height of real-world objects in real time, by merely employing their ARCore-enabled smartphones. Leveraging the strengths of Flutter for UI development and ARCore for mapping real-world environments, the system closes the gap between digital interaction and physical measurement of space. The overall design has been done such that it keeps things simple, fast, and accurate while being extensible for more complex scenarios in the future.

The app effectively realizes its fundamental goal—enabling users to properly measure physical dimensions (width and height) via an easy-to-use, camera-based AR interface. The deployment revolves around the utilization of ARCore's plane detection, anchor placement, and pose tracking functionality, which support real-time detection of planar surfaces and object boundaries. The measurement pipeline is based on computing the Euclidean distance between user-specified anchor points in the ARCore-mapped 3D space. This approach obviates the use of specialized measurement equipment, like laser rangefinders or physical rulers, thus democratizing spatial awareness for a broad audience that encompasses home users, DIYers, interior designers, and engineers or architects.

Across the duration of this study, much effort went into maximizing measurement precision, UI response, and cross-device compatibility. The app was thoroughly tested across various ARCore-supported Android devices under various light conditions and objects. The test results invariably confirmed that the system was able to provide measurements with an average margin of error of ±1.5 cm on objects measuring less than 2 meters, and ±2.5 cm for objects larger than that. These degrees of precision, though not at the level of industrial laser-based equipment, are sufficient for the majority of household and business applications where rough measurements are adequate. Notably, the app yields results in real-time, with little lag, providing users with an instantaneous perception of spatial relations.

A principal advantage of the application is that it is user-centric. The interface has been designed to mirror widely used mobile applications for fluid navigation, gesture-based inputs, and clean on-screen appearances. The measurement process consists of just a handful of steps: detecting a surface, setting two anchor points, and seeing the calculated result. User testing feedback shows high levels of satisfaction based on ease of use and comprehensibility. In addition, adding useful visual hints, like line drawings and floating distance labels, improves usability for users who do not know much about AR technology.

In addition to its accomplishments, the project encountered and addressed a number of limitations. Arguably the most notable was dependence on lighting quality and device hardware. In environments with low lighting or when scanning highly reflective materials, ARCore's plane detection sometimes failed or resulted in unreliable anchor placements. This resulted in measurement inaccuracies. Although attempts were made to lead users to ideal scanning conditions with visual cues and tutorials, this is still a limitation of the supporting AR technology. Additionally, since the app is based on vision-based

AR without recourse to depth sensors or LiDAR (present in high-end devices only), some detailed spatial features were unable to be captured with high accuracy.

Also, the issue of anchor drift due to motion instability or abrupt environmental changes was not completely resolvable using existing technology. While ARCore employs Visual Inertial Odometry (VIO) for spatial consistency, minute errors in position tracking would add up over time, particularly during long scanning sessions. These errors would result in minute displacements of virtual anchor positions, thus causing measurement variance. This task represents a more general problem in mobile AR that impacts all applications of spatial computing and can be partly alleviated only through optimization at the software level and enhanced UX instructions.

From a scalability standpoint, the system has been engineered with extensibility forward-looking. The latest version has basic linear measurements (width and height) support, but the underlying architecture can be easily extended to accommodate more sophisticated spatial operations like depth measurement, volumetric analysis, and multi-point 3D shape construction. Future versions may also include AI-based object recognition with TensorFlow Lite or ML Kit, allowing the app to automatically recognize and measure familiar objects such as chairs, tables, or appliances. This would not only enhance usability but also open up potential use cases in logistics, manufacturing, or virtual staging.

Another major area of future work is the combination of scene understanding and 3D reconstruction capabilities. By building up point cloud data over time and combining it with user-specified anchor placements, the app could potentially create 2D floor plans or even complete 3D models of indoor spaces. Such a capability would be especially handy in real estate, architecture, and interior design professions. This would, nonetheless, need more advanced depth estimation, data fusion methods, and processing pipeline optimizations to guarantee acceptable performance on mobile devices.

In export and data handling, the app already has the capability to save measurement sessions as image or JSON data. This gives users an easy way to save, view, or share their results. In subsequent versions, this information can be augmented with cloud support, so measurements can be saved online or synchronized between devices. Support for export formats such as PDF or CAD-compatible DXF would also make the app more appropriate for professionals who need formal documentation of spatial data.

The applications of this work extend beyond the particular field of object measurement. The success of this AR-based app proves the increasing maturity of spatial computing and mobile AR platforms. As more devices become ARCore-compatible and as camera and sensor technologies improve, the threshold to entry for high-quality spatial applications will keep falling. Our solution is a proof of concept that accessible AR solutions can effectively address real-world challenges with precision and at scale.

Lastly, the takeaways from this project provide important lessons on the paradigms of user interaction for spatial applications. It's evident that AR-based tools must walk a delicate tightrope between technical capability and human usability. Giving immediate visual feedback, leading the user through simple workflows, and providing redundancy for handling errors are critical components for making AR experiences a success in real-world situations. These findings could be extended to other AR-driven applications like education, retail, or remote guidance.

In summary, the AR-based dimension detecting app is an engaging demonstration of the potential to utilize mobile AR technology to overcome real-world problems. By balancing computer vision, real-time computations, and design that puts people first, the app allows its users to undertake spatial measurements effectively, efficiently, and naturally by relying solely on their smartphones. Though there are current limitations—be they reliance upon lighting, variance in hardware, and tracking drift—progression in ARCore, mobile processing, and machine learning should negate these challenges very soon. That this therefore sets forth not merely an effective product for use today but a template for innovation through augmented reality-powered spatial computing later on as well makes the breakthrough that much greater.

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