ECE 597SD

Light-based Information Anchoring with Visual Markers

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Motivation

Though it is a refreshing and fun method of entertainment to the consumer, current Augmented Reality (AR) immersion is limited by how the user is able to interact with the virtual environment and how virtual elements are accurately anchored on physical objects and locations. A particularly viable solution is the use of LED based anchors for information overlaying. The vitality of an LED based solution is enabled through their subversion of background visual noise, non obstructive nature, and resilience to partial occlusion. These robust systems can have applications like:

1) A system is proposed using Tiny-YOLOv3 model to help people with visual impairment for easy indoor navigation [4].
2) Creating systems that track gaze anchoring in VR headsets to improve trackers efficiency [5].

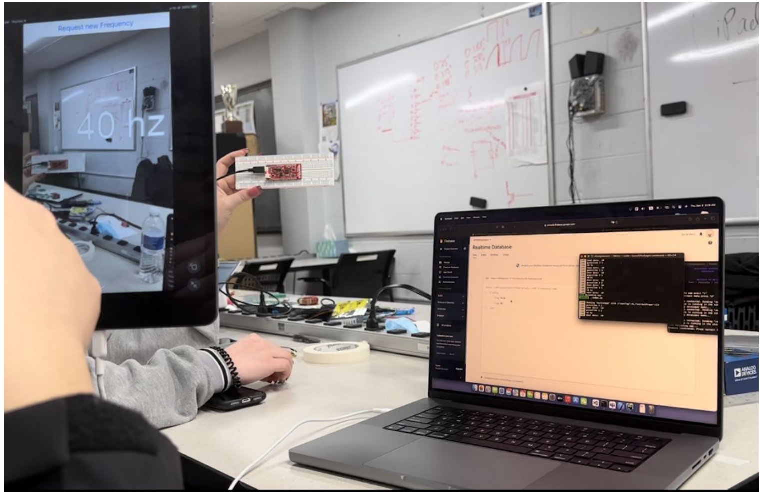
Problem Statement

This project was developed stemming from the motivation of interweaving the digital and the physical world. It was created with the aim of addressing the possibilities provided by the augmented reality environment when used in various applications for the users, one of which was to use a camera to scan the physical world and overlay it digitally to create light based anchors.

To help bridge this gap between augmented and true reality, there are several visual markers that are currently being explored. The problems or the issues this project seeks to address is to provide an LED based solution to interface the devices and provide a robust visual background marker that provides information to the user about their surroundings.

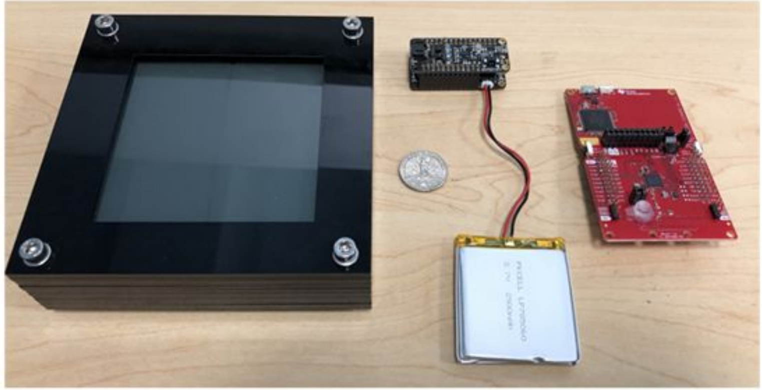
System Specification

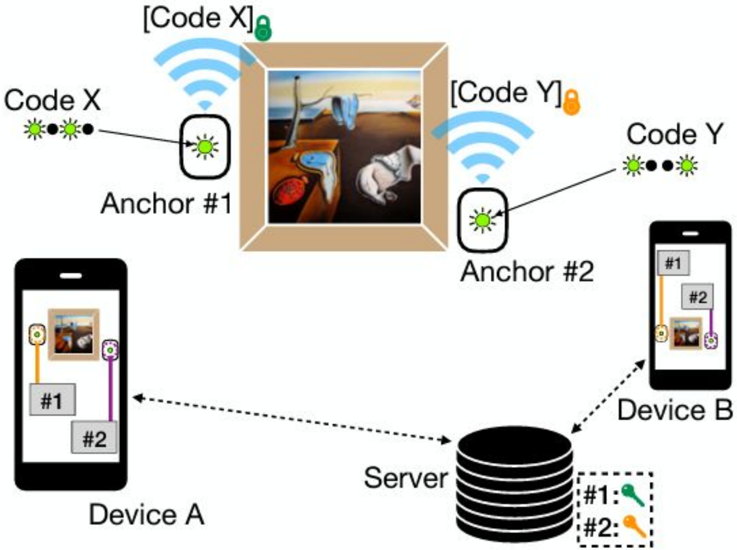
- Create an LED display that can be detected up to 6ft away
- Establish wireless communication between the sending and receiving devices ranging 6ft
- Establish synchronized communication between the sending and receiving devices
- Accurately identify the unique visual pattern ID using the receiving device
- Accurately display the visual pattern overlaid in user app
- Monitor user interface request for new visual



Design Alternatives

ALL that GLITTERS: Low-Power Spoof Resilient Optical Markers for AR





Design Alternatives

LightAnchors: Appropriating Point lights for Spatially-Anchored Augmented Reality Interfaces

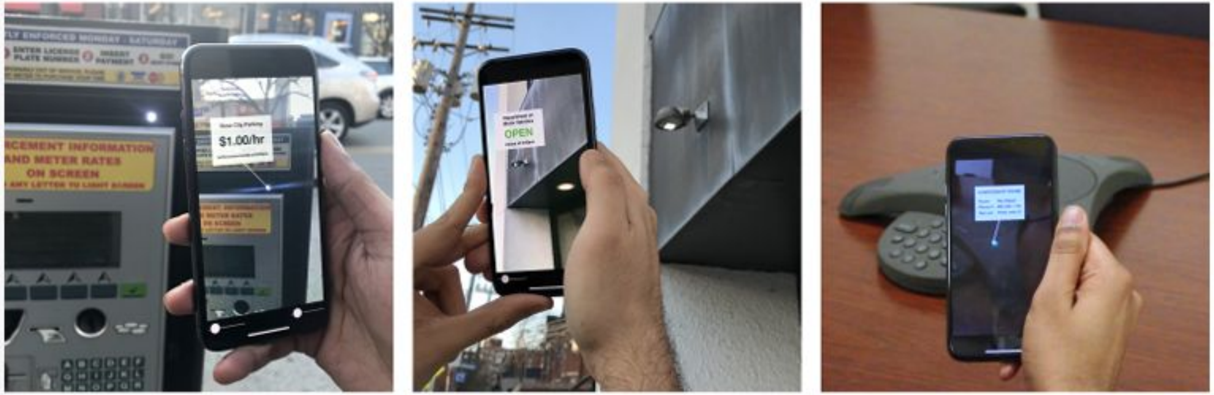


Figure 5. Example LightAnchor applications with fixed data payloads. Left: Parking meter displaying current rate. Center: Exterior light fixture denoting building operating hours. Right: Conference speaker phone displaying call-in number.

Solution

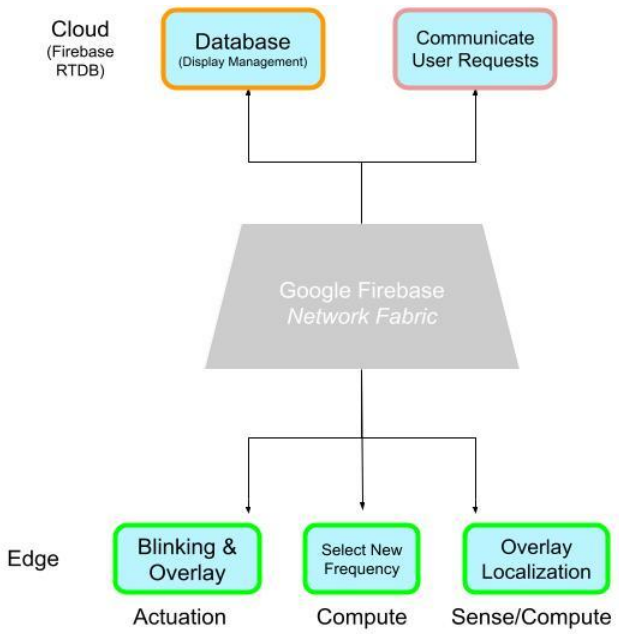
Main Technical Contributions:
Google Firebase Implementation & iPad App

- Minimize latency with the RTDB
    - All client data synced in real time
    - *Scalability*

- Cross-platform implementation and communication

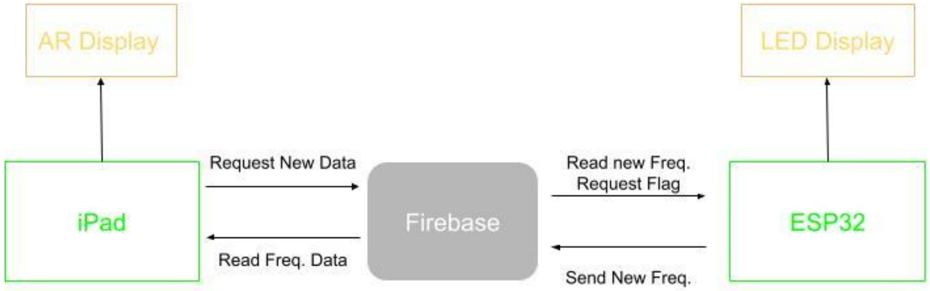
- Fully developed backend foundation
    - Devs can focus on config, etc.
    - Forfeit low level network optimization
    - Latency is completely environmentally dependent

High Level System Architecture



Implementations

- ESP32
  - Establish WiFi connection
  - Blink LED at randomly selected frequency
  - Store frequency data in RTDB Wish ESP Firebase client Library
  - Read RTDB for new data request



- An iPad application built with react native
  - Utilize ViroAR AR library allows us to overlay frequency
  - Utilize Firebase realtime storage to store data
  - A Button to request new frequency by setting a flag in database
  - Uses setstate function to stay up-to-date with firebase data

Evaluation & Results

One of the forms of evaluation that we did apply to this project is to test whether the LED is being actuated correctly with a range of frequencies, ready to be decoded.

The other forms of evaluation would involve in setting up the camera that assesses the physical surroundings and interfaces the video output seamlessly with the app on it.

The decoding of the frequencies on the app is also one of the significant bit of the project.

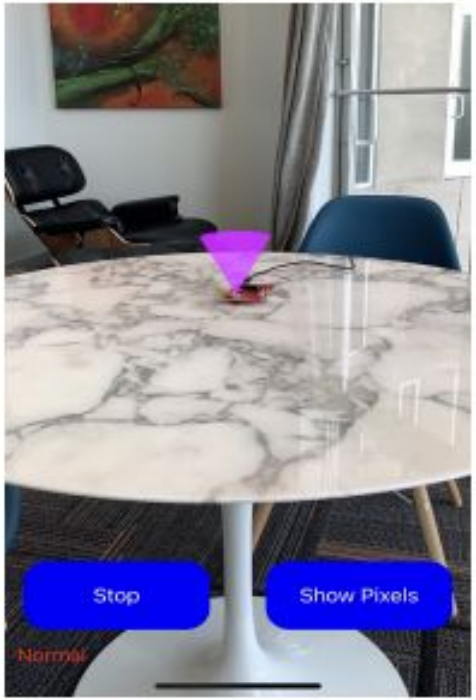
These all were met as we were able to setup the hardware such that it outputs the multiple frequencies. The camera was interfaced with the ESP32 module and which allowed the decoding part of the emitted light.

Challenges

One of the major challenges faced by AR systems is linking virtual content accurately on physical objects and locations. A major challenge in LED based communication is that the pattern decoding requires both sender device and receiver device to be synchronized in time. Any timing offset will spread the signal across multiple frames and induce errors in decoding.

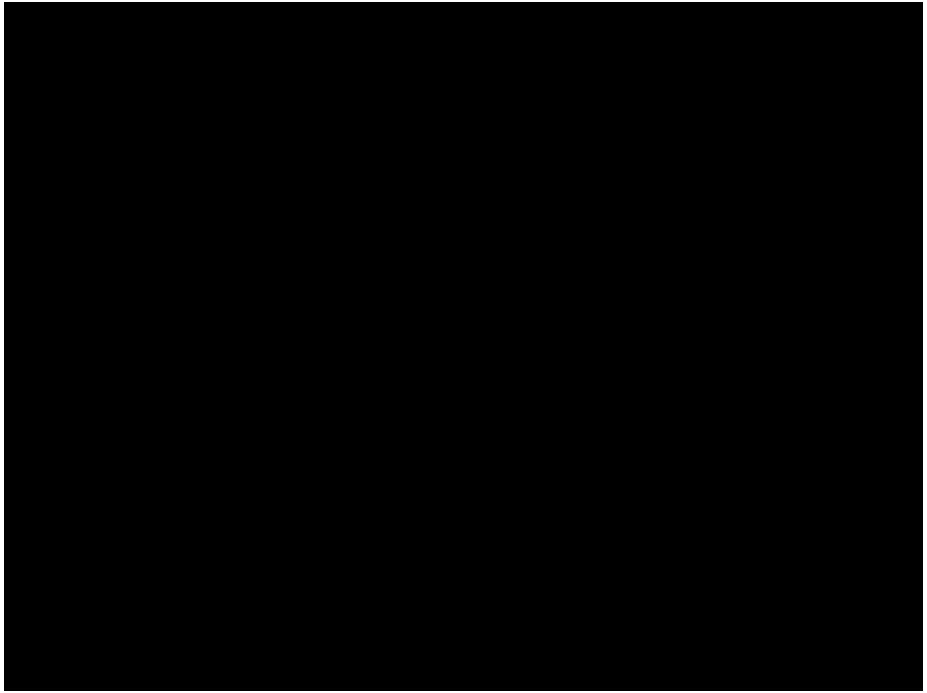
A roadblock we had to overcome was interfacing the devices, i.e. the iPad, the hardware and the Database together. With the iPad using the camera to scan the surroundings it was a challenge to facilitate and establish the channel that allows the data to be sent between the devices and get decoded.

ESP32 have trouble connecting to eduroam since extra steps is needed, and when testing the iPad app, the computer and iPad have to stay in the same wifi for the debugger to work, eduroam blocked that feature as well.



(b) Overlaying AR object

Demo



Sources

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