

VTour: 3D Virtual Tour With Google Street View and Cardboard

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Abstract

VTour, an Android Cardboard application, creates a smooth 3D virtual tour experience using cloudlets, Google Street View images and Google Cardboard[2] technology.

With VTour, Users can:

1. Tour places of interests as if they are driving by themselves
2. Enjoy going sightseeing in their rooms

Motivation

Travelling for leisure costs both time and money. Virtual tours save time, reduce costs, and therefore help users relax anytime they want.

Google Street View[1] collects panorama images from a plethora of places around the world. However, Street View only display these images in 2D. Neither a smooth video representation nor an immersive environment is available.

VTour combines Google Street View images with the powers of cloudlets and Google Cardboard to create a realistic 3D virtual tour.

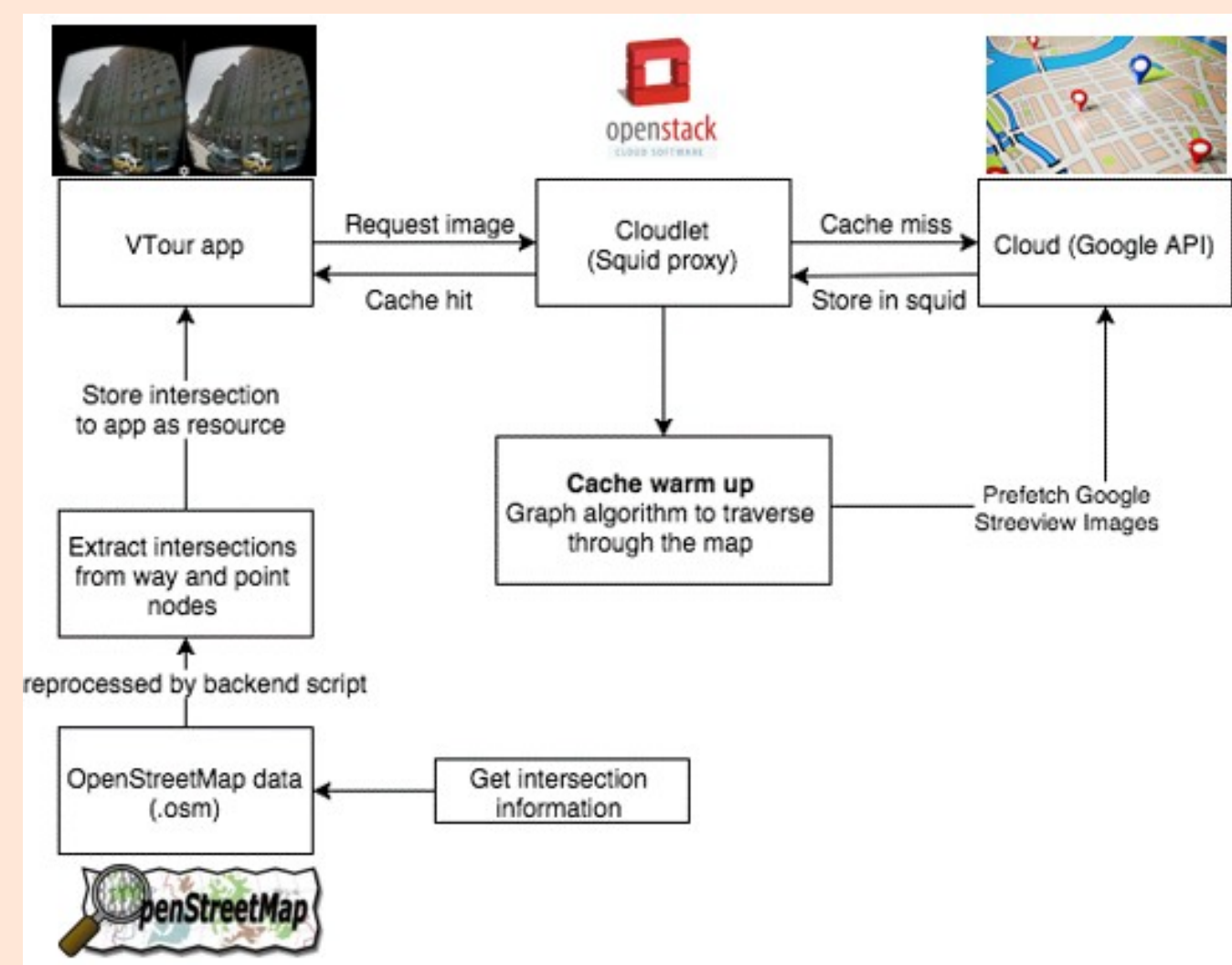


Fig1. System Design of VTour.

System Design

Setup (Figure 1):

VTour Android application + VTour Cloudlet + Cardboard

VTour Android Application:

1. Fetches and renders Street View images
2. Handles User Interaction
3. Uses the cloudlet as a web proxy

VTour Cloudlet:

4. Serves as a web proxy for VTour Android application
5. Warmed up in the demo

Cardboard: Create 3D Effect

VTour Cloudlet

A Web Proxy:

VTour cloudlet functions only as a web proxy. We used library Squid[3] to implement our prototype. VTour cloudlet is network transparent to VTour application.

Functionalities:

Every time VTour application requests a street view image, VTour cloudlet directly returns back the image if it is cached. Otherwise, the cloudlet makes a request to Google server.

Reduced Latency:

VTour cloudlet greatly reduces the network latency seen by VTour application when downloading cached images. It is at the core of a smooth virtual tour. Detailed time reduction see Evaluation section.

Cache Warmup:

In our demo, we warm up the squid proxy by sending Street View image requests from a computer. Graph traverses through multiple cities are used.

User Interactivity

City Mode:

1. Tour on primary city roads (avenue, road)
2. Enable user choice of next intersection
3. Random routing, 1x speed, static view

Highway Mode:

1. No intersection, no stops
2. Speed at roughly 500 m/s
3. 1x speed, 2x speed, static view

VTour Android Application

Architecture:

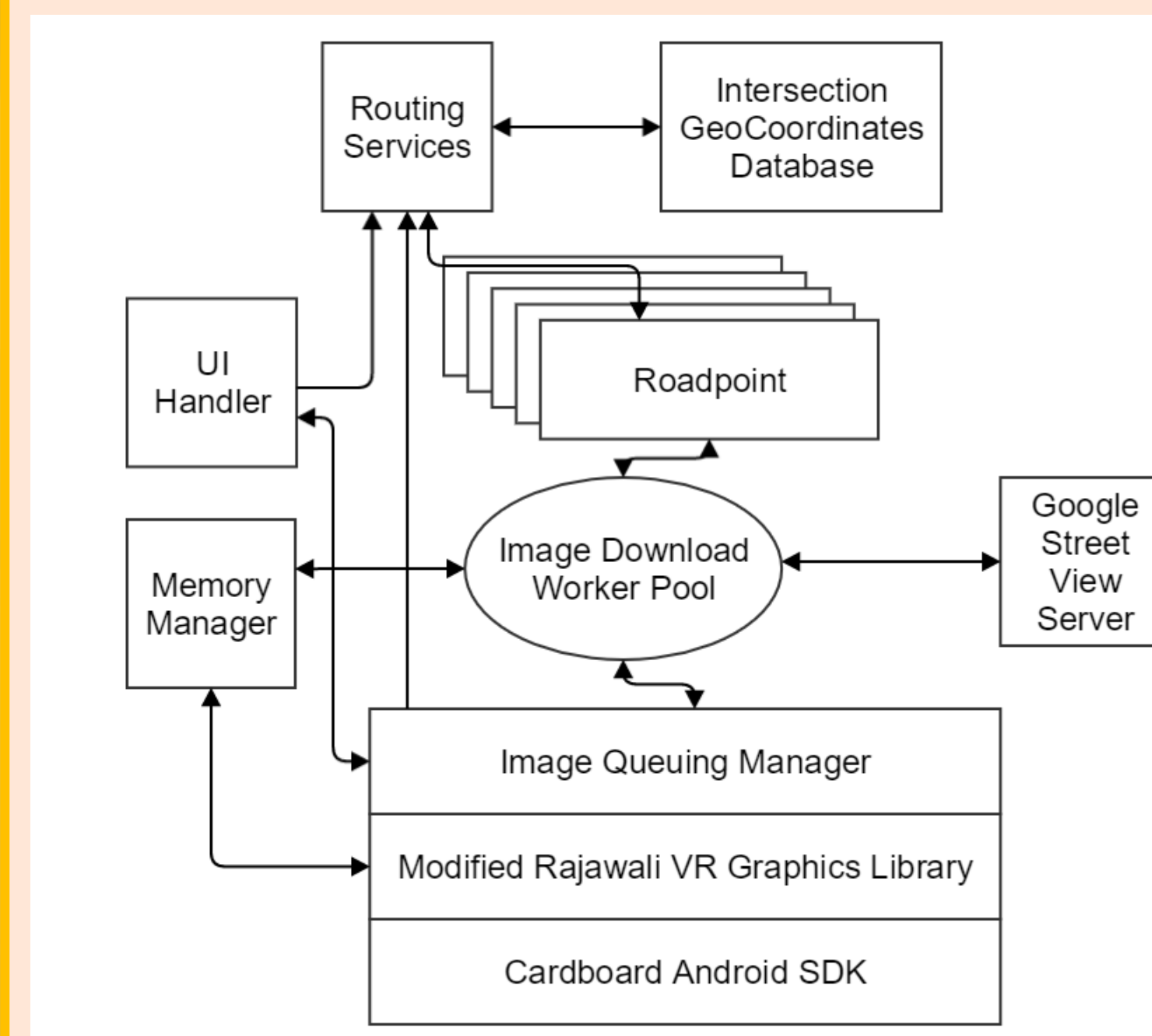


Fig2. Software Components of VTour Android App

UI handlers take inputs from users to initiate image downloading along a road and pause video rendering.

Routing Services calculate geo-ordinates along a road and intersections.

Image Download Worker Pool downloads images from Street View Server.

Image Queuing Manager makes sure images are displayed in order. We used a customized Rajawali graphic library to render 3D panorama for cardboard.

Evaluation

Latency Reduction using Cloudlet:

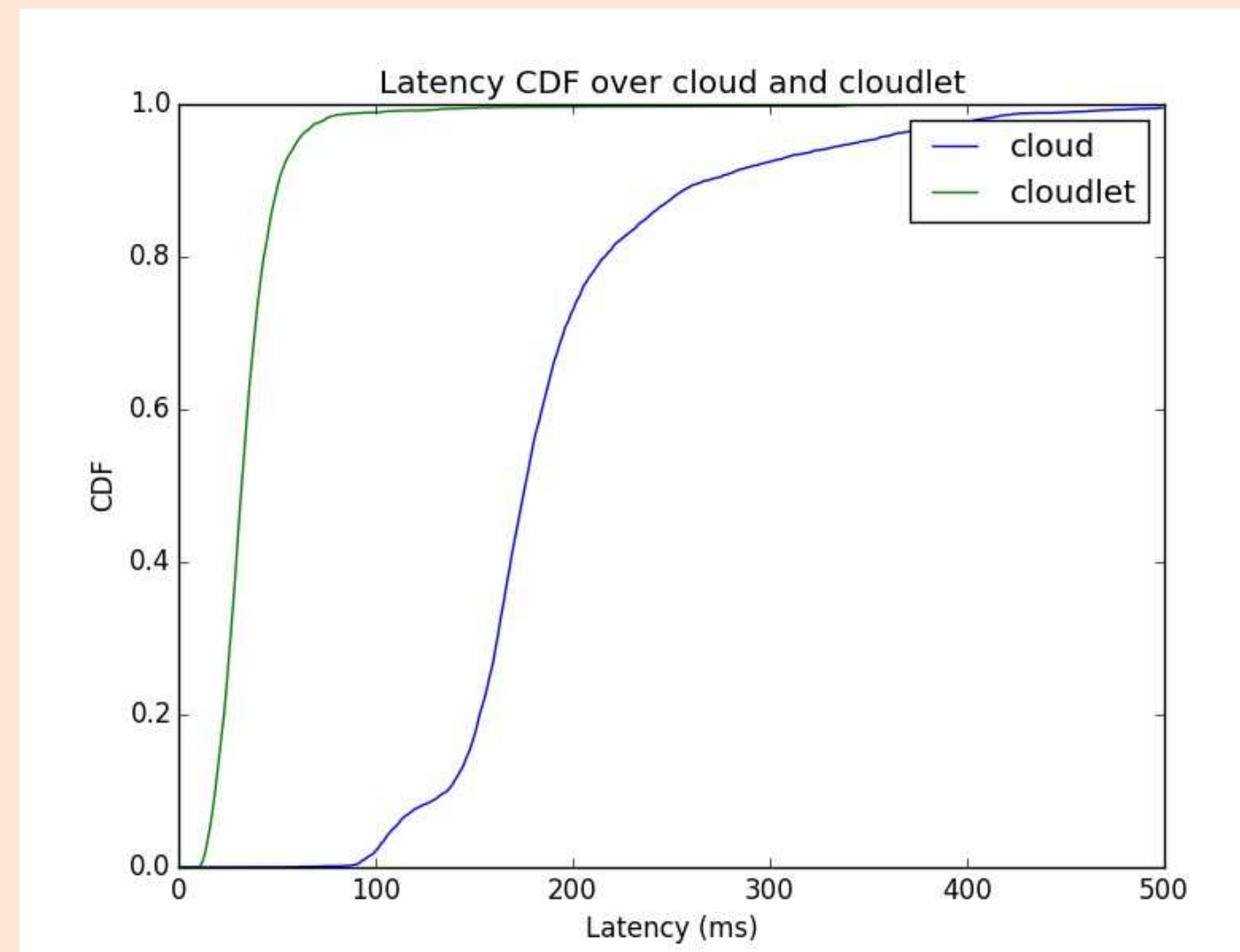


Fig3. Latency CDF of Cloud and Cloudlet

Average Frame Per Second Comparison:

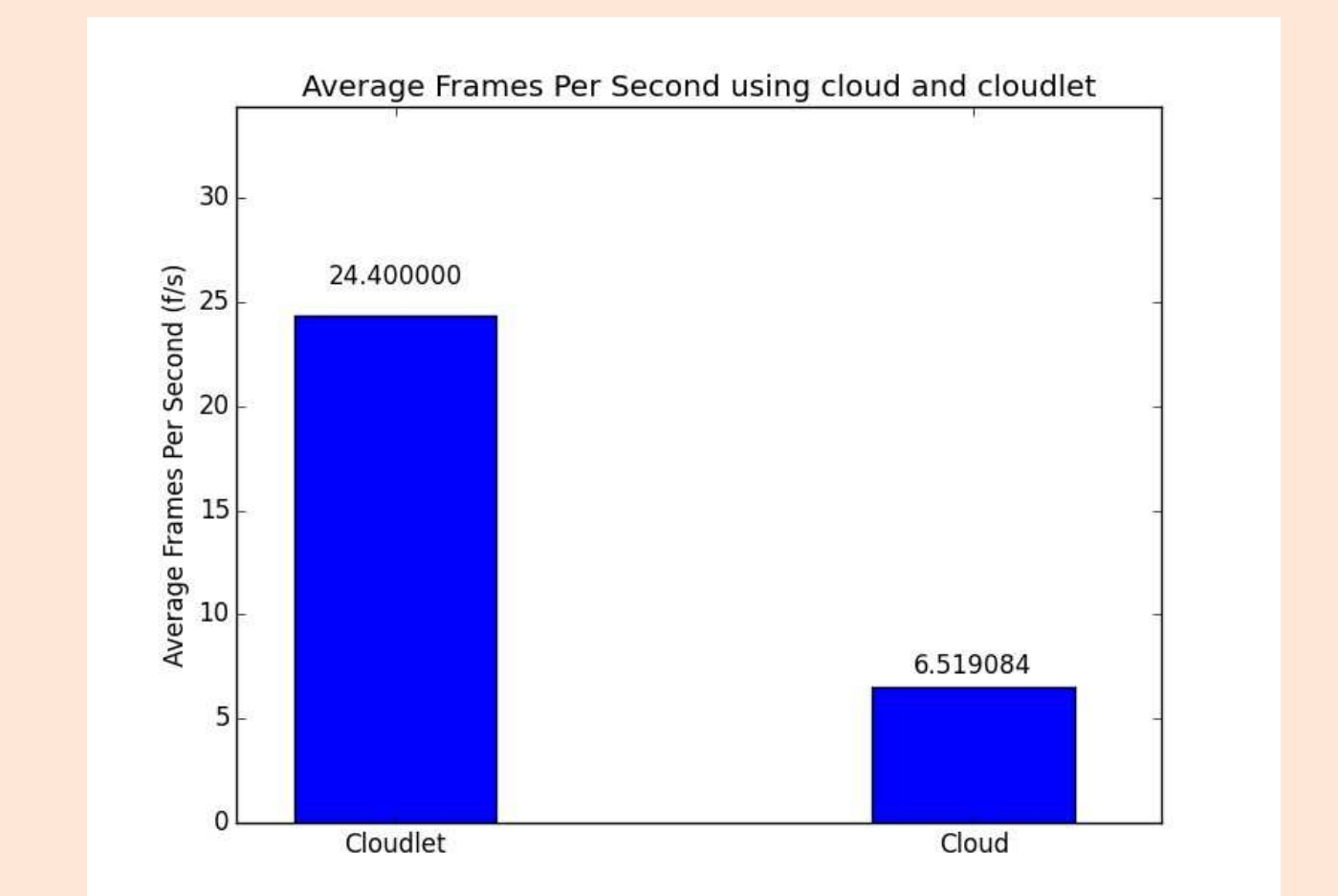


Fig4. Average Frame Per Second Using Cloud and Cloudlet

Discussion

- The places users can visit in VTour is limited by the availabilities of street view images
- Some intersections are not correctly reported in crowd-sourced OSM data.

Reference:
 [1] Street View. Retrieved November 30, 2015, from <https://www.google.com/maps/streetview/>
 [2] Cardboard. Retrieved November 30, 2015, from <https://www.google.com/get/cardboard/>
 [3] Squid-cache.org. Retrieved November 30, 2015, from <http://www.squid-cache.org/>