## Abstract

With VTour, Users can:
1. Tour places of interests as if they are driving by themselves
2. Enjoy going sightseeing in their rooms

## 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

## 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:

- **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.

### 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.

## Evaluation

### Latency Reduction using Cloudlet:

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<thead>
<tr>
<th>Latency (ms)</th>
<th>Cloud</th>
<th>Cloudlet</th>
</tr>
</thead>
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<tr>
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<td>0</td>
</tr>
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<td>200</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
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<tr>
<td>600</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

### Average Frame Per Second Comparison:

*Fig3. Latency CDF of Cloud and Cloudlet*

*Fig4. Average Frame Per Second Using Cloud and Cloudlet*

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

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Reference: