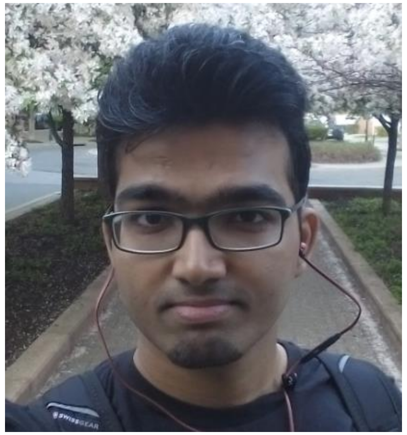
Real-Time Cyber Physical Systems Application on MobilityFirst

Winlab Summer Internship 2015

Karthikeyan Ganesan, Wuyang Zhang, Zihong Zheng
Shantanu Ghosh, Avi Cooper

TEAM MEMBERS



Karthikeyan Ganesan

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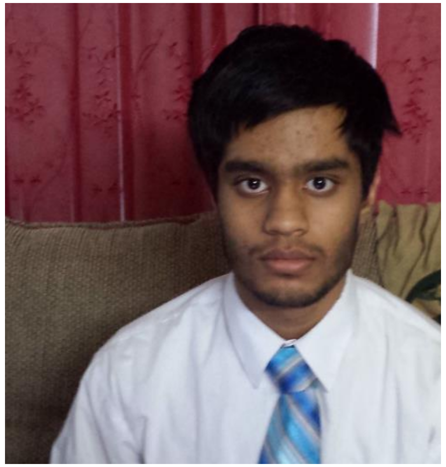


Shantanu Ghosh

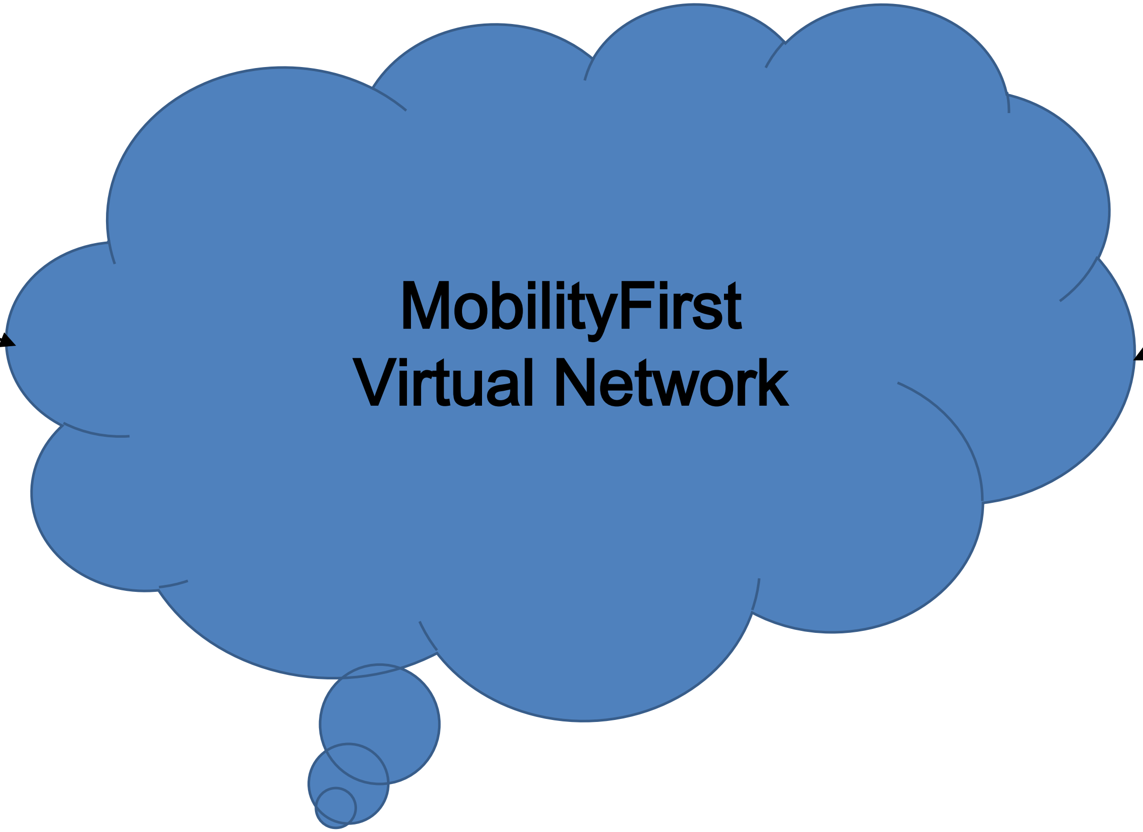
Avi Cooper

PRELIMINARY GOAL OF OUR PROJECT

CPS Application based on MF

Server side:

Implement server application for object recognition;
Return the result



MobilityFirst Virtual Network

Client side:

Run an instance of camera system;
Transmits video in standard format;
Simple graphical interface to display results

CURRENT FRAME

Image Recognition:

Done essential time analysis for different phases in Image Matching. Have some progress on Speed optimization. Also working on strategies to improve Accuracy.

Cloud Computing:

Set up the Hadoop Cluster, constructed by Master and Slaves that could run Map & Reduce jobs. Now working on Hadoop Image Processing Interface(HIPI).

Application:

Tried to debug some MF Android applications done before(mfstack, mfping, etc.)

Learning how to set up the WIFI access point on Router to enable the MF connection.

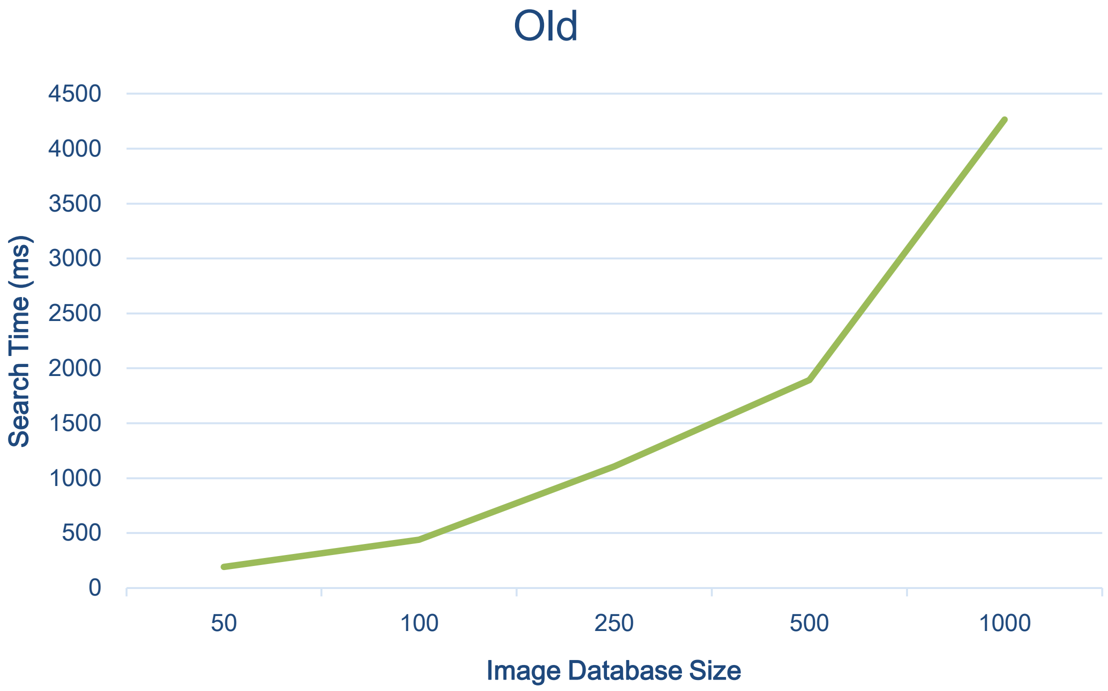
IMAGE PROCESSOR

- Server Startup
  - Load Descriptors into memory
- Image Matching
  - Isolate Descriptors from test image
  - Find Matching Descriptors from Database using the Flann Class
  - Algorithm to determine Object from matched descriptors

IMAGE PROCESSOR OPTIMIZATION: SPEED

- Server Startup
  - Load Descriptors into memory
- Image Matching
  - Isolate Descriptors from test image
  - Find Matching Descriptors from Database
    - Build a KD tree
    - Perform a knn search
  - Algorithm to determine Object from matched descriptors

IMAGE PROCESSOR OPTIMIZATION: SPEED



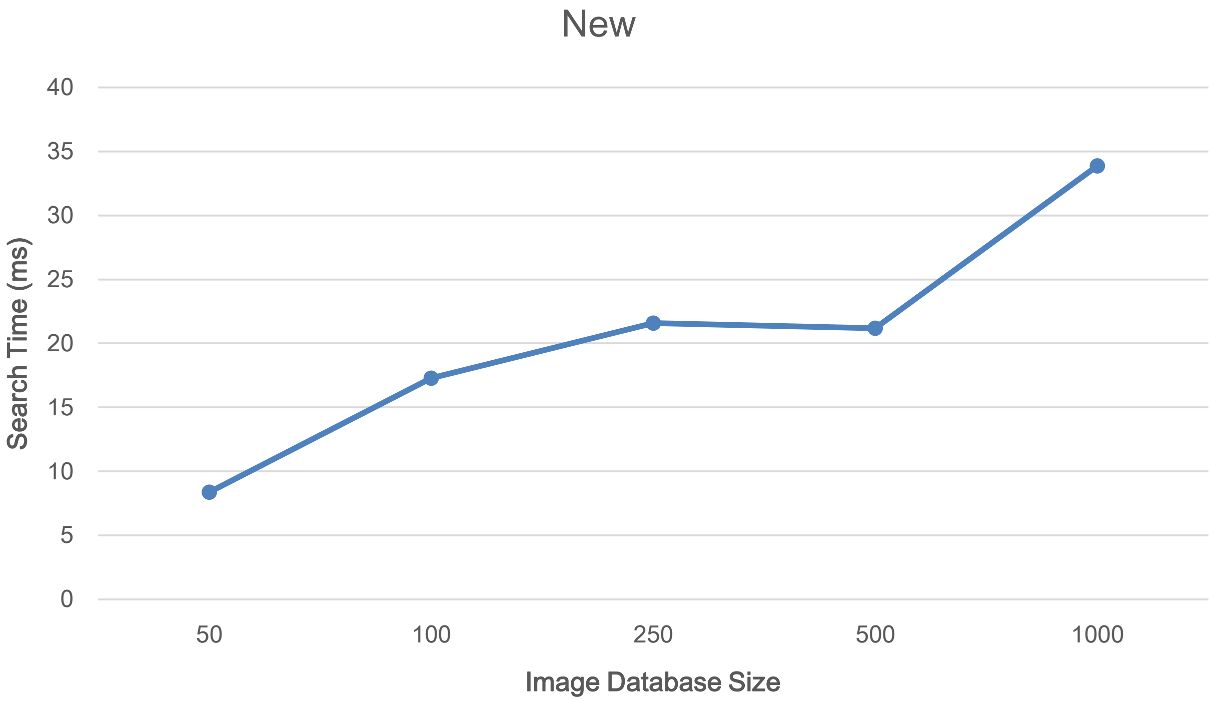


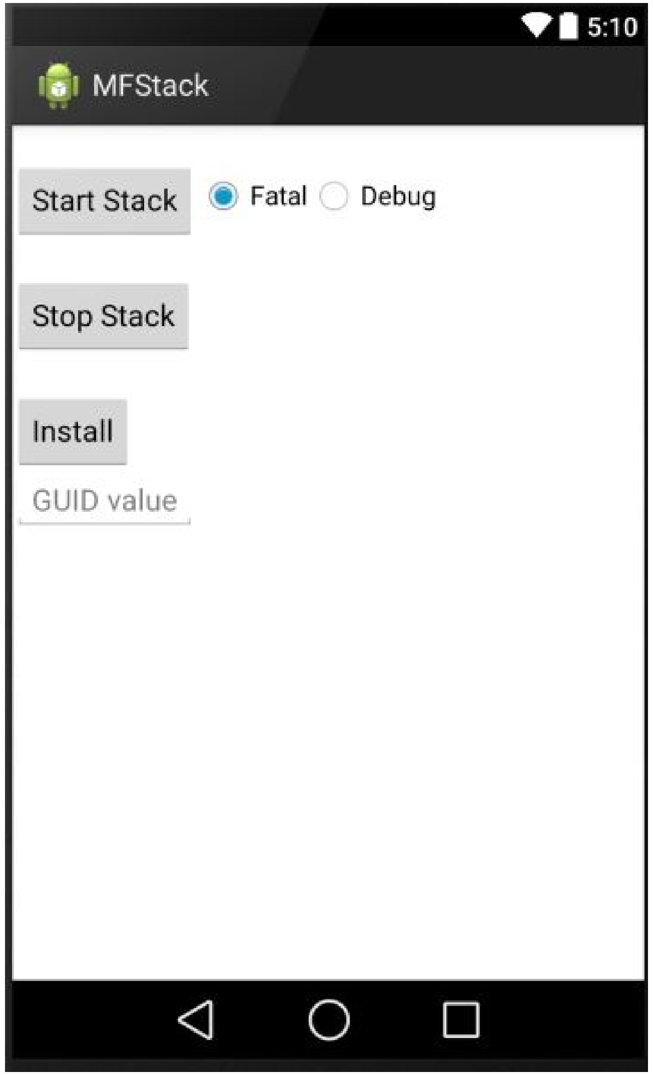
IMAGE PROCESSOR OPTIMIZATION: SPEED

- Descriptor Isolation
  - Largest portion of computing time.
  - Fixes :
    - Try utilizing the GPU to perform SURF
    - Try a method that better utilizes multiple CPU cores
    - Try different feature detector other than SURF

IMAGE PROCESSOR OPTIMIZATION: ACCURACY

- True Positives
  - Detects objects in test image that exist in Database with close to 100% accuracy
- False Positives
  - Often Falsely recognize objects that don’t exist in the image (Close to 50%)
- Fix
  - Improve the Algorithm used to determine object from Matched Descriptors with additional checks to confirm the actual existence of the object.

ANDROID PHONE

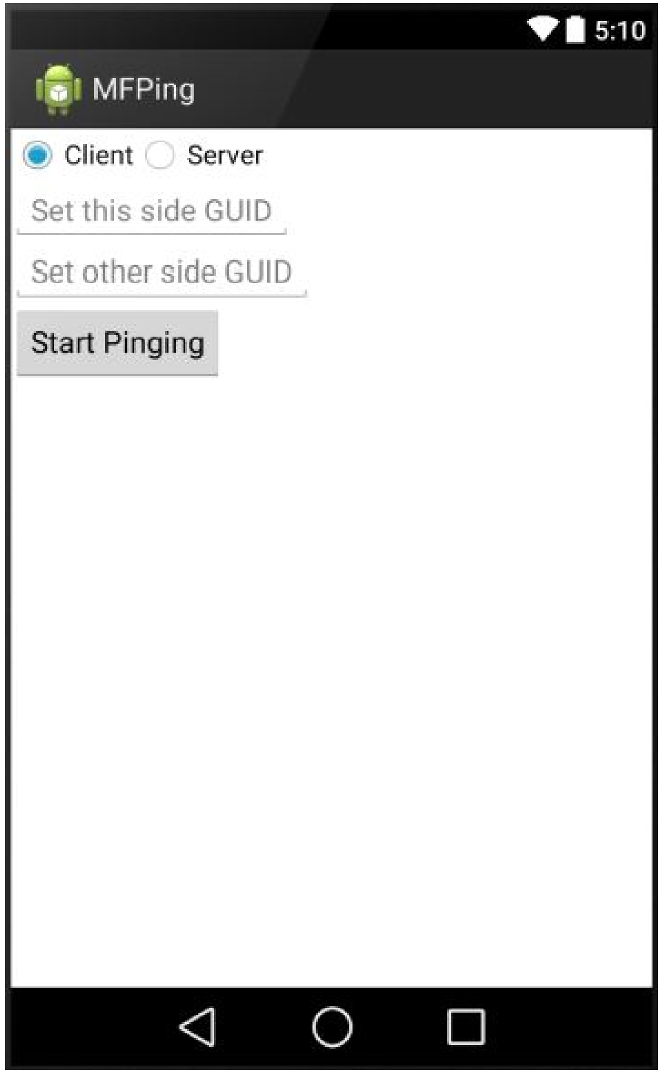


● Fatal ○ Debug

MFStack is used to install the MF stack on phone.

Also a launcher to start and stop the mf stack service.

Devices under MF network is actually communicating through the MF stack.

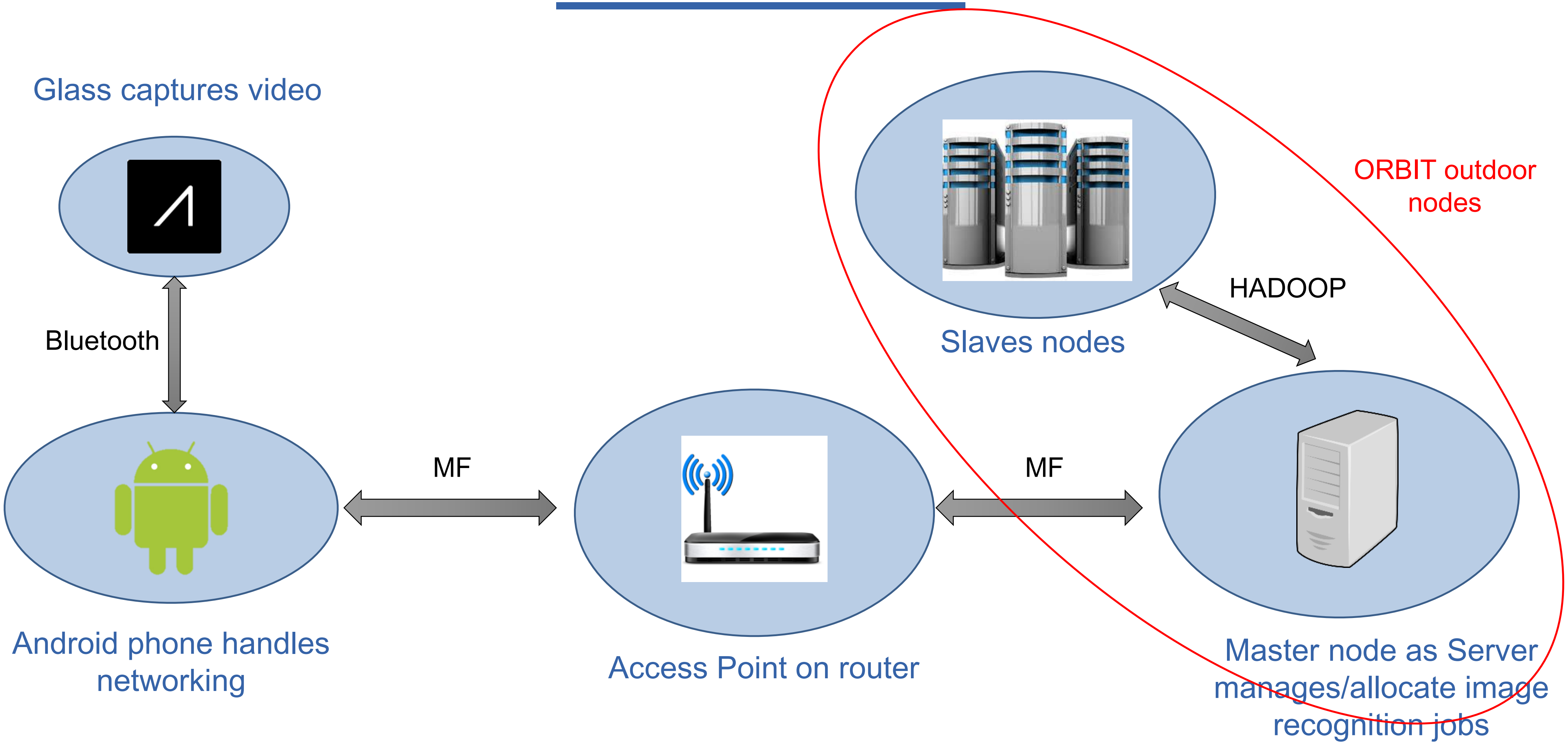


● Client ○ Server

MFPing achieves the basic ping function for MF such as the ping for TCP/IP.

We plan use it to test the MF connection after we set up the access point on router.

PLAN TO SET UP THE CONNECTION



Glass captures video

Bluetooth

Android phone handles networking

MF

Access Point on router

MF

Slaves nodes

HADOOP

Master node as Server manages/allocate image recognition jobs

ORBIT outdoor nodes

HIPI FRAMEWORK

Hadoop Image Processing Interface

Background:

Optimized image processing algorithm, current system process 1,000 images within 113 ms.

Impediment:

Load the large size of descriptors in the database into a local memory before matching images.

1,000 images : 1 GB, linear accumulation -> 10,000 images : 10 GB

HIPI:

Image processing interface under the framework of HADOOP. Distribute the database into
several machines so as to support over 10,000 images.

Next Week Plan

Set up the connection between Android Phone and orbit nodes through an access point.

Continue develop the client program based on google glass and Android phone.

Use HIPI to embedded Image Processing Program and Hadoop Framework.

Questions?