3D Reconstruction on an IMU enabled Mobile Device

Summer Undergraduate Research Award - 2015

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2013CS10231

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Under supervision of
Prof. Subhashis Banerjee
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Objectives

3D reconstruction on an IMU enabled mobile device.

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What is 3D reconstruction?

(a) Sparse reconstruction (b) Dense reconstruction

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Kartikeya
Tell about sparse reconstruction
Prateek
Tell about dense reconstruction

Why 3D reconstruction?

- Generation of a 3D printable file allowing engineers and students to analyse an object more closely
- Field of medical science
- Archaeological application
- Localization of tourist sites

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Kartikeya
chill.
Prateek
Elaborate on each.

3D reconstruction method

Intrinsic Camera Parameters

- Internal calibration matrix K is internal to the camera itself and is defined in terms of the camera focal length f and the principal points c_x and c_y defined as image centers in pixels.

$$\mathbf{K} = \begin{bmatrix} f & 0 & c_x \\ 0 & f & c_y \\ 0 & 0 & 1 \end{bmatrix} \tag{1}$$

3D reconstruction method
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$\mathbf{K} = \begin{bmatrix} f & 0 & c_x \\ 0 & f & c_y \\ 0 & 0 & 1 \end{bmatrix}$ (1)

Prateek

Speak about internal camera parameters

3D reconstruction method

Extrinsic Camera Parameters

- External calibration matrix $[R|\mathbf{t}]$ constitute the rigid transformations viz. the rotation and translation between the camera coordinate system and the world coordinate system.

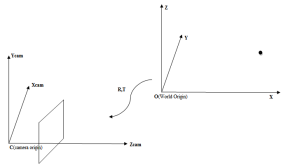


Figure : External calibration

- Together they form the projection matrix P

$$P = K[R|\mathbf{t}]$$

s.t.

$$\mathbf{x} = P\mathbf{X}$$

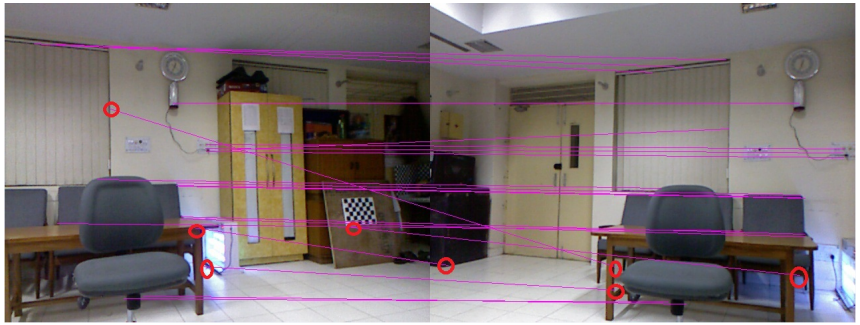
Kartikeya

Speak about extrinsic camera parameters

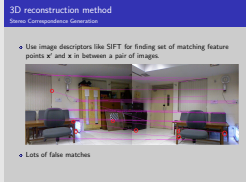
3D reconstruction method

Stereo Correspondence Generation

- Use image descriptors like SIFT for finding set of matching feature points $\mathbf{x}'$ and $\mathbf{x}$ in between a pair of images.



- Lots of false matches

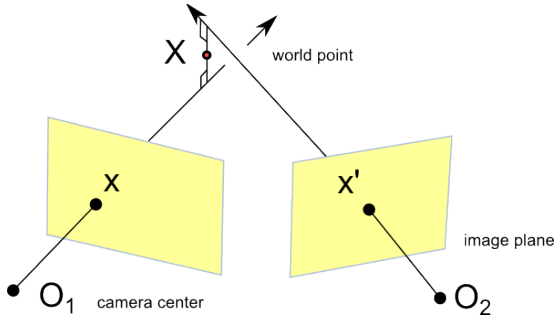


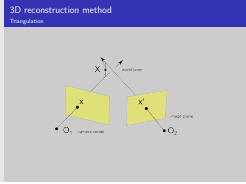
Kartikeya

speak about the false matches that are taking place which need to be removed

3D reconstruction method

Triangulation



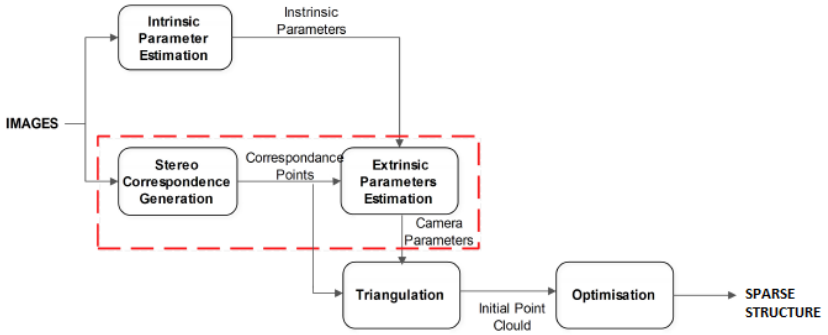


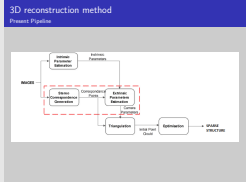
Prateek

About triangulation and pairwise image correspondence

3D reconstruction method

Present Pipeline

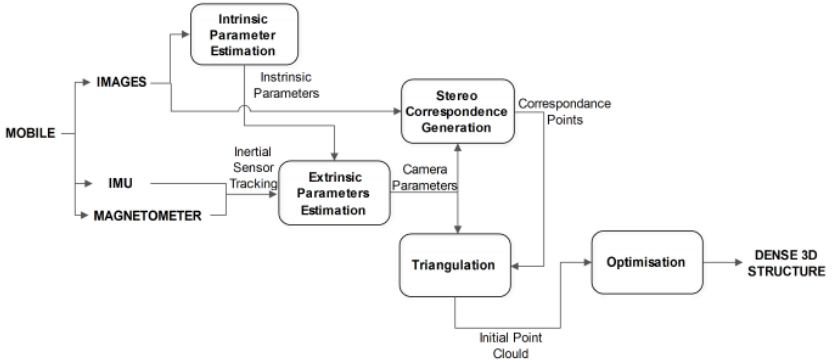


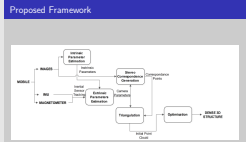


Kartikeya

Explain about the expensive red box

Proposed Framework





Prateek

Explain about the entire framework and how this is better than earlier

Phases of the Project

1) Position and structure estimation

1. Smoothening the raw sensor output data.
2. Incorporating gyroscope reading to reduce drift.
3. Using the camera feed to obtain displacement and orientation from visual tracking.

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Prateek

Give an overview about the part

Phases of the Project

2) 3D Reconstruction

1. Obtain sparse 3D reconstruction based on camera parameters obtained previously.
2. Use tracking methods for dense correspondence of points.
3. Use guided matching by indirect computation of fundamental matrix from estimated camera motion from sensor data to enrich the correspondences.
4. Triangulate dense correspondences and do global refinement.

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Use tracking methods for dense correspondence of points.
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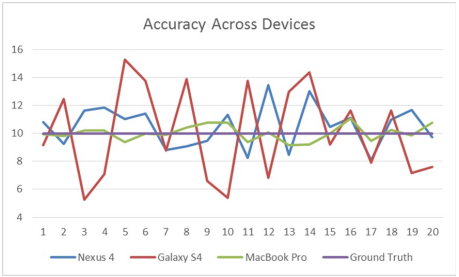
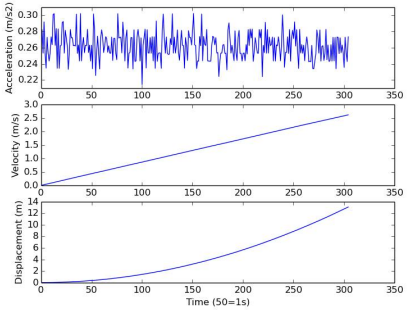
Kartikeya

Give an explanation about the 3d reconstruction part

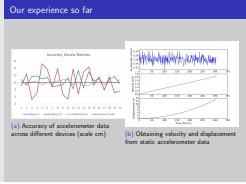
Our experience so far



(a) Accuracy of accelerometer data across different devices (scale cm)



(b) Obtaining velocity and displacement from static accelerometer data



Kartikeya

Explain figure 1

3 devices taken, for 20 readings each ad the distance calculated is plotted. The accuracy can be seen, macbook pro gives the best accuracy followed by nexus and then S4

Prateek

Explain figure 2

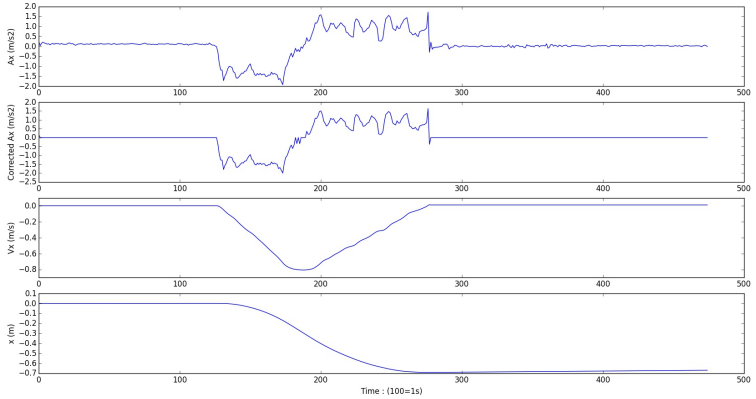


Figure : Applying smoothening techniques

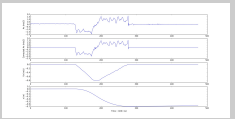


Figure : Applying smoothening techniques

Kartikeya

Explain about the smoothening taking place, static bias removal and drift correction

Future Possibilites

- Improving the algorithm for a quicker and more efficient 3D reconstruction.
- Releasing applications for Apple, Android and Windows platforms for near real time 3D reconstruction on the device itself.
- Getting a more detailed texture mapping of the object.
- Making an object recognition software on the basis of this 3D reconstruction.

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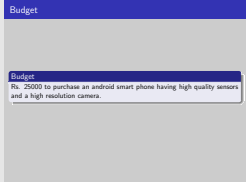
Kartikeya
explain first twoPrateej
explain last two

Budget

Budget

Rs. 25000 to purchase an android smart phone having high quality sensors and a high resolution camera.

Kartikeya



MISSION ACCOMPLISHED

Thank You