3D Reconstruction on an IMU enabled Mobile Device

Summer Undergraduate Research Award - 2015

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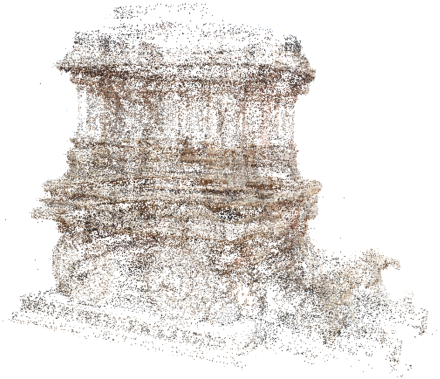
Objectives

3D reconstruction on an IMU enabled mobile device.

What is 3D reconstruction?



(a) Sparse reconstruction

(b) Dense reconstruction

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

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.

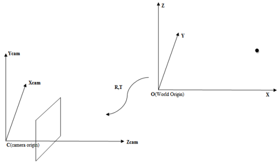


Figure : External calibration

- Together they form the projection matrix P

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

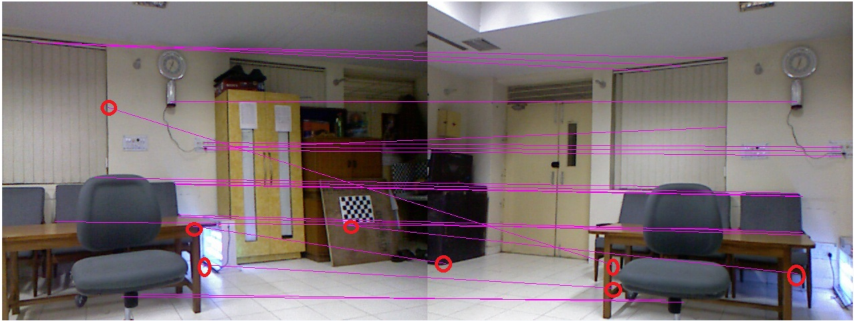
s.t.

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

3D reconstruction method

Stereo Correspondence Generation

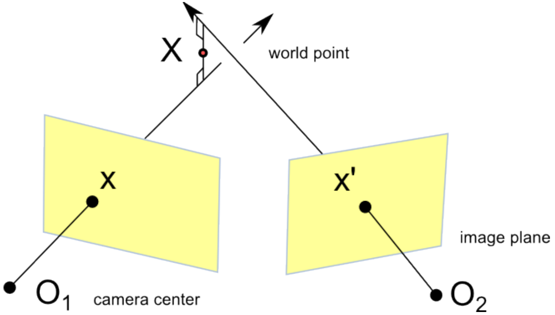
- Use image descriptors like SIFT for finding set of matching feature points $\mathbf{x}'$ and $\mathbf{x}$ in between a pair of images.



- Lots of false matches

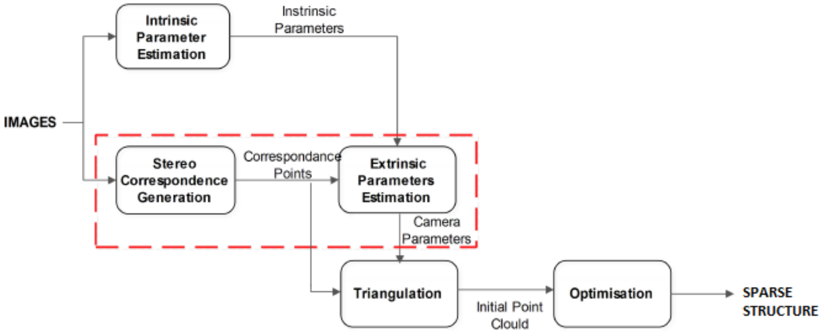
3D reconstruction method

Triangulation

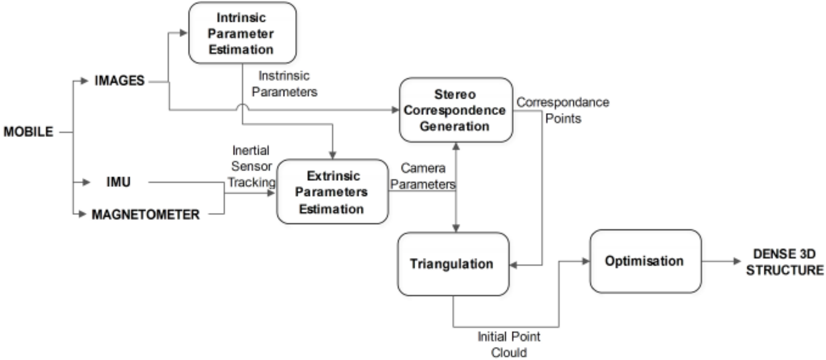


3D reconstruction method

Present Pipeline



Proposed Framework



Phases of the Project

1) Position and structure estimation

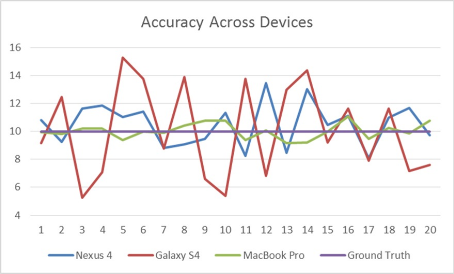
1. Smoothening the raw sensor output data.
2. Incorporating gyroscope reading to reduce drift.
3. Using the camera feed to obtain displacement and orientation from visual tracking.

Phases of the Project

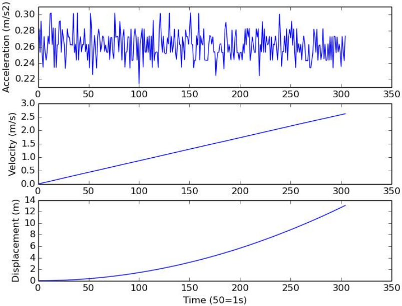
2) 3D Reconstruction

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.

Our experience so far



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



(b) Obtaining velocity and displacement from static accelerometer data

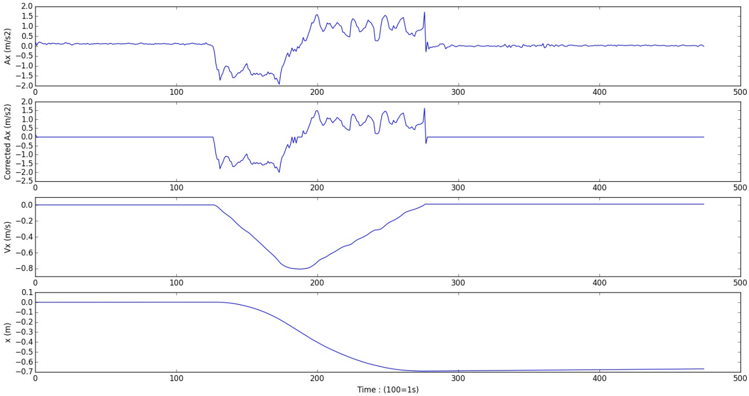


Figure : Applying smoothening techniques

More Applications

- Quick 3D printable file
- Field of medical science
- Archaeological application
- Localization of tourist sites

Budget

Budget

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

Thank You