Next Steps For Calibrations + Reconstruction

Michael Kagan, Maxime Vandegar
SLAC

September 9, 2021

Michael Kagan, Maxime Vandegar
SLAC

Moving Forward

- Best reconstruction requires precision calibration

- Calibration Options (in expected order of difficult)
  1. Known object (i.e. have model) at known position → Fit Normals
  2. Known object at unknown positions
     - Fit normal and object positions → use multiple measurements
  3. Unknown object
     - Fit normals and 3D object model → likely need multiple measurements + reconstruction algorithm

  - One idea here is to put LED in focus and make assumptions about position

- Can we skip precision calibration? Will it hurt reconstruction?
  - Could assume object at center of FoV and fit normals
  - Test by running reconstruction after fitting approx. normals
  - Must understand how variations in object position translate into errors in normal position estimates

Towards a paper

- Precision calibration takes time (so is getting reconstruction working)

- What do we want for a paper?
  - Best reconstruction we can do now → requires calibration (i.e. time)

  - Just want some sort of reconstruction → Skip precision calibration
    - Will people be interested if we don't show best possible resolution?

    - OK if only need to see reconstructed 3D object, not necessarily most precise
      - Not necessarily useful for quantitative metrics

    - This needs to be tested, not clear it will be good enough
      - Can try study with simulation studies

  - More generally, reconstruction with system is complex enough that we likely want to release accompanied software for computational imaging

backup

Status

- Mirror prototype is nearly ready to be made… time for Reco

- Before we can Reconstruct… we must Calibrate.
  - If we don't know where the mirrors are, we can not reconstruct

- Calibration by differentiating the simulator…what we know
  - **Need to know what the object is.** Point Source is great

  - IF we know where the object is ➔ Optimizing normals works quite well

  - IF we don't know the object position:
    - Optimizing normals does converge, but results can be very wrong

  - We can optimize for object position and normal
    - Benefits from several measurements
    - MUCH slower than normal only optimization

  - IF we don't know the object:
    - We can try to fit it (i.e. with NN) at same time as normal
    - Not yet tried, likely much harder than previous options

Next Steps

- Calibrate with LED… but with precisely measured object position
  - Murtaza idea: Get LED in-focus, assume ideal position
    - Not all mirrors may be in focus at once
      - fit in focus mirrors
      - move objector or dome (with precision movements)
      - Fit new in-focus mirror normal

  - LED Model? Once in focus, fit normal to LED bright spot center

- Another Idea: fit a know printed object, like a box with contrast-lines
  - Just box → can add this model to code and fit
  - With lines → May be able to calibrate from contrast-line defocus

- Reconstruction
  - Once we know normal, should try Filtered backprojection
  - Continue work towards neural net fit.