

# Vision Tracking at Thessaloniki Metro: A Case Study

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# Introduction

- Tracking has variety of applications in construction
  - Calculate Productivity
  - Detect Travel Path Conflicts
  - Activity Sequence Analysis
  - Enhance Site Safety
  - Monitor Project Progress

# Radio Frequency Tracking

- Global Positioning System
- Local Positioning System
  - Radio Frequency Identification (RFID)
  - Wireless Fidelity (Wi-Fi)
  - Ultra wideband (UWB)

# Radio Frequency Tracking

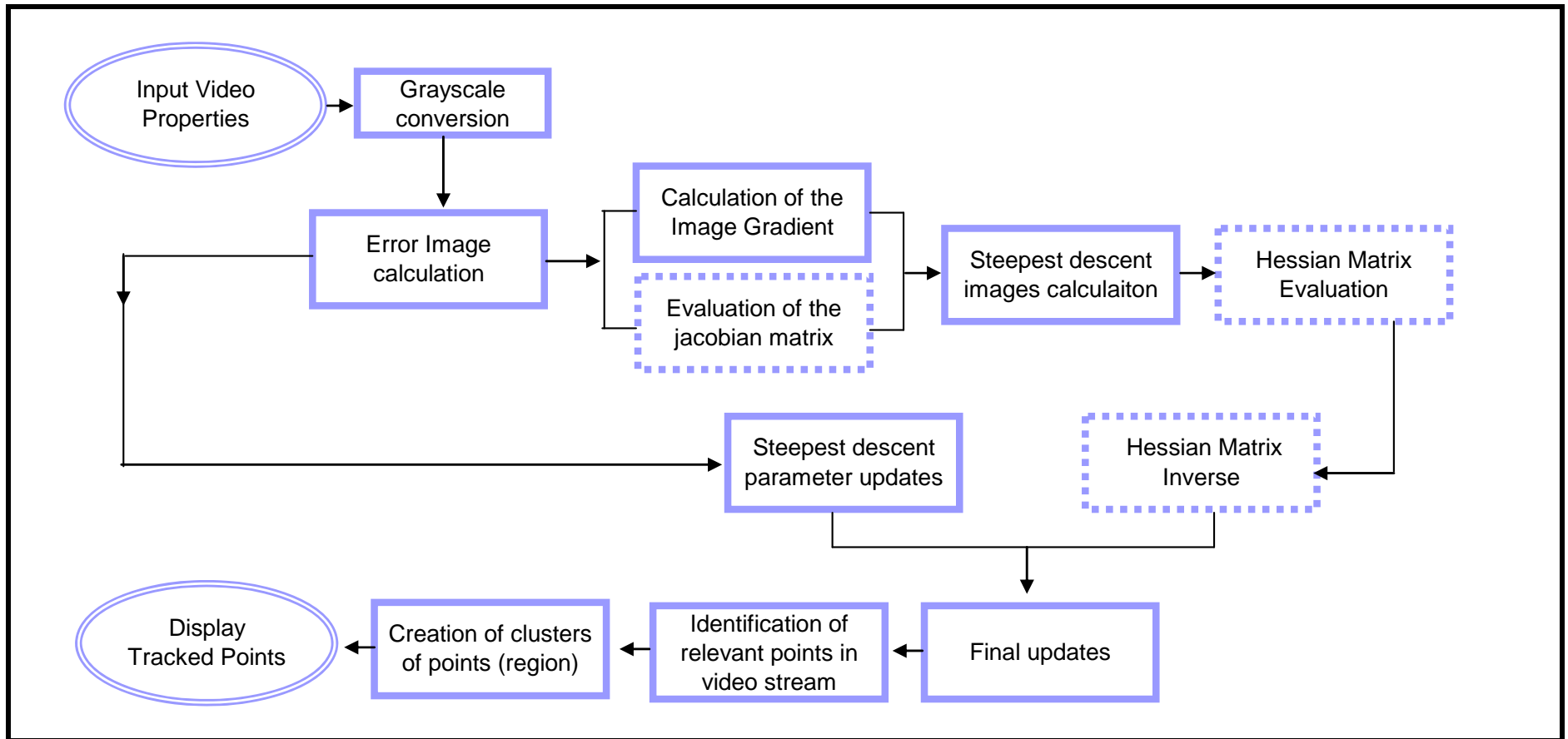
- Limitations
  - Tag each entity to be tracked
  - Privacy and Union Issues
  - GPS- Applicable outdoors only
  - RFID- Person not tracked continuously
  - Wi-Fi- Limitations in tagging entities of different shapes, sizes
  - UWB- Measurement of infrastructure

# Vision Based Tracking

- Combine video cameras and computer algorithms
- Multiple entities tracked with one sensor
  - Unlike tagging of each entity in radio frequency tracking
- Tracks entities from a distance
  - Unlike tracking from sensors on 'interesting' entity in radio frequency tracking

# Image Alignment Algorithm

(Baker and Matthews 2002)



# Vision Based Tracking

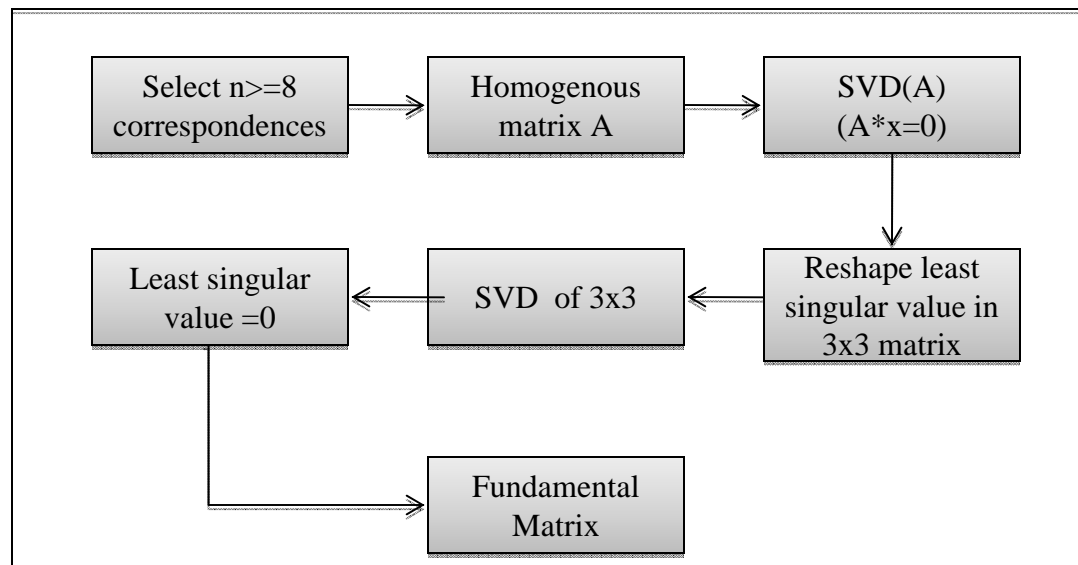
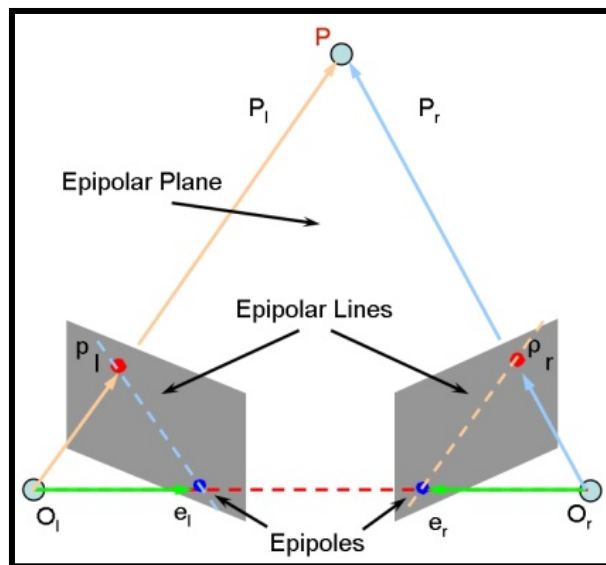
- Limitations
  - Tracking in 2-D
    - Not useful for safety and productivity measurement
  - Manual recognition of entities to be tracked
    - Time consuming

# 3-D Vision Based Tracking

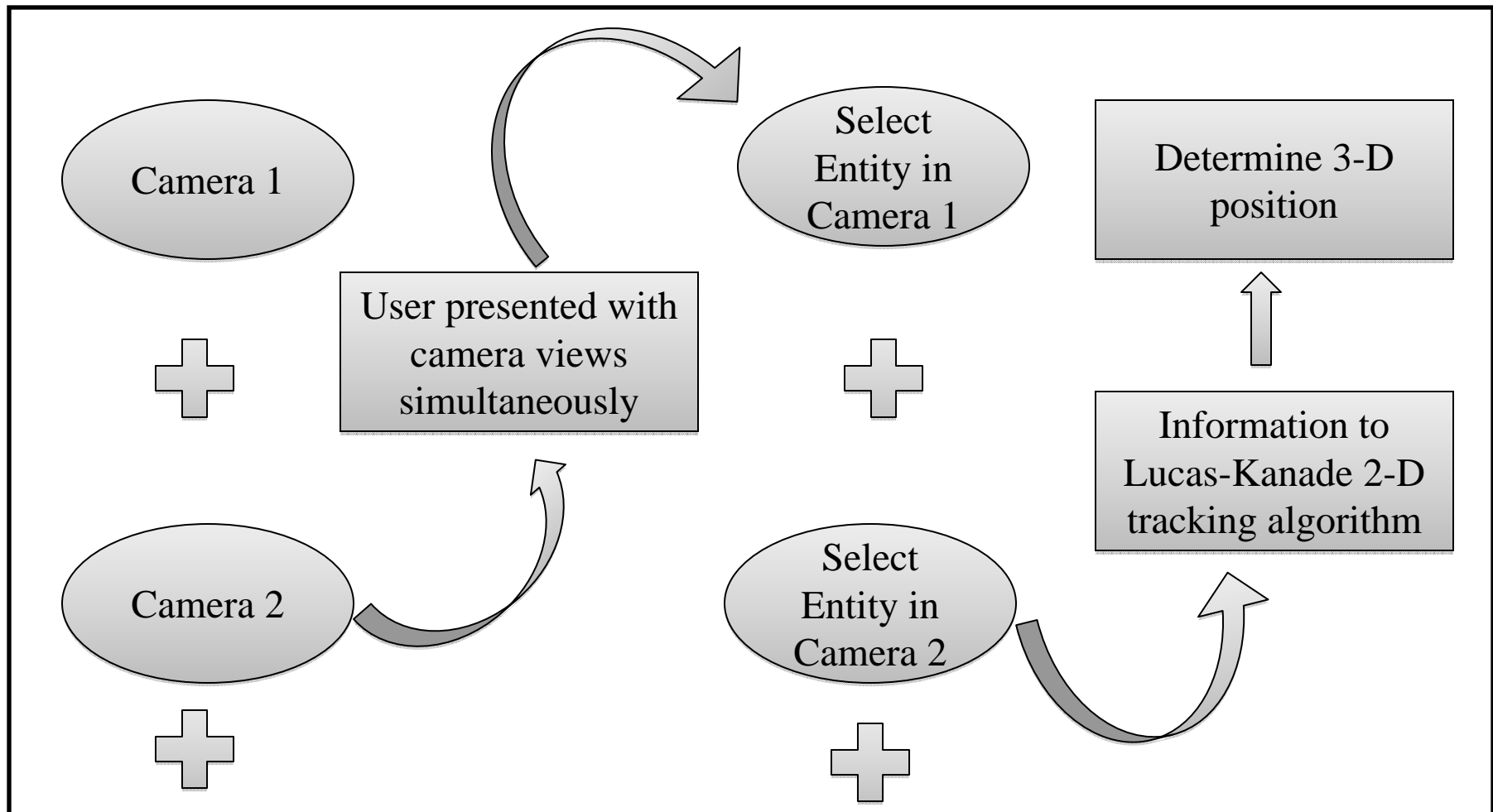
- Addresses limitations of 2-D tracking
- Lucas Kanade 2-D Tracking algorithm with Epipolar Geometry to give 3-D position
- Model based recognition being developed

# Epipolar Geometry

- 8-point algorithm to calculate fundamental matrix
- Projection of centroid across epipolar plane in both views gives intersection point in 3-D space



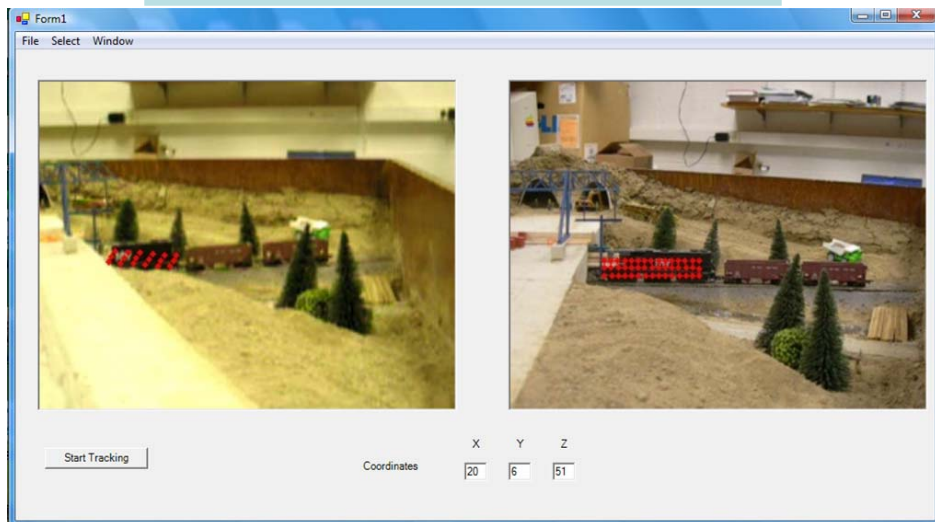
# 3-D Vision Based Tracking



# Validation

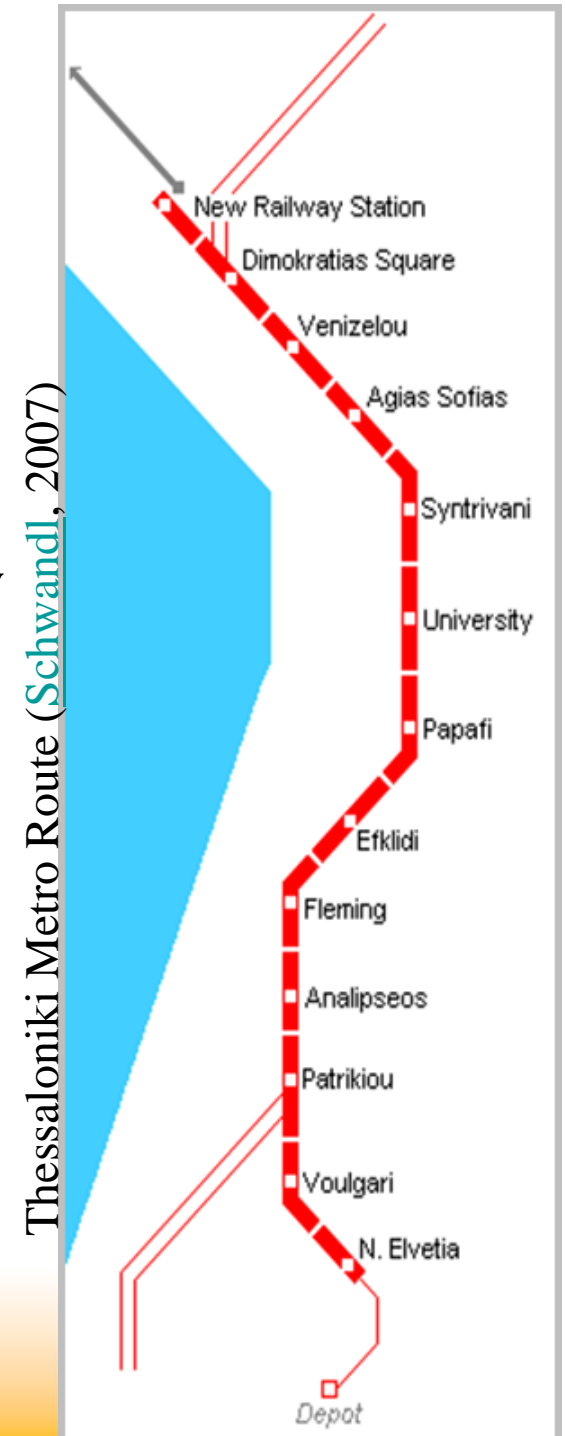


- Preliminary experiments at CIT Laboratory to validate method
  - Small scale (1:80) model
- Successful preliminary results
- Necessary to validate on a real construction site



# Thessaloniki Metro

- Validation project
  - Sponsored by NSF IREE
  - Collaboration with Aristotle University
- Thessaloniki Metro
  - €1.1 billion
  - 13 Stations from E-W
  - Site Conditions
    - Equipment, Construction Methods, Weather



# Validation Process

- Selection of Construction Site
  - Variety of construction activities
  - 6 active sites at Thessaloniki Metro
  - Video feeds collected daily



# Equipment Set-up

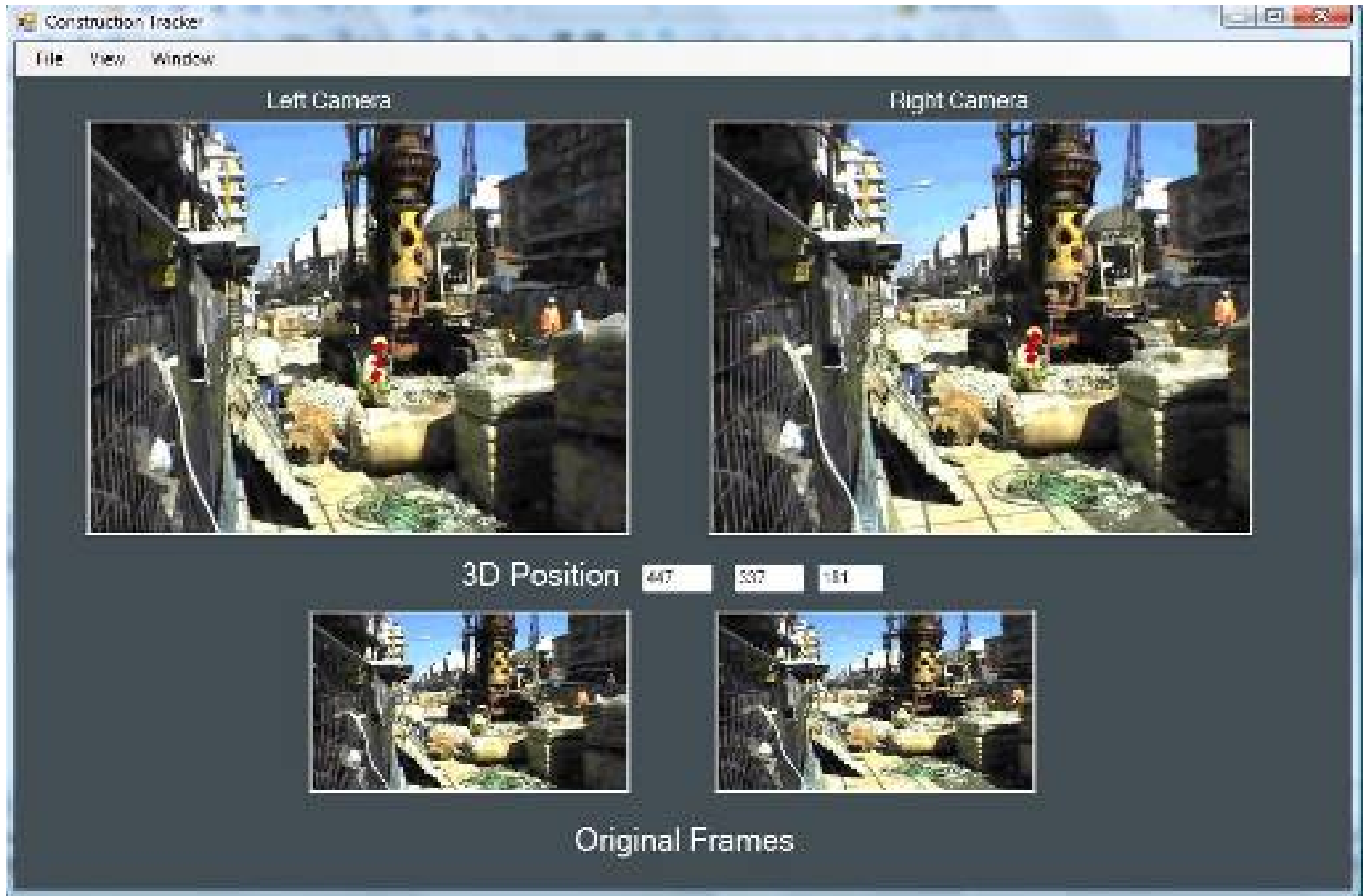


# Validation Process

- On-site Arrival
  - Set-up equipment at adjacent building
  - Video shoot scheduled activity
  - Drive Mobile Laboratory Truck to another location for more video data
  - Collected over 2TB of data in four months









# Conclusions and Future Work

- Thessaloniki Metro Project provided test bed to validate the developed 3D tracking method
- Comparison of our tracking method results with contemporary methods to check performance
- Development of recognition models to automate recognition of entity to be tracked

# Acknowledgements

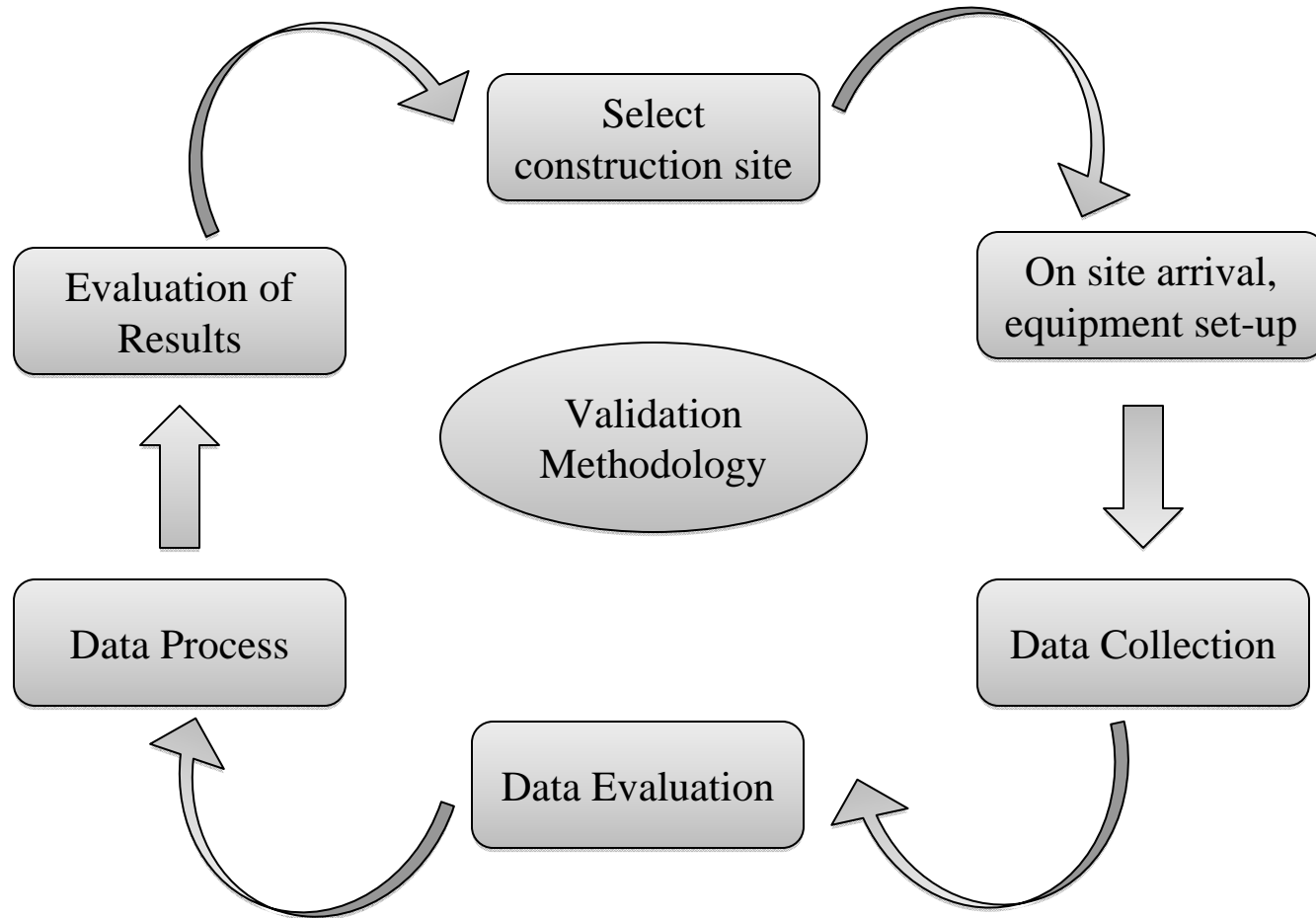
- Project sponsored by the US National Science Foundation
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- Collaborators in Greece
  - Dr. Demos Angelides
  - Pr. Glykeria Kalfakakou
  - Students
    - Dimitris Sideris, Lucia Georgiou
- Student researchers from Michigan
  - Francisco Cordova, Russell Hinkle, Phillip Clark, Peter Mattes

Thank you!

Any questions?

END..

# Validation Process



# Validation Process

- Data Collection and Evaluation
  - 6 hours of video feed/day
  - Spreadsheet storage of entity being tracked
- Data Process and Evaluation of Results
  - Video feeds processed using 3D tracking algorithm
  - Actual positions calculated and compared with code results
  - Values of precision, recall and generality calculated to evaluate performance

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# Motivation

- Acquiring tracking information is complicated
- Disadvantages of common tracking practices
  - Occlusions/Obstructions
  - Too many entities to track
  - Privacy issues
  - Tracking possible only for a certain distance

# 3-D Vision Tracking

- Benefits
  - High Accuracy
  - Low cost
    - No need for individual sensor for entity to be tracked
    - Standard security cameras
  - No need to tag entity to be tracked