

Construction of Data Flow Networks for Tracking in Augmented Reality Applications

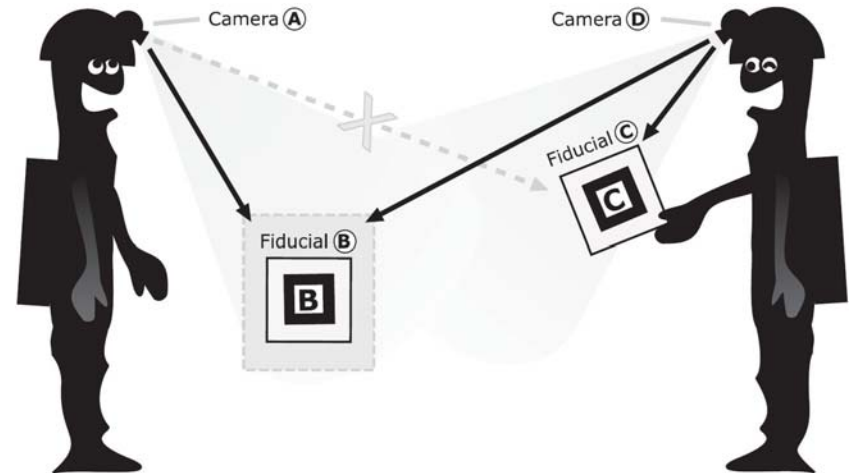
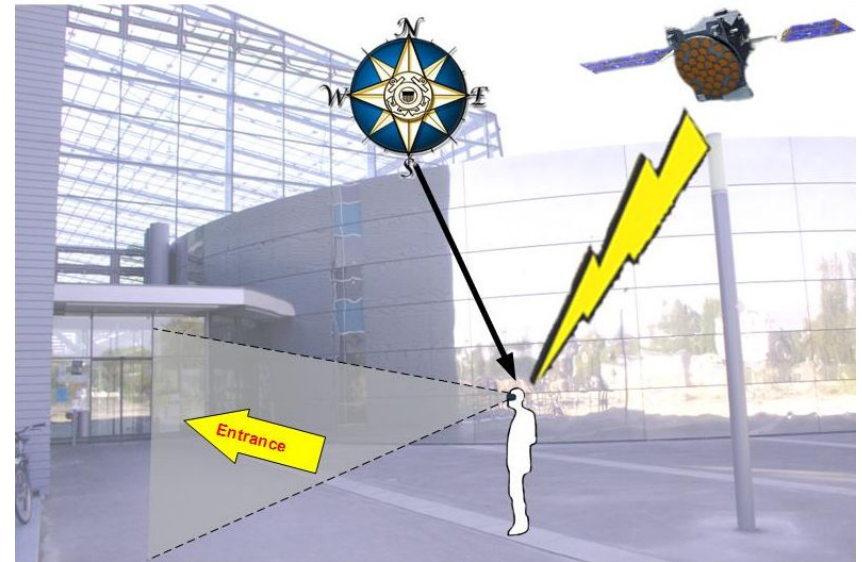
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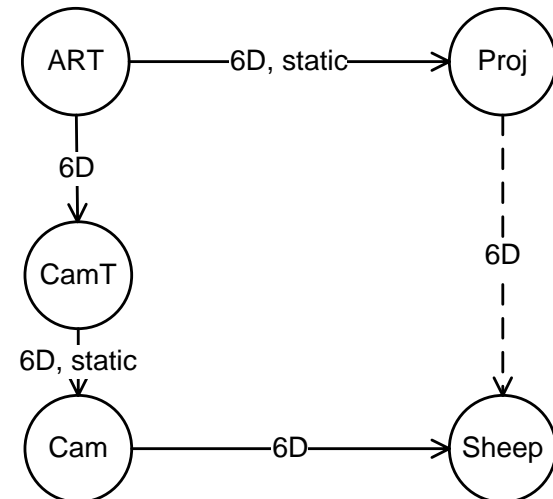
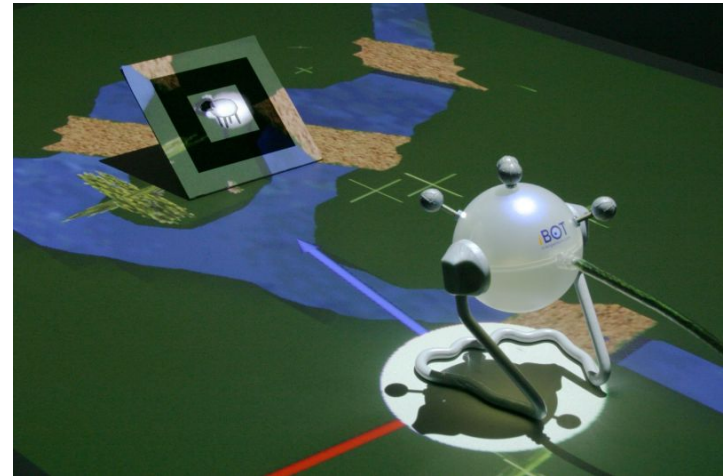
Motivation

- Ubiquitous tracking setups
- Challenge: Unknown sensors
 - Type
 - Accuracy
 - Placement
 - Mobile
- This presentation:
 - Unsynchronized Sensors



Spatial Relationship Graphs (SRG)

- Describes relationships between coordinate frames
- Formalizing tracking setup descriptions
- Nodes
 - coordinate frames
 - features
- Edges
 - measurements
 - reference to trackers
- Edge attributes
 - type of measurement
 - static/dynamic relationship

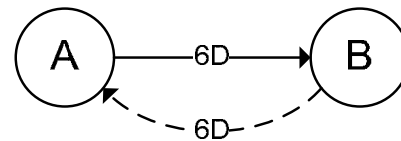


Spatial Relationship Patterns

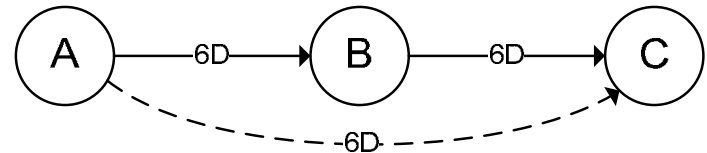
- Create a dataflow network
 - low latency at runtime
- Input / Output Edges
- Patterns describe possible geometric transformations
- Application adds new edge to SRG
- Subgraph matching system can detect possible applications

D. Pustka, M. Huber, M. Bauer, G. Klinker. **Spatial Relationship Patterns: Elements of Reusable Tracking and Calibration Systems.** to appear in *5th IEEE and ACM International Symposium on Mixed and Augmented Reality, ISMAR 2006*

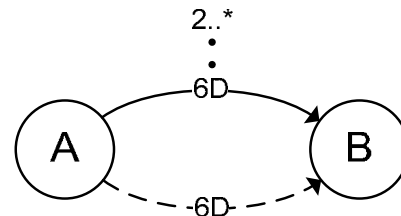
- Inversion



- Concatenation

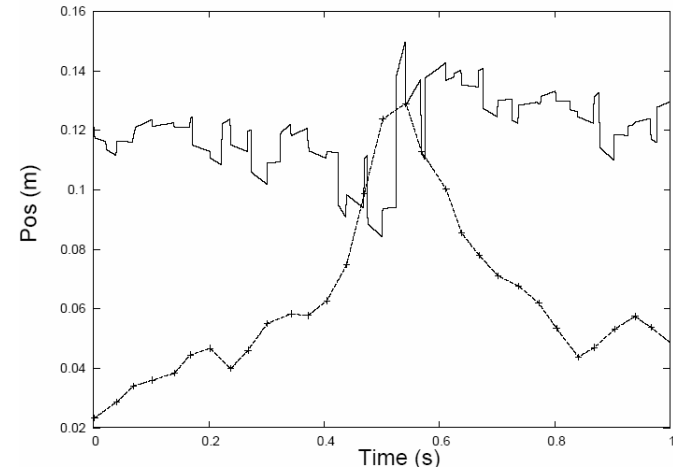
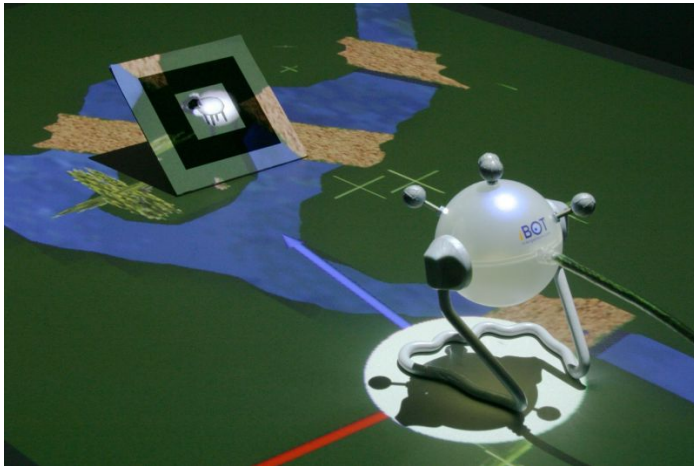


- Multiple-Sensor Fusion

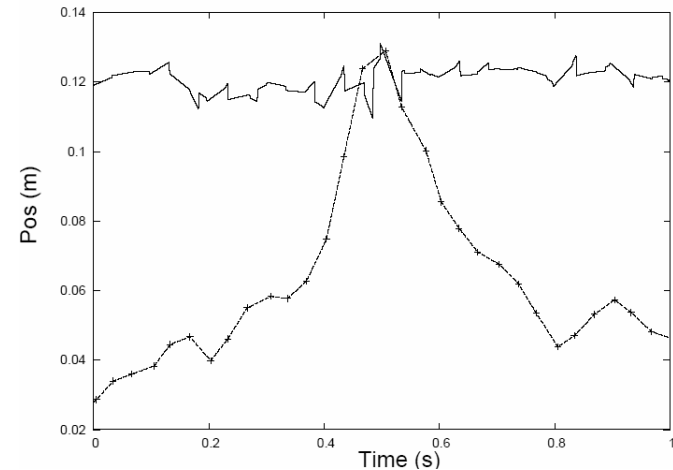


Problem: Measurement Simultaneity

- Combined measurements need to be made simultaneously!
- Example: Concatenated measurements with 30ms shift



with 30 ms shift

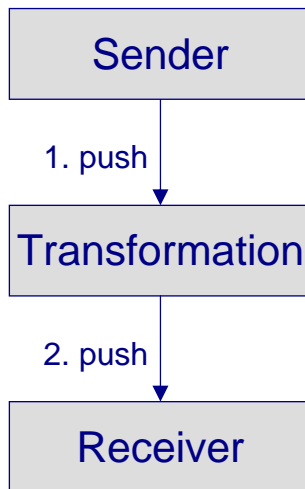


compensated by interpolation

Push-Style and Pull-Style Communication

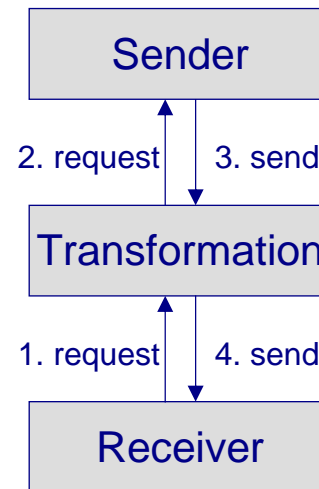
□ Push-Style Interface

- asynchronous
- all tracking hardware



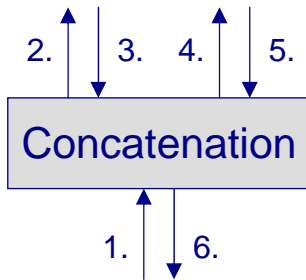
□ Pull-Style Interface

- synchronous
- request by timestamp
 - senders are continuous

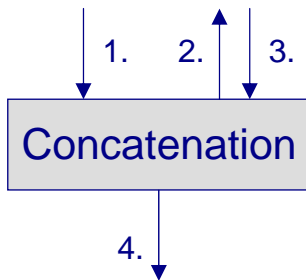


Combining Multiple Measurements

- Pull-Pull



- Push-Pull

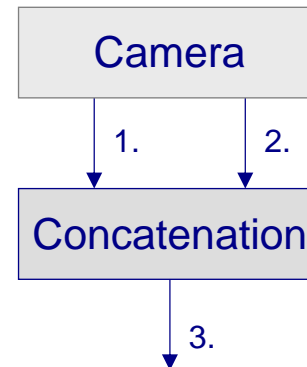


- Push-Push

- not possible in general

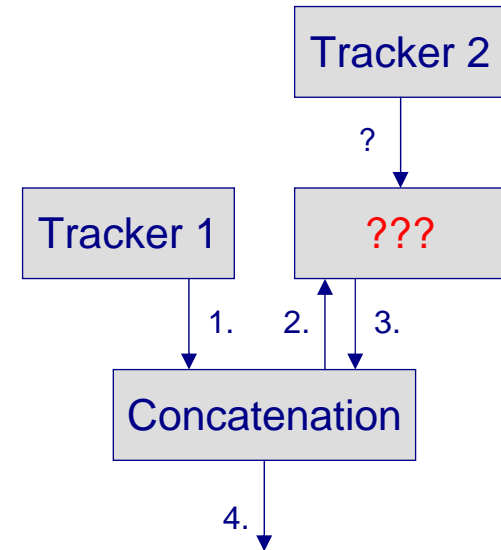
- Special case:
Synchronized push

- If incoming measurements are synchronous



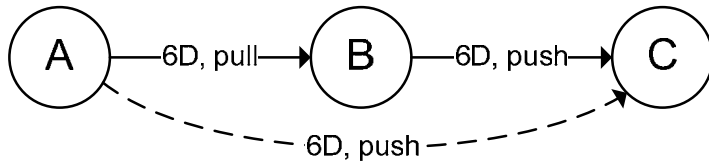
Push-To-Pull Conversion

- Buffering
 - Only valid for quasi-static relationships
- Averaging
 - Improves error characteristics
 - Only valid for static relationships
- Interpolation/Extrapolation
 - Linear, quadratic, SLERP
- Kalman Filter
 - Different motion models
 - Improves error characteristics
 - Provides accuracy estimates

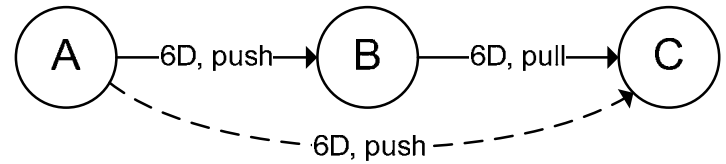


Required Components (I)

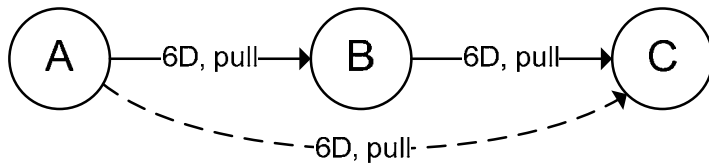
Push Concatenation I



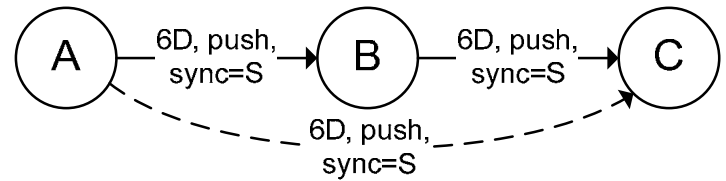
Push Concatenation II



Pull Concatenation

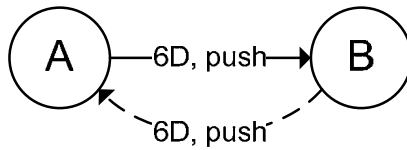


Synchronized Push Concatenation

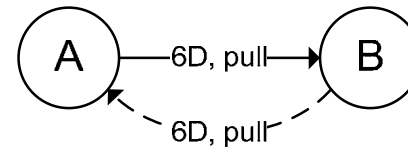


Required Components (II)

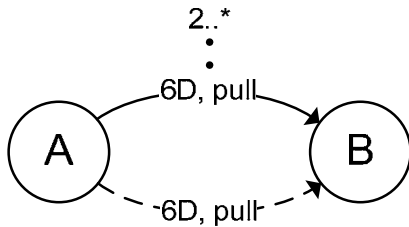
Push Inversion



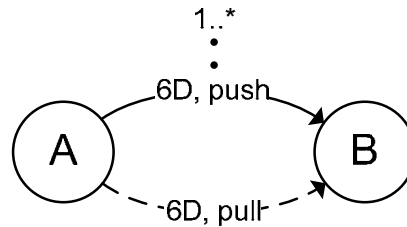
Pull Inversion



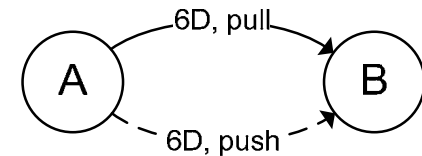
Pull Fusion



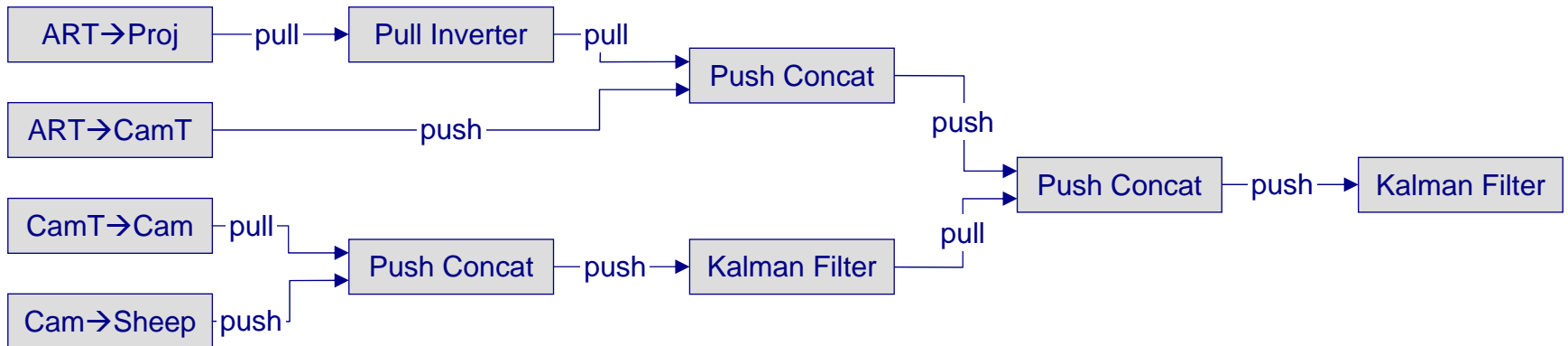
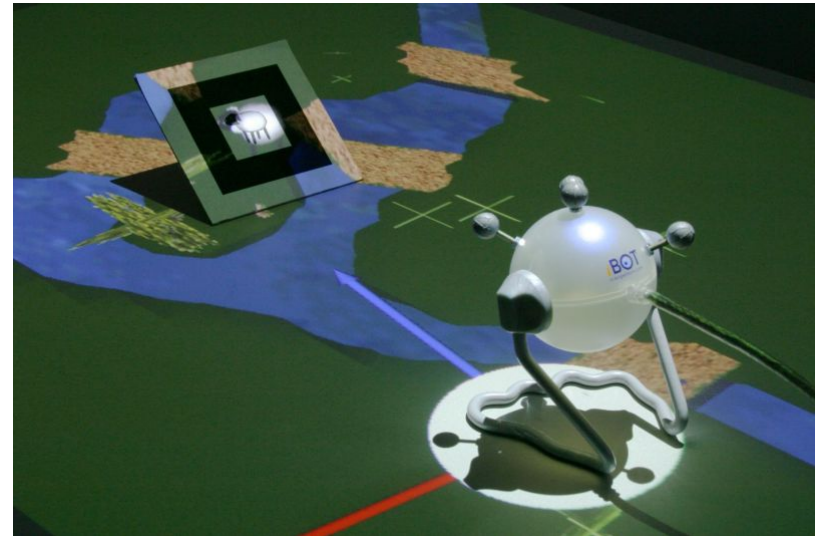
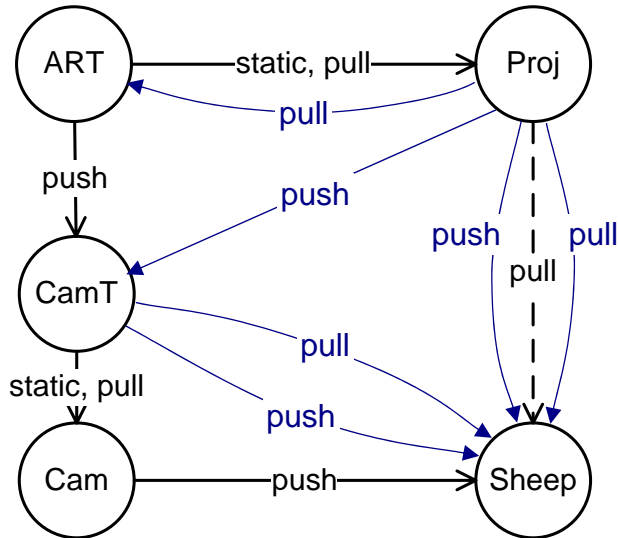
Kalman Filter



Sampler



Example Data Flow



Conclusion

- Refined system of patterns
 - Solves most tracking and calibration problems involving 6DOF trackers
 - Reuse of components
 - Concept can be applied to other forms of combination
- Systematic way to think about synchronization
 - Modeling of setups
 - Automatic data flow construction

Questions?

Thank you for listening