

Integration of Odometric Sensors for Augmented Reality. Analysis and Application.



10.02.2009

Integration
Gesamtfahrzeug,
Versuchsfahrzeugaufbau



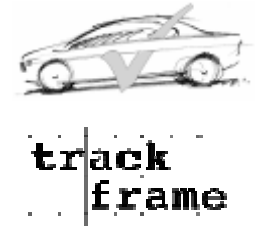
München



Freude am Fahren

Introduction.

Problem indoor tracking.

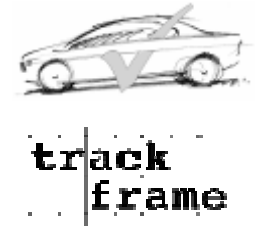


- Goal.
 - Realtime tracking.
 - Wide area indoor environment.
 - Pose.

- Problems.
 - No GPS available.

- Existing techniques.
 - Ubisense.
 - Expensive.
 - Proprietary.
 - Inertial tracking.
 - suffers from drift over time.
 - Tracking with RFID gates.
 - expensive, only cell based tracking.

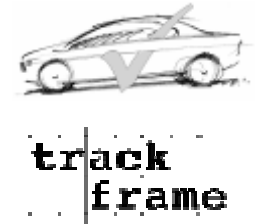
Introduction. Scenario.




- Description.
 - Tracking a moving forklift.
 - Using markerbased tracking.
 - Sparse navigationpoints.
 - Markers attached to pillars in the building.


- Requirements.
 - Cost efficient.
 - Adaptive accuracy.
 - Realtime positional and orientational data.
 - Indoor navigation.
 - Integration with existing storage systems.

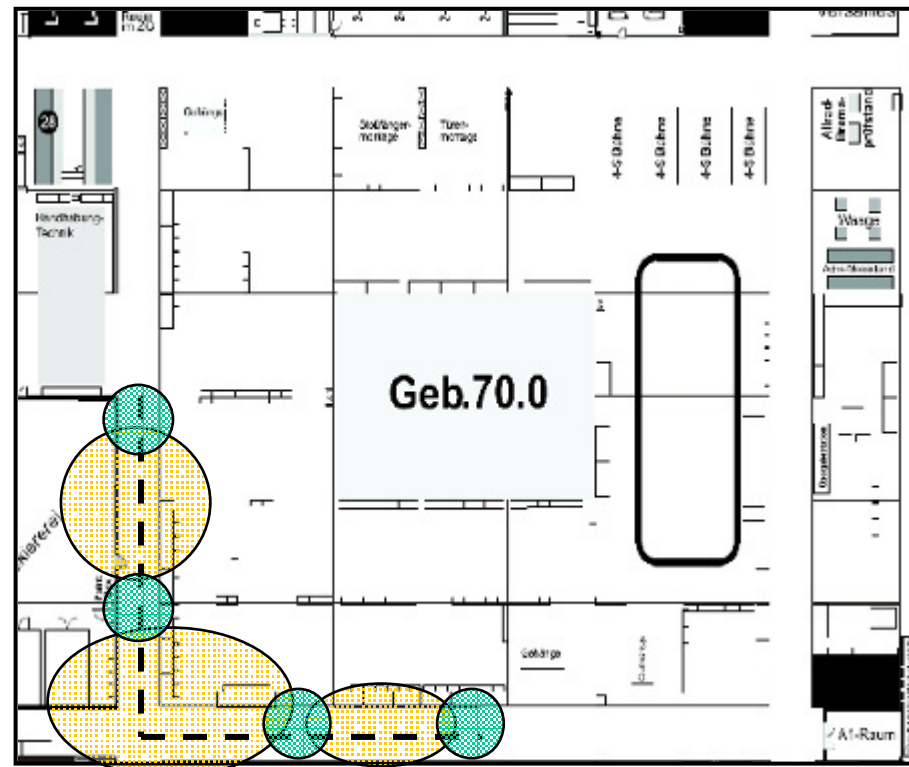
Introduction. Scenario.



— · — · Exemplary path of a fork lifter

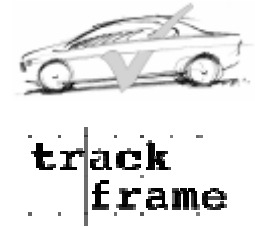
 Zones with high precision tracking
Technique:
Markerbased tracking
Precision:
~0.1m

 Zones with low precision tracking
Technique:
odometric tracking, gyroscope
Precision:
~1-2m



Introduction.

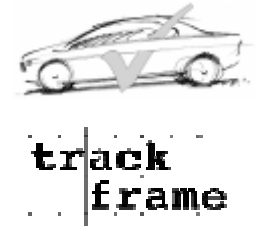
Odometric Tracking.



- Different methods of odometric tracking.
 - Mechanical.
 - Optical flow.
- Tracks 3DoF poses on a surface.
 - 2DoF position.
 - 1DoF orientation.

Introduction.

Odometric Tracking.



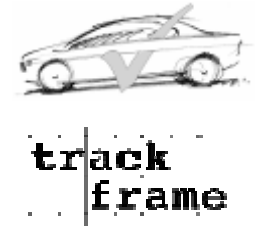
- Different methods of odometric tracking.
 - Mechanical.
 - Optical flow.

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 - 1DoF orientation.

- Optical Odometric Tracking.
 - One sensor delivers 2DoF.
 - At least two needed for 3DoF.

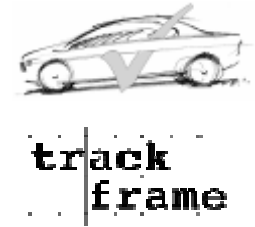
Introduction.

Integration using other sensors.

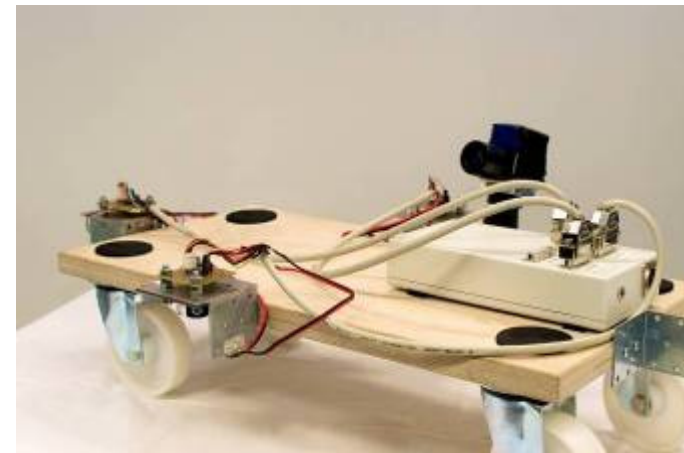


- Inside-out optical tracking.
 - Initializing odometric tracking.
- Gyroscope.
 - Improve robustness of orientation tracking.
- Sensor fusion.
 - Extended Kalman-Filter for error-reducing sensor-fusion.

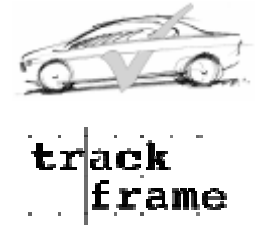
Setup. Platform.



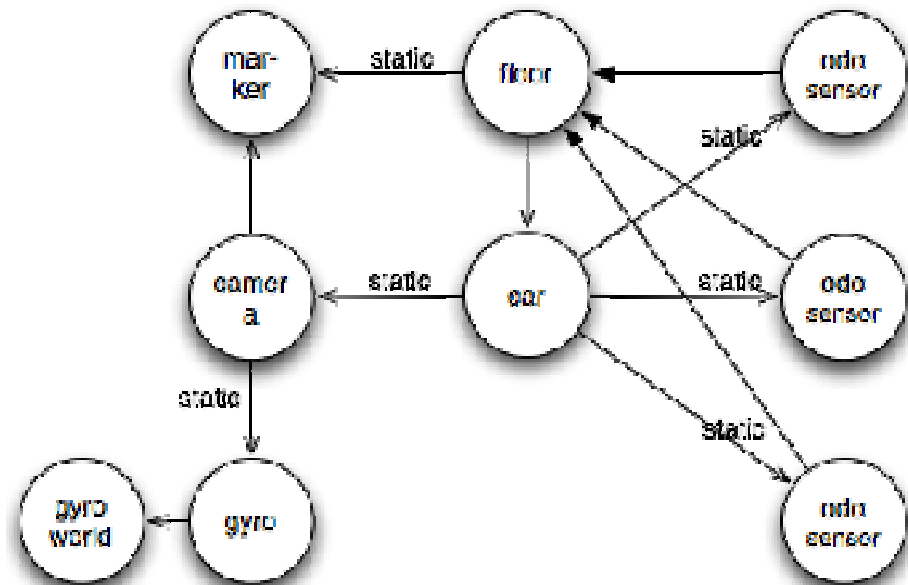
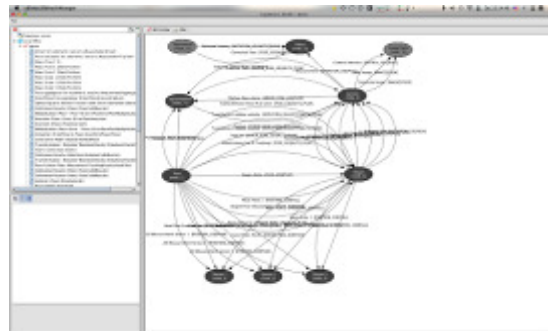
- Platform for proof of concept and evaluation.
 - Odometeric sensors.
 - Camera.
 - Gyroscope.



Setup. Tracking Overview.

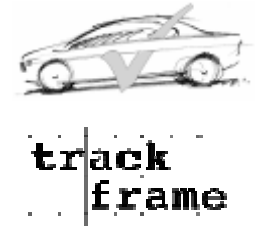


- Tracking the car on the floor.
 - Managed in trackman.
 - Makes complex fusion setup feasible.
 - Implemented in ubitrack.

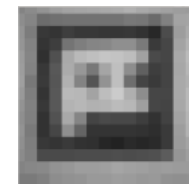
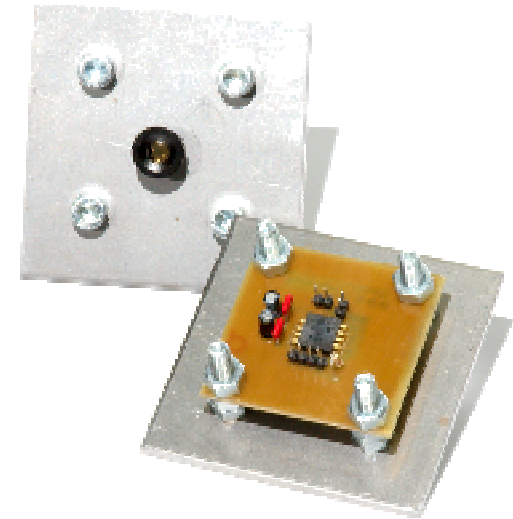


Setup.

Odometric: Hardware Sensor Module.



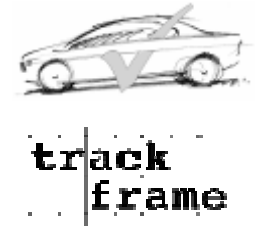
- Custom circuit based on LSI optical flow sensor.
 - Same family as optical computer mice.
- Minimal number of external components.
- Communicates via serial SPI bus.
 - 2DoF sensor data.
 - Complete Images for debug and focus.
- Optical operation range extended to 10cm.
 - Telefocus lens mounted .
- Illumination module.
 - Provides constant bright light.



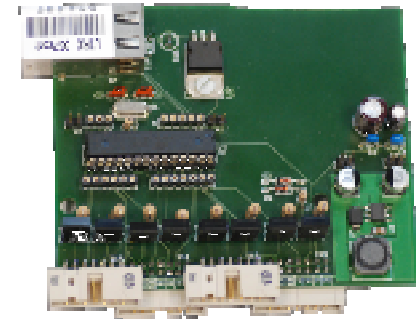
2mm x 2mm
15x15 px

Setup.

Odometric: Hardware Interface.

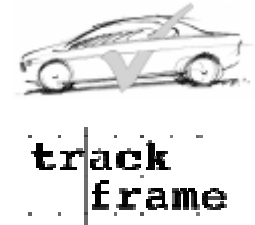


- Custom fabricated interface board.
- Communication with odometric sensors.
 - Multiple globally synchronized SPI busses.
- Communication with host.
 - Ethernet adapter.
- Power distribution for illumination modules.
- Timestamp generation and synchronization.
- Debug functions.
 - Alive test.
 - Debug images.



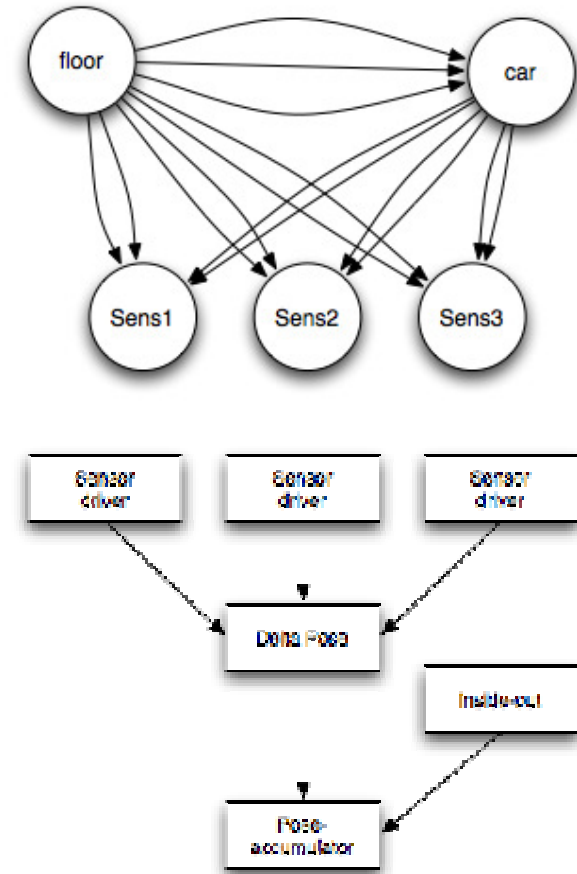
Setup.

Odometric Tracking SRG.

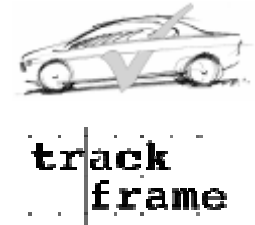


- Calibration.
 - Scale.
 - Angle.
 - Position.
- Tracking.
 - Integrated in Ubitrack.
 - Measuring distance per time.
 - Calculation of full 3DoF pose differences.
 - Accumulation of pose differences.

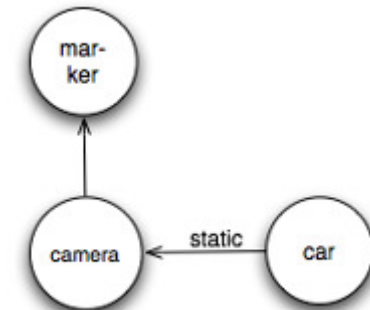
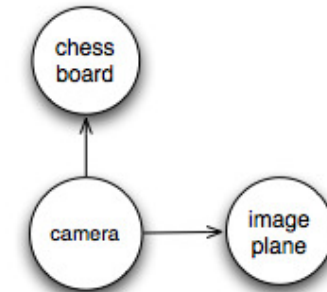
$$H_n^{\text{floor car}} = H_0^{\text{floor car}} \prod_{i=1}^n \Delta H_i^{\text{floor car}}$$



Setup. Camera SRG.

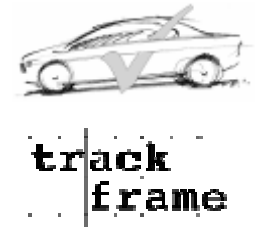


- Optical inside-out tracking.
- Calibrations.
 - Standard camera calibration.
 - Hand-Eye calibration.
- Marker tracker.
 - Initialization for odometric tracking.
 - For regions with high accuracy.

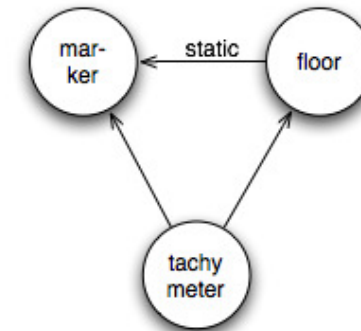


Setup.

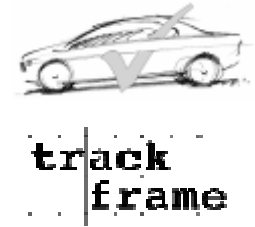
Calibration Marker Floor.



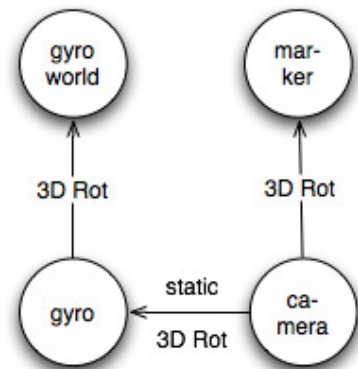
- Using tachymeter for calibration marker to floor.
- Two absolute orientation calibrations.



Setup. Gyroscope.

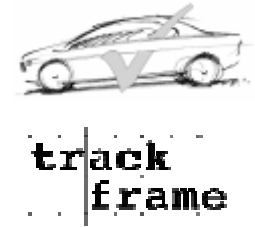


- Mounted rigidly to the camera.
- Hand-Eye calibration of static orientation offset.
- Propagation of rotational velocity.



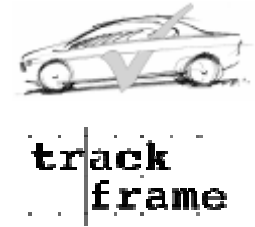
Evaluation.

Overview and Results.



- SmARtrack as reference.
 - Calibration of SmARtrack.
 - Trackman for error analysis.
- Results.
 - ~ 10% positional error for odometric tracking.
 - ~ 10% rotational error for odometric tracking.
- Summary.
 - Feasible for bridging gaps in tracking setups.
 - Areas with high accuracy by fusion with inside-out.
 - Used
 - 4 Absolute Orientation Calibrations.
 - 2 Hand-Eye-Calibrations.

Outlook.



- Addition of accelerometers.
- Industrial robot for in-depth investigation of odometric sensors characteristics.
- Inside-out tracking for on-the-fly scale calibration.



track
frame

Thank you!

Question?