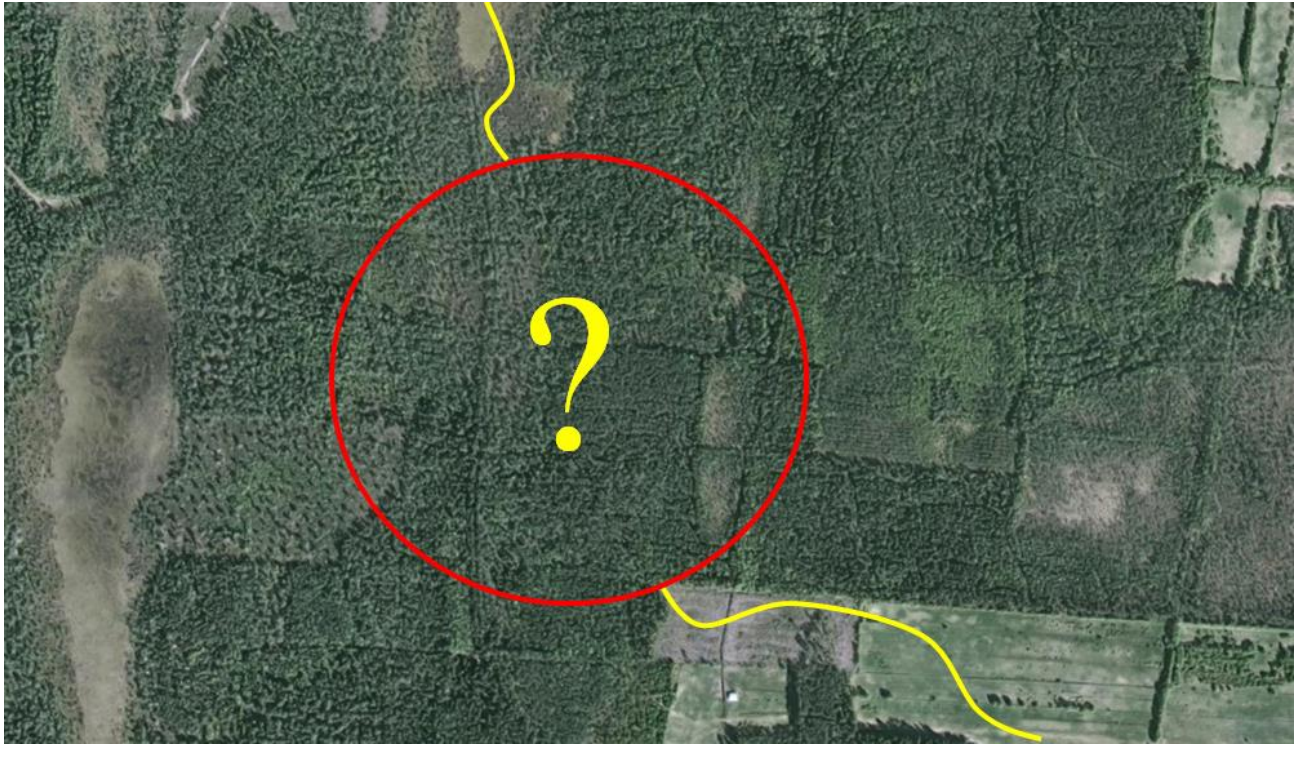
Stereo vision aided inertial navigation in forested areas to create 3D models

Design-Build-Test Ht 16

Problem background

- Difficult to track position using satellite based systems in forested areas.



The solution: Visual and inertial tracking assistance

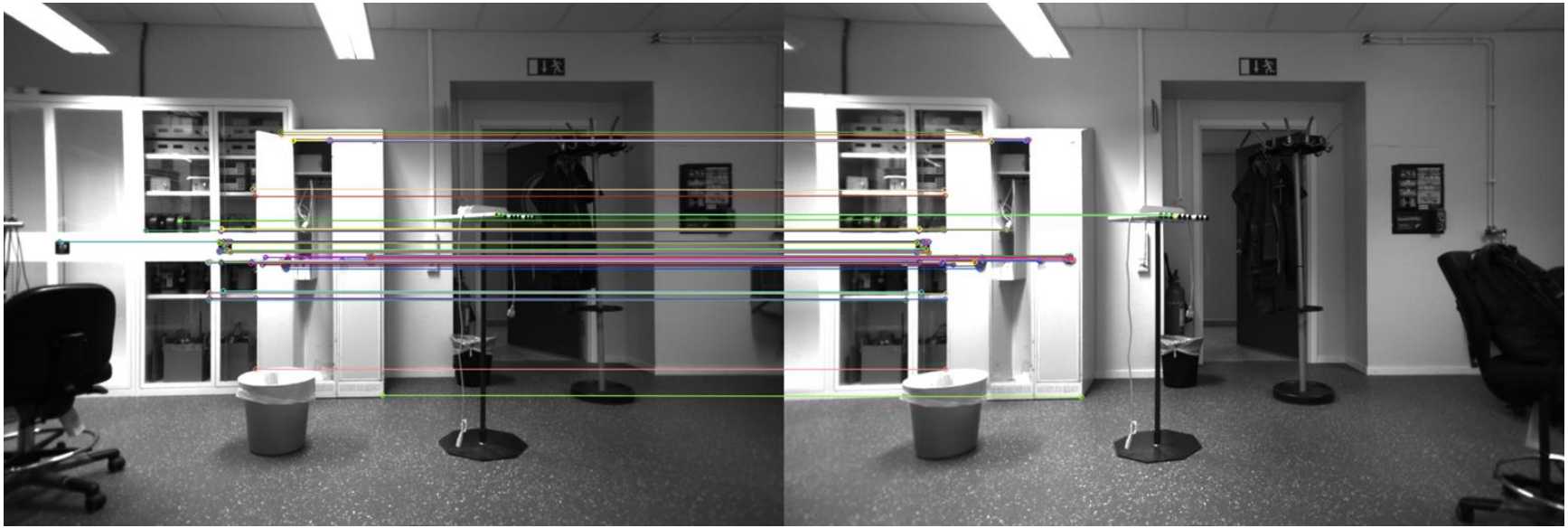
The task: To build a mobile position tracking system consisting of an IMU, a GPS and a stereo camera, to be used in a forest environment.

Point Grey Bumblebee XB3

Novatel SPAN-IGM-S1

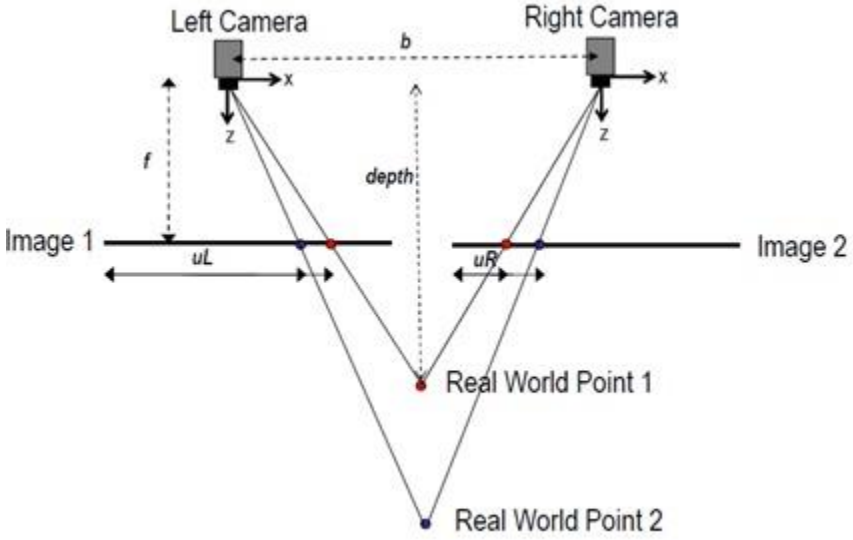
Navigation by **stereo cameras**

1. Match features between two consecutive images



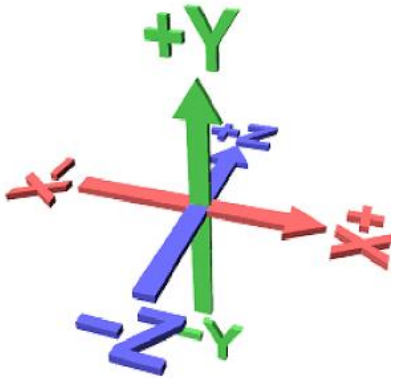
Navigation by stereo cameras

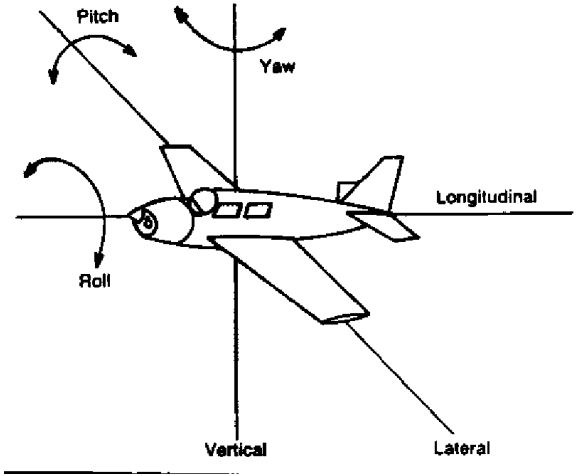
2. Distance is found by triangulation

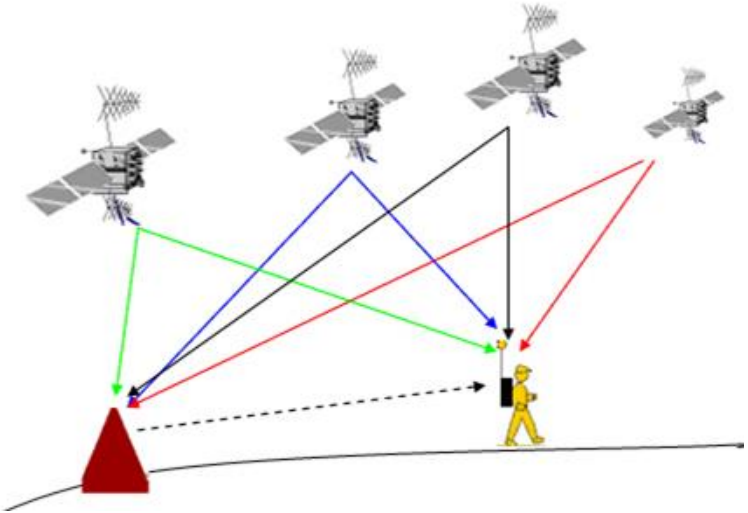


Navigation by **IMU enabled GPS devices**

Difference in acceleration, rotation and global coordinates from satellites

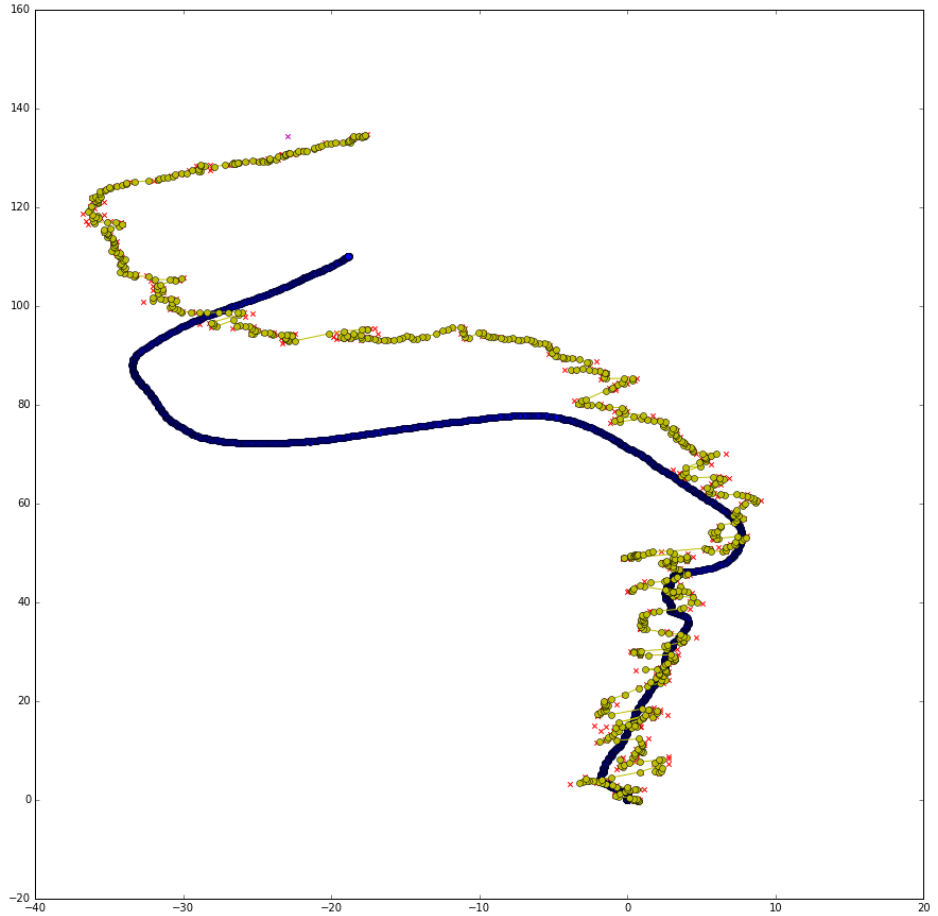




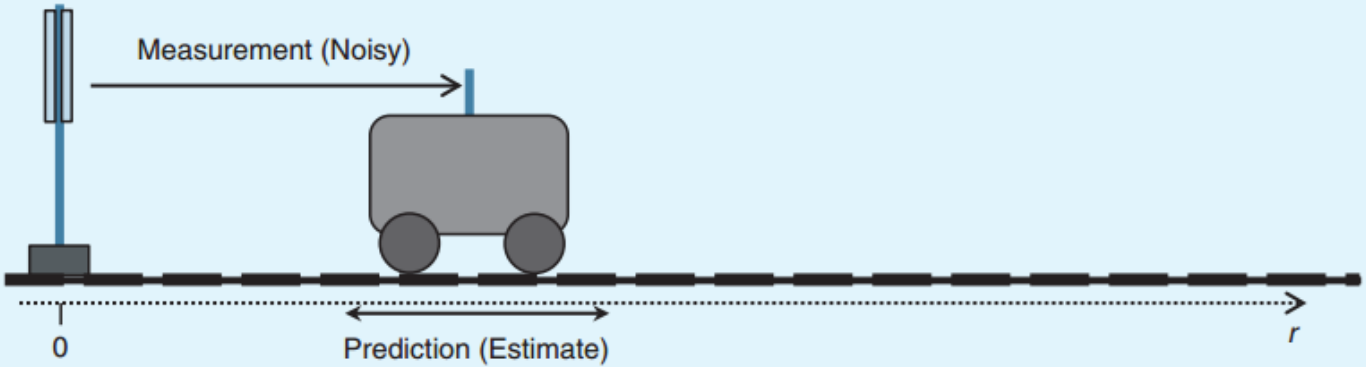


Sensor fusion

- Drift in the trajectory
  - Stereo camera
  - Inertial measurement unit
- Sensor fusion by Kalman filter



Kalman filter



[FIG1] This figure shows the one-dimensional system under consideration.

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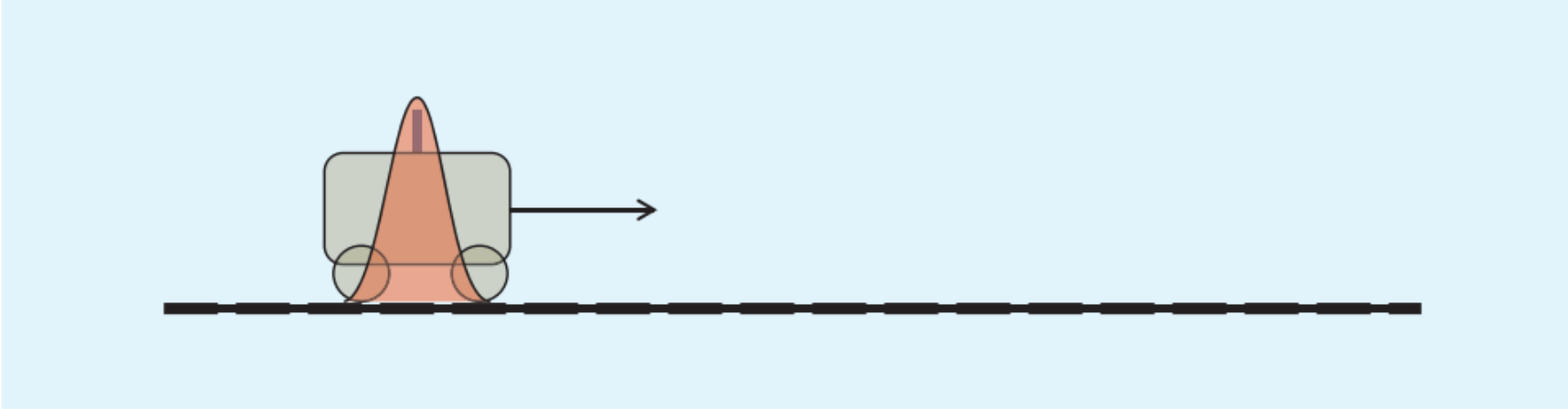
Kalman filter



[FIG2] The initial knowledge of the system at time $t = 0$. The red Gaussian distribution represents the pdf providing the initial confidence in the estimate of the position of the train. The arrow pointing to the right represents the known initial velocity of the train.

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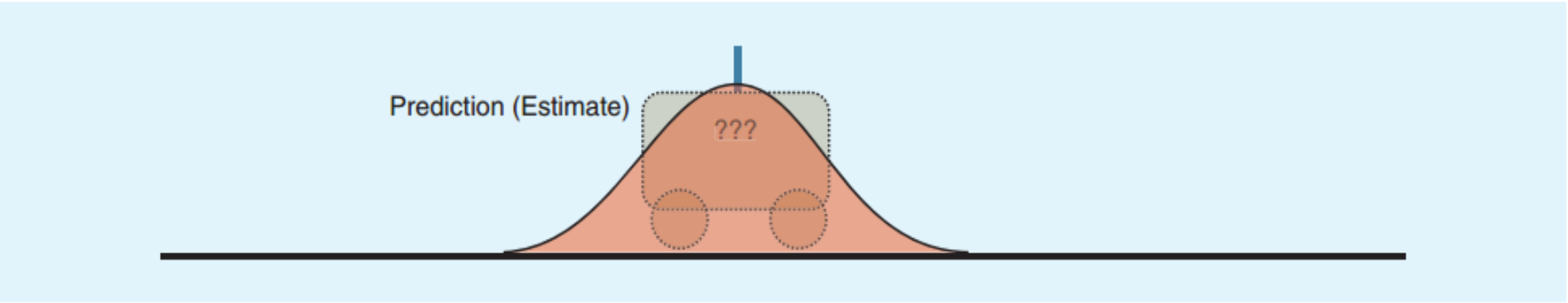
Kalman filter



[FIG3] Here, the prediction of the location of the train at time $t = 1$ and the level of uncertainty in that prediction is shown. The confidence in the knowledge of the position of the train has decreased, as we are not certain if the train has undergone any accelerations or decelerations in the intervening period from $t = 0$ to $t = 1$.

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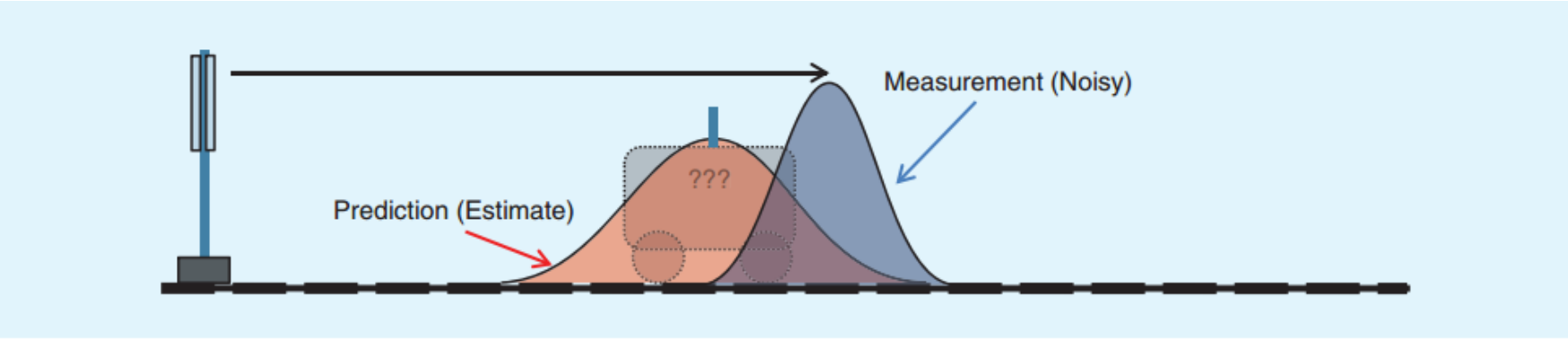
Kalman filter



[FIG4] Shows the measurement of the location of the train at time $t = 1$ and the level of uncertainty in that noisy measurement, represented by the blue Gaussian pdf. The combined knowledge of this system is provided by multiplying these two pdfs together.

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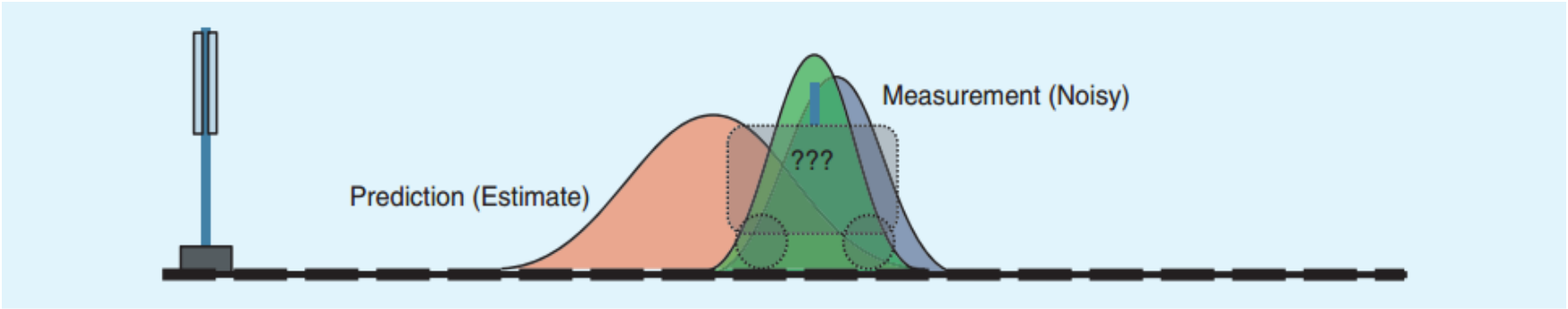
Kalman filter



[FIG5] Shows the new pdf (green) generated by multiplying the pdfs associated with the prediction and measurement of the train's location at time $t = 1$. This new pdf provides the best estimate of the location of the train, by fusing the data from the prediction and the measurement.

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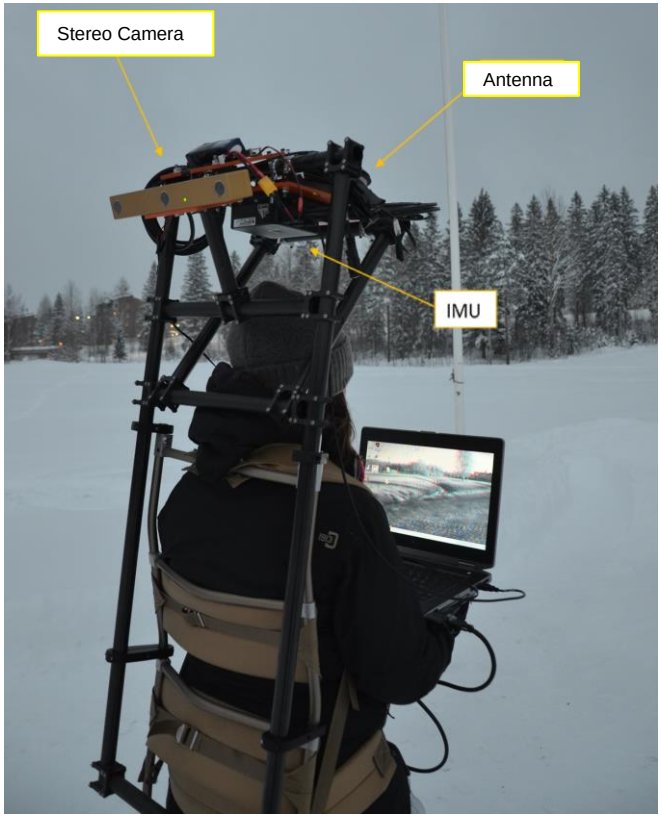
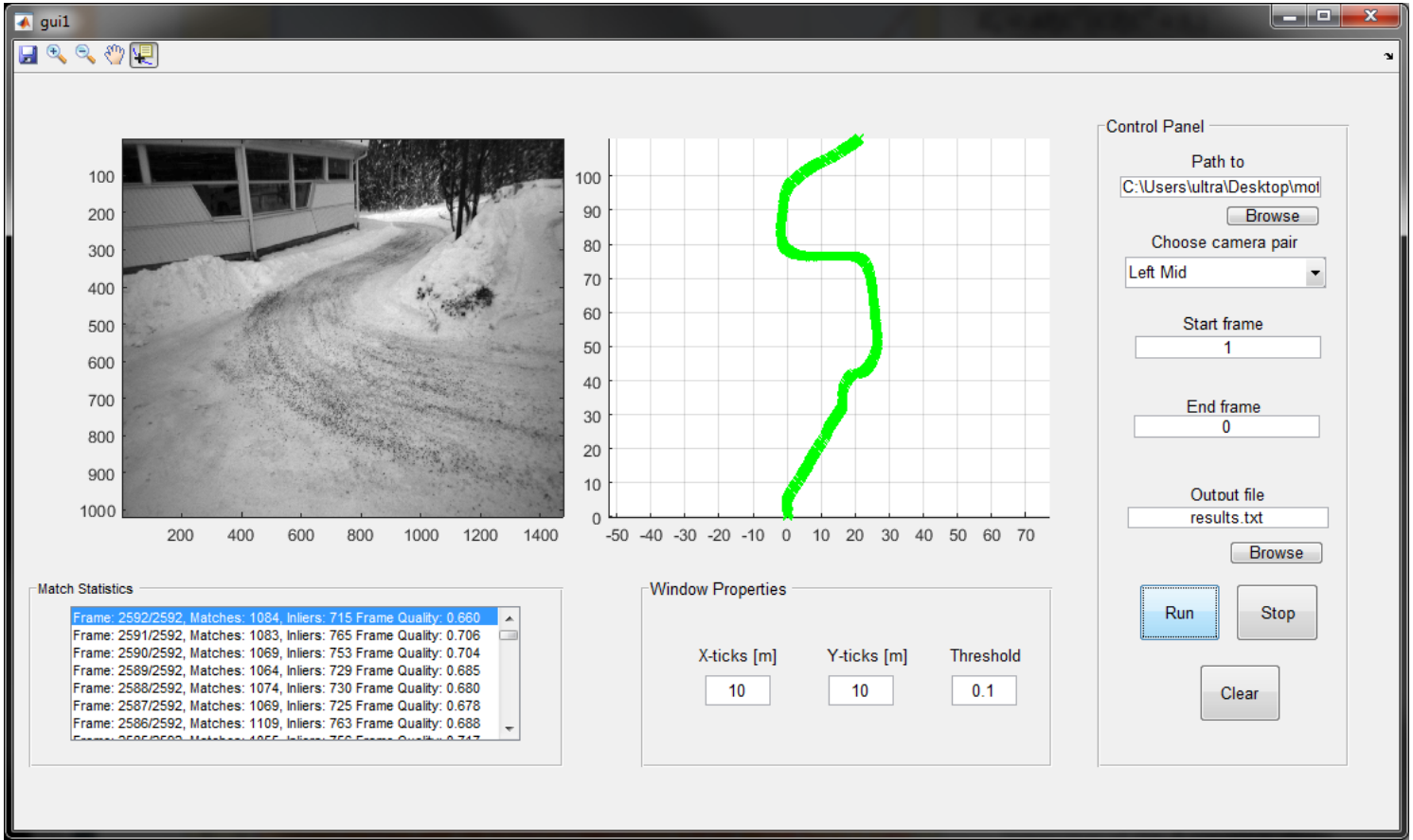
The system in action

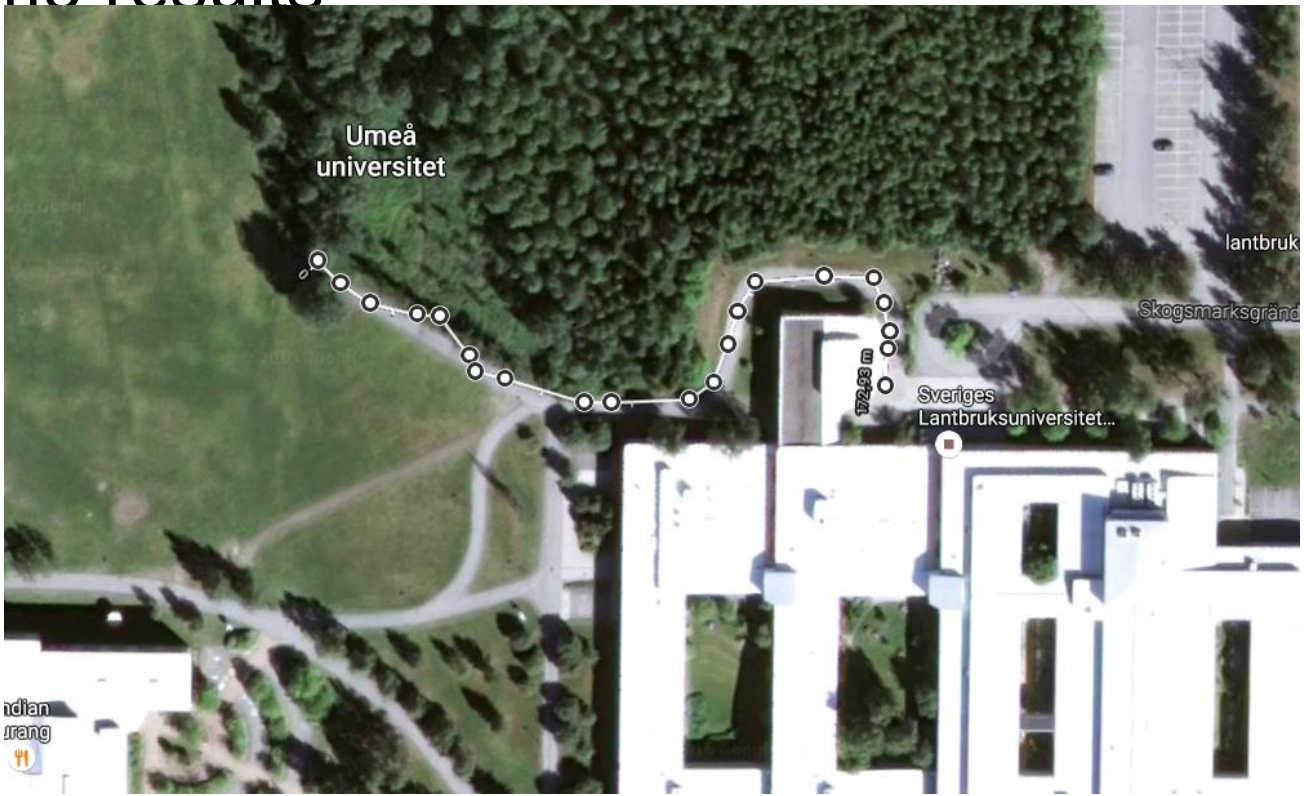


Demo

Demo results



Demo results



Future work

- Implement a Kalman filter
- Optimize camera parameters
- Dynamic use of the three cameras
- Adding additional sensors (compass)?

Questions