Technion – Israel Institute of Technology



HW3

Vision Aided Navigation

086761

|  |  |  |
| --- | --- | --- |
| Alon Spinner | 305184335 | alonspinner@gmail.com |
| Sher Hazan | 308026467 | sherhazan@campus.technion.ac.il |

December 5, 2021

## Question 1 : Consider a prior on random variable and two measurements from different observation models with and .

### Develop an expression for the posteriori information matrix , such that .

Comparing both right sides give us the bayes rule:

We can write each of the terms explicitly:

Maximizing likelihood:

We linearize around :

In this way we can write:

Denoting as follows:

We can now apply Pseudo-Inverse to obtain that minimizes the linear expression’s norm:

We know that the covariance is

Hence, the information matrix is just:

### Consider now a pinhole camera sensor with the corresponding measurement model: , An image observation of a landmark l is obtained. Additionally, a prior on is available. Indicate what is the initial re-projection error.

We assume this measurement was provided after were incorporated to the prior.

### Write an expression for the joint pdf in terms of prior and measurement likelihood terms.

### Develop an expression for the joint information matrix over and as in consider is given.

On this section we will shorthand a few steps that have been fully covered in the section (a).

We need to linearize :

Hence:

Denoting

We can write:

Least squares solution using pseudo inverse will provide the following information matrix:

## Question 2 : Consider two camera poses and , where the following convention is assume. Here, the superscript denotes some global reference frame. Assume each camera captures an image and let and be two corresponding image observations from these two images.

### Develop the epipolar constraint, expressing all quantities in the second camera frame. Express the constraint in the form

### Assume the true values of the camera poses and are not actually known, and instead we have a prior on each camera Assume the residual error in the epipolar constraint from the previous clause can be modeled as zero-mean Gaussian with covariance , derive a probabilistic expression for MAP .

The model we obtained in the previous section with the added Gaussian Noise:

To find the MAP estimate we’ll use:

## Question 3: Prove the fundamental matrix is singular.

To prove that is singular we need to prove that is singular:

We developed the Essential matrix in the previous question:

The determinant of a Rotation matrix cannot be singular as it just transforms representations. It is not allowed to have a kernel space. In-fact, .

Hence, we need to prove that

Blackbox.