Homework 3

Tongji University 2022 Class Computer Science and Technology College Software Engineering Major Machine Intelligence Direction Computer Vision Course Assignment

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Nonlinear Least Square (NLS) Method

According to the problem, we have:

$$L(h) = \frac{1}{2}\big(f(x+h)\big)^T f(x+h) + \frac{1}{2}\mu h^T h \quad (1)$$

$$= \frac{1}{2}\left(f(x)\right)^T f(x) + h^T \left(J(x)\right)^T f(x) + \frac{1}{2} h^T \left(J(x)\right)^T J(x) h + \frac{1}{2}\mu h^T h \quad (2)$$

The first derivative can be derived as:

$$dL = (J(x))^T f(x) + (J(x))^T J(x) h + \mu h \quad (3)$$

And the second derivative is:

$$d^2 L = (J(x))^T J(x) + \mu I \quad (4)$$

where I is the identity matrix.

Let $A = (J(x))^T J(x)$, and replace $J(x)$ with J. We can obtain:

For any $x \neq 0$, let $y = Jx$, then:

$$0 \leq y^T y = (Jx)^T Jx = x^T J^T J x = x^T A x$$

Thus, A is positive semi-definite.

For all eigenvalues $(\lambda_i \geq 0, i = 1, 2, \cdots, n)$ of A, we have:

$$A v_i = \lambda_i v_i$$

And it follows that:

$$(A + \mu I)v_i = (\lambda_i + \mu)v_i$$

All eigenvalues of $(A + \mu I)$ satisfy $(\lambda_i + \mu) > 0, i = 1, 2, \cdots, n$.

Therefore, $(A + \mu I)$ is positive definite, i.e.:

$$(J^T J + \mu I)$$

is positive definite.

Since $d^2 L = J^T J + \mu I$, it can be concluded that $L(h)$ is a strictly convex function.

Speed Belt Ranging

After training with YOLO and obtaining the `best.pt` file, the folder contains a test video (HW3_Pro2.mp4) with a bounding box.Below is the effect of one of the frames:

Experimental Report on 3D Model Scanning and Data Processing

See folder contents for details:.../CV_2251730_Liu Shuyi_Assignment3/HW3_Experiment3.pdf