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Accelerating Robotic Arm Calibration on GPGPUs

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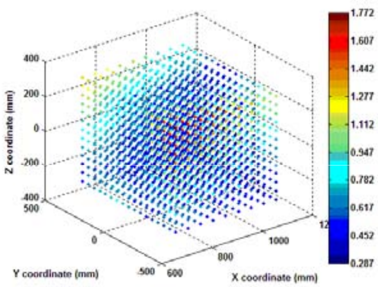
Research Objective: To Reduce the time for industry robot calibration by implementing the algorithm in GPGPUs.

Introduction

●Ideally, a robot arm should move to an exact location.

●Bias errors cause the final position to be different

●The object of calibration is eliminate these errors.

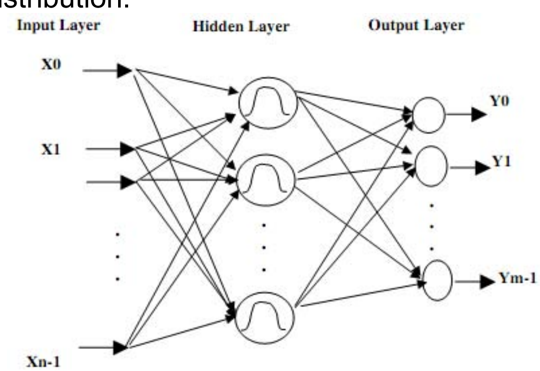


● Errors on xyz-dimension.

● The colors represent the magnitude of error.

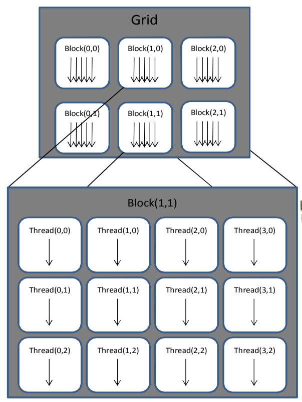
Methodology

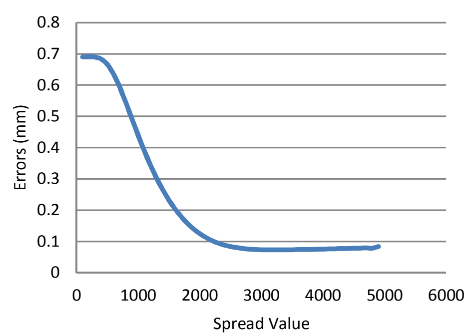
Radial Basis Function Neural Networks (RBFNN) are good at predict this kind of distribution.



● The output of the hidden layer of RBFNN is determined by Euler distance between the input and the center. The center is determined by real data from measurement

● Parallelize Euler distance matrix operations. Obtain thousands of threads: each data point is one thread





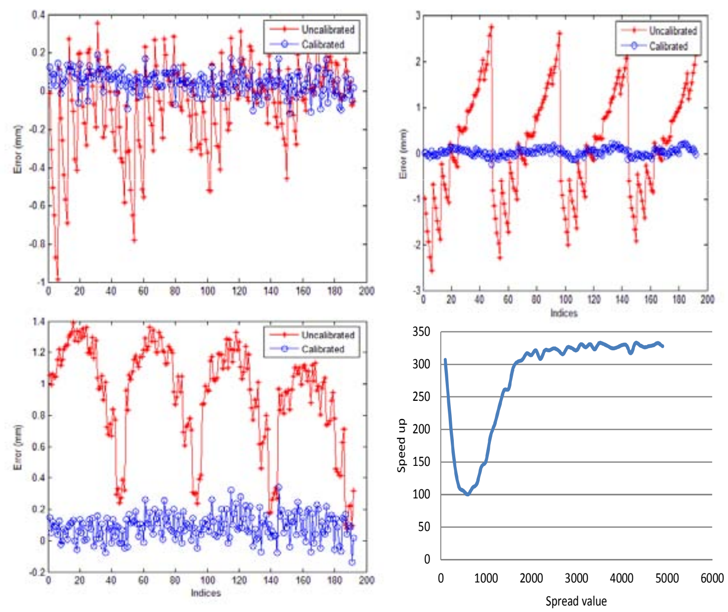
● The learning curve is generated by 7-fold cross validation. We can see that the error decreases with increase of spread values.

● We set the spread value to 3500.

Result

●Red lines: original errors. Blue lines: errors after calibration

●Average error before calibration: 0.71. verage error after calibration: 0.079. Improvement in precision: 88%



● Runtimes:Before (Matlab toolbox based code): **1 week.** After (GPGPU implementation): **10 min.** Final speedup of over 300 X.

Conclusion

●GPGPU based parallelization provides significant speedup.

● This enables more detailed calibration that was not computationally possible earlier.