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Accelerating Robotic Arm Calibration on GPGPUs

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Accelerating Robotic Arm Calibration on GPGPUs

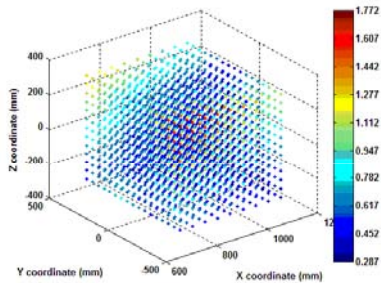
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Research Objective: To Reduce the time for industry robot calibration by implementing the algorithm in GPGPUs.

Introduction

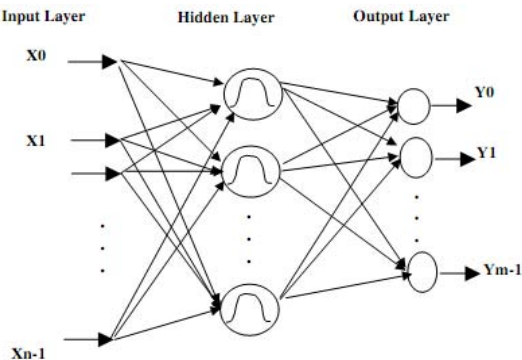
- Ideally, a robot arm should move to an exact location.
- Bias errors cause the final position to be different
- The object of calibration is eliminate these errors.



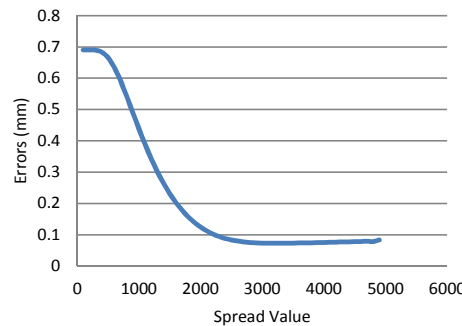
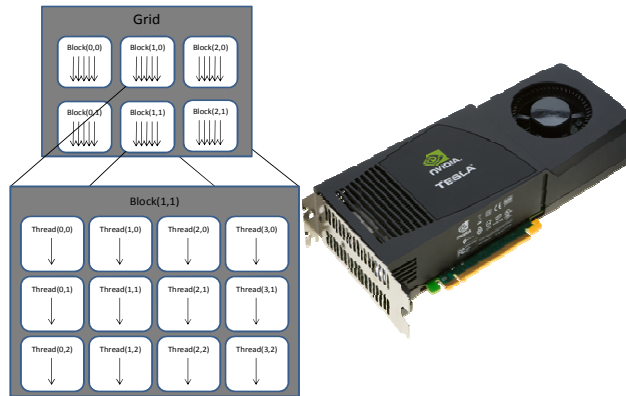
- Errors on xyz-dimension.
- The colors represent the magnitude of error.

Methodology

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



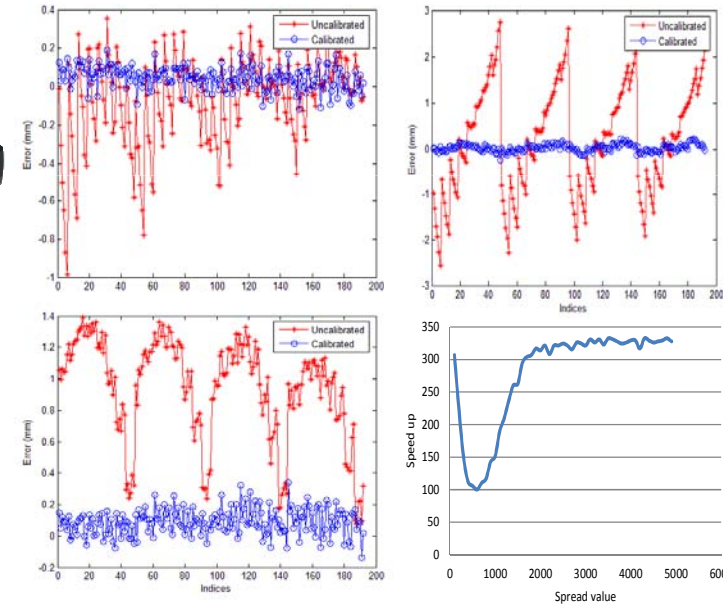
- The output of the hidden layer of RBFNN is determined by Euler distance between the input and the center. The center is determined by real data from measurement
- Parallelize Euler distance matrix operations. Obtain thousands of threads: each data point is one thread



- 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. Average 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.