A Novel Human Machine Interface: Hardware Implementation of the Kalman Filter with Faddeev's Algorithm for Advanced Co-Processing

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This project presents a novel approach to the hardware implementation of the Kalman Filter using Faddeev’s Algorithm for improving the processing speed of an innovative human machine interface (HMI) device using the concepts of 3D vision, support vector machines, and Kalman Filter optimization. The HMI device acts as a touchscreen projection. In the first phase of this project, an HMI device was engineered on the Altera DE2i-150’s mobile Intel Atom processor using the Microsoft Kinect, and was processed using OpenCV and Microsoft’s Kinect SDK libraries. In the second phase, a hardware implementation of the Kalman Filter was presented. A circuit using Faddeev’s algorithm was converted to Verilog code, and was simulated using ModelSim. The experimentation phase presented an extensive comparison between the use of a software and a hardware variant of the Kalman Filter. As the hardware variant uses 32 bit for representing decimals, it is quite known that the accuracy will be lower than the software variant and its floating point representation. Results showed only a 0.4 pixel increase was found between mean displacement, maximum peak, and root-mean-square roughness from using the hardware implementation. Furthermore, only 20000 clock cycles, equivalent to 0.4 milliseconds on the DE2i-150, were used to calculate each optimized state. The results show the effectiveness of a methodology to implement the Kalman Filter with good accuracy and a high speed performance. Real world applications of the device include: improving teaching techniques in education, collaboration in research, work, and business environments, and consumer use for entertainment.

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