Faculty of Electrical Engineering & Computer Science
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# Development of an FGPA-Based Adaptive Control for Selective Laser Melting.

## *ABSTRACT - Masterthesis*

Selective Laser Melting (SLM) is an additive manufacturing technique which allows producing three dimensional metallic parts, using layer by layer fashion. Real-time control of an SLM process is desired but challenging, because of the non-linearity of the process and the high speed requirement. Current SLM systems employ heuristic open-loop controls with constant actuating quantities, which lead to high error rates. Due to its numerous influencing factors, the laser melting process is a very complex process. Due to this complexity, a sufficiently fast closed-loop control system has been realized on Field Programmable Gate Arrays (FPGAs) technology. Although SLM is sometimes applied as an open-loop technique, closed-loop control is mandatory in applications where homogeneous results are required, because the type, size, and geometry of the part being treated influence the process. The inherent no repetitiveness of the technique makes a control of process parameters fast and accurate enough according to the features of the melt pool necessary. The control system has to fulfil three main conditions in these cases. The settling time must be short enough so as to allow small parts to be adequately treated. In addition, it has to be able to adequately respond to heating effects caused by the power applied to the target metallic part. Finally, it has to be fast enough to track complex. The aim of the project is to implement control strategies on FPGA to reduce the error rate and cycle duration. Cycle duration has been reduced using fast response DAC and ADC implementation at high clock frequency i.e. at 40MHZ. According to the results being verified it proves that FPGA is the fastest compare to microcontroller with respect to timing. Whereas FPGA takes only 1.6 micro seconds for data acquisition and data conversion with sampling time of 500ksps and Arduino device takes up to 100 micro seconds for data acquisition and data conversion in Analog to Digital converter. But the complete PID controller is realized on Arduino and results are verified and shows that there is no fluctuation and variation with respect to reference voltage. And error rate is reduced completely in Arduino microcontroller where fluctuation and variation is completely zero. Whereas deviation in FPGA is about 0.3V and this can be overcome by using complete PID controller on FPGA. Also the error rate is verified using Pmod DA4 DAC where the mean error is almost zero compare to R-2R DAC.