Performance modelling of production printers

Canon Océ (www.oce.com) is a world-leading developer of high quality production printers. Such production printers print several hundred thousands of pages per day. Typical applications include on-demand printing of books (e.g. for Amazon) and transaction printing (e.g. for credit-card companies). The behaviour of a production printer emerges from the interaction of complex physical and mechanical aspects.

We want to approximate the productivity of such printers with high-level, fast modelling. Accurately predicting the behaviour without doing time-consuming detailed simulations is a challenging task, essential to obtain feedback during the design process, and to allow the customer to efficiently plan and use the machine.

The duplex loop in the printer (Figure 1) is more than 10 meters long and various requirements on the distance between sheets lead to complicated paper scheduling behaviour. We are also looking at predicting other dimensions of such schedules, such as the print quality and running costs, which also depend on such scheduling decisions. It is not trivial to capture print quality in a good quality measure.

Figure 1: Production printer with large duplex loop

Initial efforts to model the productivity include the work of approximating print time for pattern-based jobs in flow-shops as described by Umar Waqas et. al. [1]. With these models, we can currently predict the average productivity for very long jobs of repeating patterns. In addition to this initial first-principle model, we have also investigated the applicability of some machine learning techniques. This project aims to extend these models to more general cases, such as more complex patterns or even all heterogeneous jobs. We also aim to gain more understanding in the transient phenomena in certain restricted cases.

There are several on-line and off-line possibilities for learning how to abstract the printer behavior. Canon Océ has software to calculate paper schedules and show the behavior of their printers. On the other hand, measurement logging from real printers can also be used to determine typical patterns and even more detailed printer behavior.

Project description

This project will be executed at *Océ Technologies BV in Venlo* under the supervision of the Electronic Systems group of the TU/e, and can start at any moment. We expect you to do the following:

- Learn about the general behaviour of the printer
- Investigate techniques applicable to model production scheduling

- Create abstract models that can efficiently predict (a. o.) productivity, job quality, running cost
- Verify the abstract models' accuracy

Additionally, we would be interested in exploring the following topics, based on the created models:

- Design Space Exploration for printer layouts
- Print-shop scheduling

Skills and knowledge

- Modelling and programming experience
- Understanding complex interactions
- Some affinity with heuristic algorithms and/or machine learning

If you are interested in this topic for an internship or Bachelor or Master project, please contact Joost van Pinxten (j.h.h.v.pinxten@tue.nl) or Marc Geilen (m.c.w.geilen@tue.nl) for more information.

References

[1] U. Waqas, M. Geilen, S. Stuijk, J. van Pinxten, T. Basten, L. Somers and H. Corporaal, "Fast Estimator of Performance with respect to the Design Parameters of Self Re-entrant Flowshops," *Digital Systems Design 2016, Euromicro conference,* 2016.