Study of an automated testing procedure

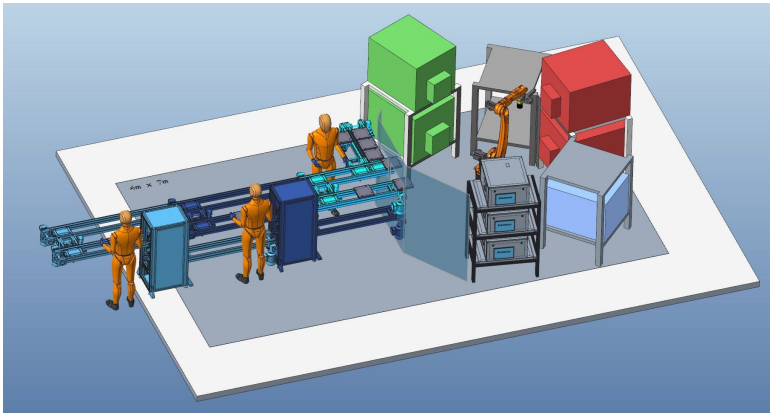

Figure 1: A visualization of the system.

By concretizing the visions of a project team, a concept for an automatic solution for a manual testing procedure was developed. A solution that included automatic error handling and job scheduling, the technique of choosing the right actions at the right time to maximize the efficiency of the system. The developed concept was then used as a base in the development of a program for simulating production sequences, making it possible to evaluate the job scheduling algorithm and estimate the capacity of different system configurations.

During the production of Axis Communications AB's cameras, the optics modules have to do a number of tests and calibrations that are performed in different test stations. The test and calibration sequence differs between different models. This has so far been done manually by having operators move the units between test stations. However, Axis are planning to automate the procedure by having an industrial robot move test units between the different test stations. The essential requirements can be summarized as follows. The throughput of the system and the utilization of the different test stations should be as high as possible. It should be possible to connect and disconnect test stations during production, without interrupting the rest of the system. The system should be able to automatically handle unexpected states, such as test units being moved, having units already within the system upon start up, test stations which break during production etc. The system should handle potential deadlock situations to keep the production running. And finally, relevant data concerning tests, test stations and the flow of production should be stored for traceability reasons and visualized to achieve an overview of the production.

Two concepts were generated. In one concept, called the ID-tag concept, information which is both generated within the system and then needed further down the test sequence of a specific test unit is stored on the test unit itself. This information is thereafter read when the unit arrives to the different subsystems within the system. In the other concept, called the database concept, the generated information is instead stored in a database and thereafter accessed by the different subsystems within the system. It was concluded that both concepts offer similar capabilities, but the ID-tag concept achieved this with a less complex system. However, the project team at Axis was more experienced in working with databases and it was assessed that the lower complexity of the ID-tag concept was not significant enough to overlook the experience of the team. Therefore, the database concept was recommended for a future implementation.

The analysis of job scheduling mainly lead to three different techniques for maximizing the efficiency of the system: a prioritization rule, the A*-algorithm and beam search. The chosen prioritization rule, a rule that selects the test unit which requires the least setup time for the robot and test station tend to but is not guaranteed to maximize the throughput, i.e. how many units that are completed per unit of time. With A* each possible solution is computed and the most efficient one is chosen, guaranteeing an optimal solution but requiring high computational power. Beam search is a combination of these two techniques where the number of solutions to compute in the A* algorithm are decreased by only evaluating the alternatives that scores the best according to the prioritization rule.

In the simulation program, the user specifies the available test stations, occurrence of breakdowns, buffer size, an incoming rate of test units with a given test cycle, test units already placed inside the system upon start up, etc. The simulation program will then run these sequences using the derived prioritization rule as well as specified time durations for tests and the movement of the robot. Once the simulations have completed, the user is presented with relevant data such as total time, throughput utilization factors etc.

This project provides a foundation for a future implementation of the system. The derived system concept can be used as a base for a future system design and the simulation software can be used to evaluate several production capabilities such as, how many test stations of each type that should be used at a certain production rate.

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