

Automatic Part Recognition in Additive Manufacturing with the Help of Artificial Intelligence

(A technical article from 2019, author: M.Sc. Tobias Nickchen, doctoral student at Protiq)



Industrial companies face constant competition. To avoid falling behind, they need to continuously optimize their internal processes. This requires examining every part of the process chain. In this context, the optimization potential in the sub-process of part-to-order assignment was investigated.

Among industrial manufacturing processes, additive manufacturing is a comparatively young, emerging production method. Additive manufacturing offers various advantages over conventional manufacturing processes.

The production costs of a part are largely independent of the quantity to be produced.

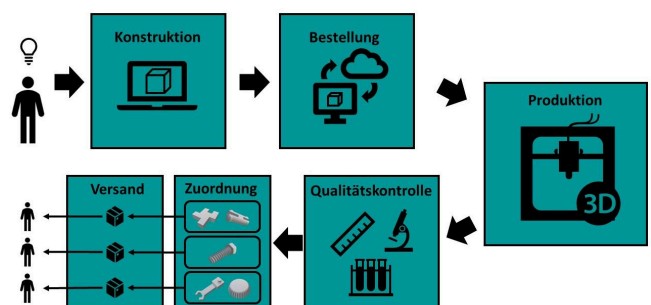
Since no product-specific tools or molds are required for production, even one-off parts can be manufactured cost-effectively.

Furthermore, the low manufacturing constraints result in a high degree of design freedom. The combination of these two positive aspects makes the process ideal for producing custom-made parts or prototypes. This gives private and industrial users alike the opportunity to bring almost any creative idea to life.

Optimizing the Process Chain

To minimize the time from the idea for a part to its delivery to the user, the entire process needs to be optimized. At Protiq GmbH, large parts of the process chain

are already automated. This chain runs from design and the actual production process through quality inspections to the finished part that is delivered to the customer. Production cost calculation based on the part's CAD model, as well as further steps in the digital pre-processing and automated post-processing of the parts, have already been optimized through automation at Protiq GmbH. However, to further minimize the time from the idea to the physical part for the customer, the entire process chain must be examined and optimized. In this context, the process chain section of part assignment following the Selective Laser Sintering (SLS) process was examined more closely.



Selective Laser Sintering

Selective Laser Sintering (SLS) is the most widely used process for the additive manufacturing of plastic parts in industrial production. It is a powder-based process. In a build chamber, plastic powder is applied layer by layer and melted by a laser wherever the part or parts are to be created. Immediately after melting, the material solidifies again into a solid plastic body. By applying the powder layer by layer, a three-dimensional body is built up piece by piece. With SLS, it is possible to produce not just one part in a build chamber but any number of different parts, nested three-dimensionally in space, thus making optimal use of the build chamber. However, this means that after production, the parts produced together must be separated and sorted again. Since doing this manually is very time-consuming, it makes sense to use automation technology methods to simplify the process.



Support from Machine Vision

In the age of Industry 4.0, the automation of production chains using robotics with associated sensors and actuators has long been the standard in many industrial processes. One example of the use of so-called “machine vision” in series production is the conveying and sorting of goods on conveyor belts. Modern camera technology enables objects to be identified automatically, including their respective position and orientation on the conveyor belt. As a result, objects can be picked up and fur-

ther processed automatically by robots without human assistance.

Machine Learning

For machine vision systems to be able to distinguish between different objects automatically, they need information about how they can recognize individual objects and what distinguishes the various objects from one another. These object properties are called features. In series production, the objects to be picked are always the same series parts. This offers the advantage that, when setting up a new production line, the features for distinguishing the individual objects can be generated manually based on the objects. Although this manual feature engineering is relatively laborious and can take days to weeks, it only has to be carried out once per production line. In addition, the machine vision system can be optimally adapted to the objects to be sorted.

However, the SLS process is mostly not used for series production. At service providers such as Protiq GmbH, hundreds of different parts are manufactured anew every day. The conventional approach to commissioning a sorting system is therefore not practical. Daily manual feature engineering to sort the current parts is simply not possible. In order to nevertheless enable automated sorting of the produced parts, approaches from machine learning (ML) must therefore be used.

Deep Learning

The use of machine learning methods is widespread in image processing. One research field within ML is so-called deep learning (DL). The name derives from the use of deep learning systems such as deep neural networks (DNN). These systems are able to learn many nonlinear problems independently on the basis of existing training data. The advantage is that manual feature engineering is no longer necessary. Instead, the system independently learns so-called deep features based on the training data. In the case of sorting, these are learned in such a way that the individual objects can be optimally distinguished by the features.