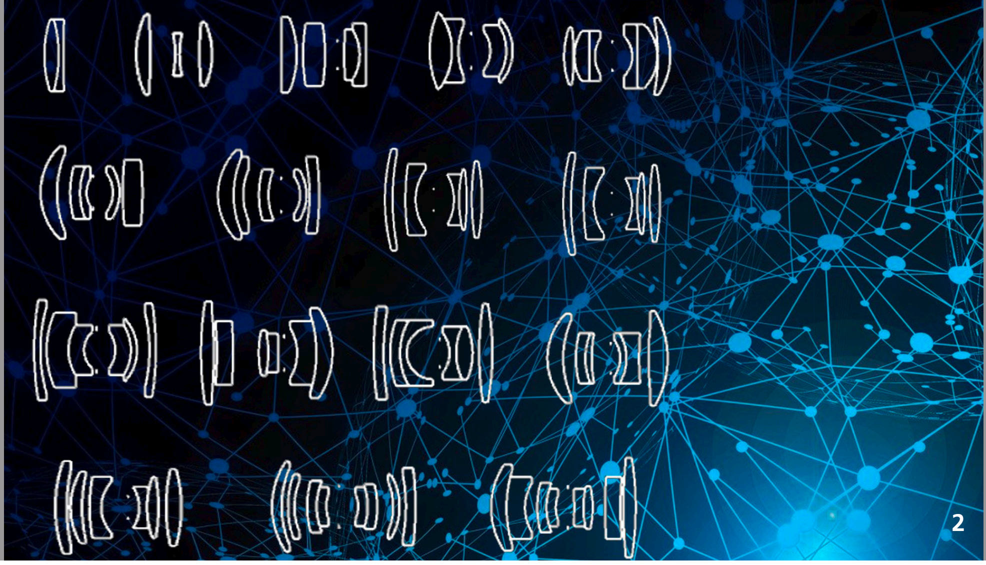

REINFORCEMENT LEARNING FOR AUTOMATED DESIGN OF OPTICAL SYSTEMS

Task

Optical systems are currently designed using ray or wave optical simulation software. The optical system is optimized in terms of required target functions, which results from iterative modifications that the designer makes and the automated optimization of variable parameters. For research purposes, the question now arises whether this design and optimization strategy can be executed by a reinforcement learning approach. In this approach, an agent takes over the task of the optical designer, modifying and optimizing the optical system based on a ray-tracing program.

Method

An agent is trained for different use cases using a reinforcement learning algorithm. By evaluating a target function, which measures the optical aberrations of the system, for example, the agent independently learns the effects that various actions have on the system. In the process, for example, lens radii or the distances between lenses are modified. The agent's goal is to obtain a desired focal length or to minimize the optical aberrations.

Results

In a proof-of-concept, the Chair for Technology of Optical Systems at RWTH Aachen University used a two-lens system to design the lens bending in such a way that the spherical aberration is minimized for the given focal length. A neural network is trained using the proximal policy optimization approach. After a successful training phase, the approach can be used to automatically optimize the two-lens system. In another proof-of-concept, the lens spacings of a three-lens lens are varied to produce a desired target focal length for the optical system. In both examples, the objective function can be achieved within a few seconds.

Applications

The automated design of optical systems can be applied to the development of laser or imaging systems. Such a method is particularly advantageous for agile product development.

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