RESEARCH NEWS

Machine learning for precision medicine

Rapid test to diagnose asthma

Asthma is one of the most common respiratory diseases worldwide, affecting more than 235 million patients. It is often more difficult to diagnose in children than in adults. An early diagnosis is especially important for children as to prevent severe attacks of the disease. A team of researchers at the Fraunhofer Research Institution for Marine Biotechnology and Cell Technology EMB has joined forces with some high-tech companies to develop a rapid test that requires only a drop of blood to diagnose asthma. To do this, the partners use machine learning.

Dyspnoea, shortness of breath and coughing are just a few of the potential symptoms of asthma. Those affected suffer sudden attacks of bronchial constriction. Identifying the disease quickly is crucial, as that is the only way as to lower the threat of asthma attacks, which can even be fatal. It is particularly important to identify the disease early in children in order to quickly intervene and alleviate the symptoms. However, diagnosing children is more complicated and tedious than diagnosing adults. Some of the test methods that entail blowing into a tube cannot be used for small children. Time-consuming lung function tests can only be performed from the age of four or five. To address this issue, Fraunhofer EMB has teamed up with Pattern Recognition Company and Raytrix GmbH in the "KillAsthma" project sponsored by the German federal state of Schleswig-Holstein. A new rapid test is expected to return a finding after just 60 to 90 minutes – and all it requires to diagnose asthma is a drop of blood and the immune cells it contains.

AI-based immune cell analysis

The movement profile of the blood cells of asthmatics differs from that of healthy individuals. "In patients with asthma, the immune cells move much more slowly in the presence of an inflammatory stimulus," explains Dr. Daniel Rapoport, head of the Working Group on Cell Technology at Fraunhofer EMB. The team of researchers draws on this knowledge in developing the test set. The idea is to observe the immune cells in the drop of blood under a specially developed holographic microscope for about 90 minutes and, based on their movement pattern, to assess whether the patient has asthma. The microscope, also referred to as a cell scanner, enables automatic, three-dimensional cell tracking in real time.

Artificial intelligence (AI) plays a key role here, recognizing characteristic patterns in the complex movement patterns of thousands of cells. But how does the technology work

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in detail? The blood and a substance that triggers the inflammatory stimulus are filled into a microfluidic cartridge and then placed in the miniaturized microscope, which comprises an LED and an optical CMOS image sensor that is linked with the computer software. The images are evaluated using specially developed algorithms. "We can observe 2000 to 3000 cells simultaneously, ensuring high statistical precision," says Rapoport. The identified movement patterns are then transferred to a neural network. Self-learning algorithms analyze the blood cell movement patterns and calculate the diagnostic index. "AI lets us identify deviations in the patterns. We use self-learning algorithms to capture these differences. Extensive training data helps the neural networks recognize patterns and distinguish between the profiles of asthma sufferers and healthy individuals."

Extending the method to other diseases

It can be concluded that AI is also capable of learning other deviations from the norm. "Our method can also be used to analyze other diseases. This is especially true for autoimmune and chronic inflammatory diseases such as Crohn's disease, ulcerative colitis and rheumatism. Diagnosing these conditions is a long, tedious process and can be expedited considerably with a tailored rapid test," says the Lübeck-based researcher. "Initial tests have been successfully completed. The image evaluation showed that our holographic microscope is superior to a high-powered microscope." Rapoport and his project partners are currently optimizing the hardware and the method. Their long-term goal is to identify individual manifestations of asthma to enable the development of personalized treatment plans.

Picture 1: The holographic microscope enables automatic, three-dimensional tracking of immune cells in real time.

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