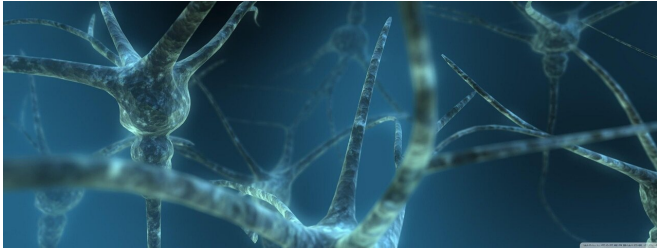# Using AI to diagnose neurological diseases based on motor impairment

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Credit: Pixabay/CC0 Public Domain

The way we move says a lot about the state of our brain. While normal motor behavior points to a healthy brain function, deviations can indicate impairments owing to neurological diseases. The observation and evaluation of movement patterns is therefore part of basic research, and is likewise one of the most important instruments for non-invasive diagnostics in clinical applications. Under the leadership of computer scientist Prof. Dr. Björn Ommer and in collaboration with researchers from Switzerland, a new computer-based approach in this context has been developed at Heidelberg University. As studies inter alia with human test persons have shown, this approach enables the fully automatic recognition of motor impairments and, through their analysis, provides information about the type of the underlying diseases with the aid of artificial intelligence.

For the computer-supported movement analysis, subjects usually have to be tagged with reflective markings or virtual markers have to be applied to the video material produced in the framework of the assessment. Both procedures are comparatively complicated. Furthermore, conspicuous movement behavior has to be known in advance so that it can be further examined. "A real diagnostic tool should not only confirm motor disorders but be able to recognize them in the first place and classify them correctly," explains Prof.

Ommer, who heads the Computer Vision group at the Interdisciplinary Center for Scientific Computing at Heidelberg University.

Precisely that is made possible by the novel diagnostic method developed by his team, and known as "unsupervised behavior analysis and magnification using deep learning" (uBAM). The underlying algorithm is based on machine learning using artificial neural networks and it recognizes independently and fully automatically characteristic behavior and pathological deviations, as the Heidelberg scientist explains. The algorithm determines what body part is affected and functions as a kind of magnifying glass for behavioral patterns by highlighting different types of deviation directly in the video and making them visible. As part of this, the relevant video material is compared with other healthy or likewise impaired subjects. Progress in treating motor disorders can also be documented and analyzed in this way. According to Prof. Ommer, conclusions can also be drawn about the neuronal activity in the brain.

The basis for the uBAM interface is a so-called convolutional neural network, a type of neural network that is used for image recognition and image processing purposes especially. The scientists trained the network to identify similar movement behavior in the case of different subjects, even in spite of great differences in their outward appearance. That is possible because the artificial intelligence can distinguish between posture and appearance. Besides the recognition and quantification of impairments, a detailed analysis of the symptoms is also important. "To study them in detail, we use a generative neural network," says Prof. Ommer. "That way we can help neuroscientists and clinicians focus on subtle deviations in motor behavior that are likely to be overlooked with the naked eye, and make them easily visible by magnifying the deviation. Then we can exactly demarcate the type of disease in the individual case."

The research team has already been able to prove the effectiveness of this new approach with the aid of different animal models and studies with human patients. They tested, inter alia, the precision with which uBAM can differentiate between healthy and impaired motor activity. In their publication on the topic, the scientists report a very high retrieval rate both in mice and human patients. "In all, our study shows that, as compared to conventional methods, the approach based on artificial intelligence delivers more detailed results with significantly less effort," Björn Ommer emphasizes.

With respect to the application, the scientists hope that uBAM will be used both in basic biomedical research and in clinical diagnostics and beyond. Prof. Ommer: "The interface can be applied where traditional methods prove too complicated, tedious, or not efficient enough. Potentially it could lead to a better understanding of neuronal processes in the brain and the development of new therapeutic options."

Besides the Heidelberg researchers working with Prof. Ommer, scientists from the University of Zurich and University Hospital Zurich, Balgrist University Hospital and the Neuroscience Center Zurich were also involved in developing the uBAM interface. Part of the funding for the study came from the German Research Foundation as well as the Branco Weiss Fellowship Society in Science and the Swiss National Foundation. The results were published in the journal *Nature Machine Intelligence*.

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