The following article is an English translation of the original report written by the Yangtze River Monitoring and Scientific Research Centre. The English translation of the original report was done by ZWEEC Analytics and should not be attributed to any other party.

The original report can be found at the following hyperlinks:
https://res.cenews.com.cn/h5/news.html?id=140737
(China Environment News, 29 Dec 2020)
https://cjjg.mee.gov.cn/xwdt/jnyw_1/202012/t20201229_815303.html
(Ministry of Ecology and Environment of The People's Republic of China, 29 Dec 2020)

New Breakthroughs in Automatic Monitoring of Algae, a New Tool to Safeguard Clear Waters

Source: Yangtze River Monitoring and Scientific Research Centre, 29 Dec 2020
Authors: Peng Yu, Wang Ying Cai

After three years of research and development tackling key challenges, new breakthroughs in Artificial Intelligence (AI) recognition and identification of planktonic algae have been achieved at the middle route of the South-to-North Water Diversion Project. This project is led by the Yangtze River Eco-Environmental Supervision Administration and Scientific Research Centre (hereinafter referred to as the Yangtze River Monitoring and Scientific Research Centre), of the Ministry of Ecology and Environment of the People's Republic of China, under the National Water Special "13th Five-Year" Water-Focused Subject Item "South-to-North Water Diversion Mid-line Water Quality Monitoring Critical Technology and Systems Optimisation Technology Project".

This project focuses on fulfilling the actual needs and demand for automatic online monitoring of planktonic algae at the mid-line of the South-to-North Water Diversion Project, where the research on AI recognition and identification of planktonic algae was carried out.

The AI planktonic algae recognition and identification technology has achieved breakthroughs in various aspects, namely fully automated multi-channel algae sampling, auto-focusing, imaging, identification, and computation of planktonic algae. This technology possesses obvious technical advantages which enable fully automated analysis of multiple parameters, such as types of algae, proportions and densities.

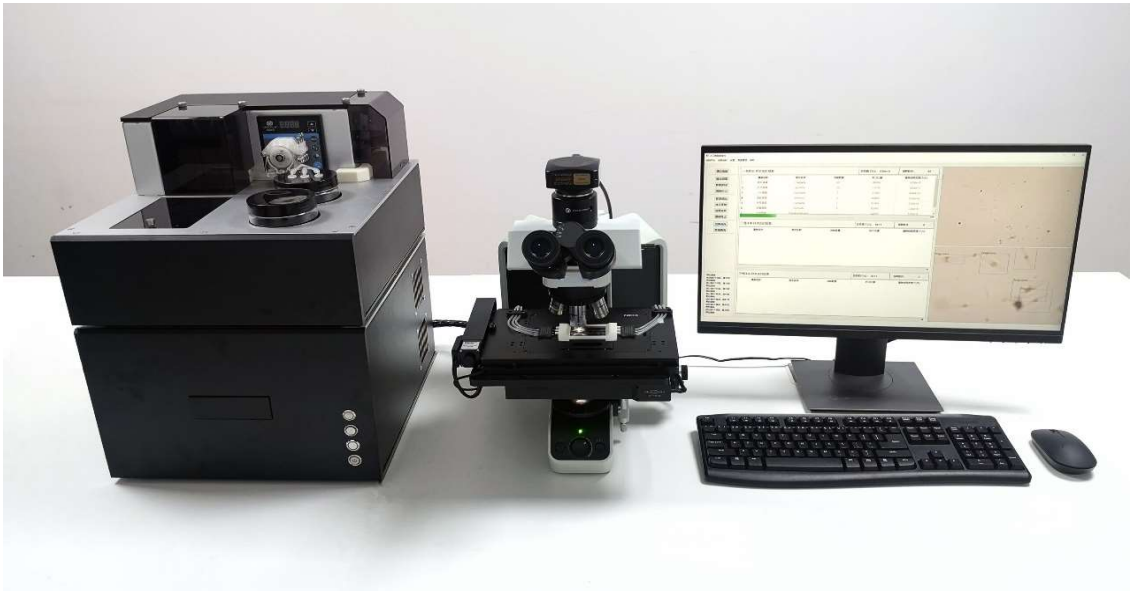

Image 1 shows the AI planktonic algae identification and computation technology

Today, monitoring of planktonic algae in China and other countries is still conducted predominantly by manual inspection, with monitoring equipment largely based on spectroscopy or traditional image recognition algorithms. The traditional methods of algae identification and computation are often prone to detection errors and are thus impractical for usage on large scale. To achieve breakthroughs in the accuracy of algae identification, the Yangtze River Monitoring and Scientific Research Centre established a strategic collaboration with the South-to-North Water Diversion (The Central Route) Engineering Construction Administration Bureau, ZWEEC Environmental Technologies (China) Co., Ltd., as well as relevant departments to spearhead research and development of AI identification of planktonic algae at the middle route of the South-to-North Water Diversion Project, achieving significant progress in technological aspects of automatic sampling, multi-depth-of-field microscopy and image processing, and AI planktonic algae recognition and identification model. This project is supported by the National Water Special “13th Five-Year” Water Focused Subject Item "South-to-North Water Diversion Mid-line Water Quality Monitoring Critical Technology and Systems Optimisation Technology Project”.

The AI planktonic algae identification technology is integrated with a control box and water sample loading device, creatively realising processing 15 units of water samples with automated sampling capabilities for algae recognition and identification procedures. The water sample loading device has an automatic oscillation capability, which ensures uniform injection of algae samples. The technology also has the capability of automated cleaning of pipelines and the multi-channel algae observatory cartridge, which prevents pipeline blockage, thus extending the useful life of the cartridge and pipelines.

Image 2 shows the automatic sampling system of the AI planktonic algae identification and computation technology

The novel microscopic image scanning system, with the cooperation of software and hardware, utilises the multi-channel algae observatory cartridge to photograph and compare test samples at different focal plane depths under the microscope, ensuring that all images at different positions and different forms of planktonic algae in the current field of view are taken, and the clearest individual microscopic images of algae can be screened and processed, which lays the foundation for the subsequent intelligent identification process.

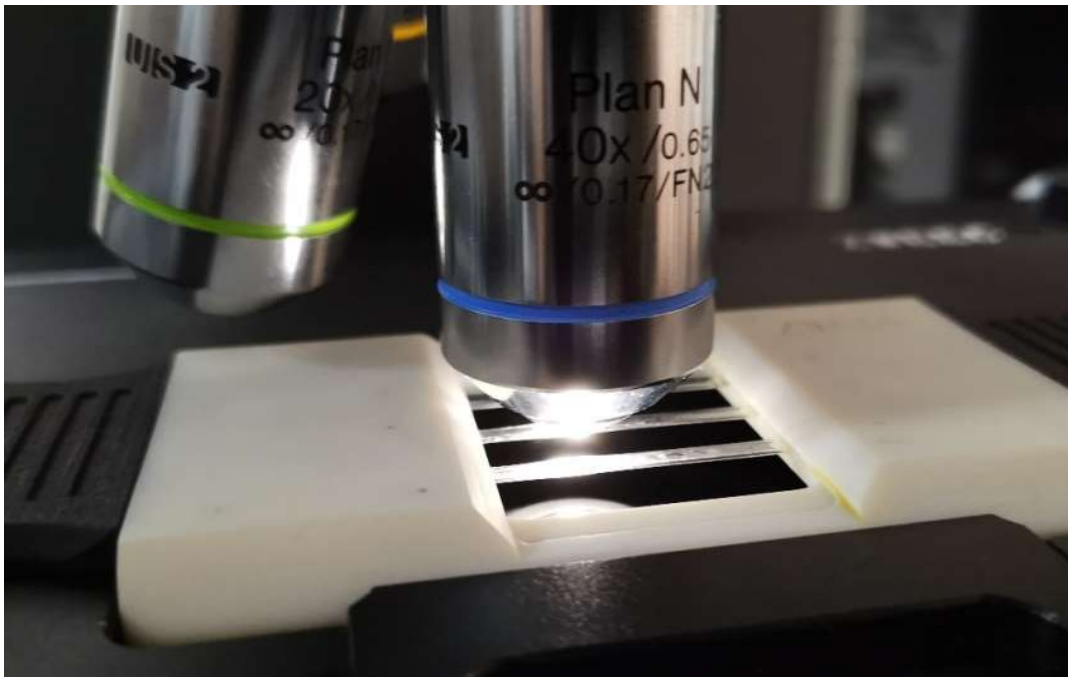

Image 3 shows the novel automated microscopic algae image scanning system of the AI planktonic algae identification and computation technology

The development of the AI software of planktonic algae identification technology is the primary focus and key challenge of this research and development project. Planktonic algae are characterised by diverse species and clusters, wide variety of arrangement patterns, close similarity between different types of species and have complex classification system. Enabling the technology to accurately recognise and identify planktonic algae is an advanced technical challenge at the forefront of the industry. To resolve this technical challenge, the project team spearheaded a targeted approach: Taking the feature detection method based on deep neural network as the core, supplemented by the artificial feature detection method assisted by expert knowledge, thereafter, the final target detection result is generated after the fusion of decision-making layers. After three years of hard work, a standardised library of labelled images has been constructed for the mid-line planktonic algae identification system, and deep learning training and optimisation have been carried out. The intelligent identification of common algae in the main canal of the mid-line of the South-to-North Water Diversion Project has been realised, and it has large-scale promotion and application value.

At present, the research achievements of AI identification of planktonic algae have been patented, and the academic innovation in the field of AI identification of planktonic algae has also been recognised by professional peers globally. The research results have been published at "The 42nd International Medical and Biological Engineering Society Annual Meeting (EMBC 2020) in Year 2020", a key international conference in the field of Artificial Intelligence.

Automatic identification of planktonic algae is an important direction for development of the algae monitoring industry. The AI planktonic algae identification technology can be widely used in the field of ecological and environmental protection in the future. It provides a strong support for lake and reservoir eutrophication monitoring, algae bloom monitoring, early warning as well as prevention and control, alleviating the challenges of shortage of skilled algae monitoring professionals in China. The technology will also gradually expand to applications in the automated monitoring of zooplankton, fish and other aquatic organisms, which will accelerate the development process of China’s automated monitoring of water ecology.

Editor: Sun Hao
Yangtze River Monitoring and Scientific Research Centre

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