MOONSHOT RESEARCH & DEVELOPMENT PROGRAM

Research Topic

(3) Scientific Applications

Progress until the fiscal year 2022

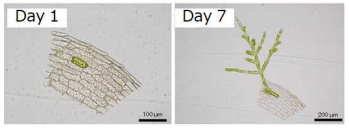
1. Summary

For future social implementation, collaboration with scientists and the application of prototypes of AI-robot scientists are crucial. The project has selected scientific research topics that can greatly benefit from AI and robots.

(1) Bio-stimulants (Uozumi-PI, Arisawa-PI)

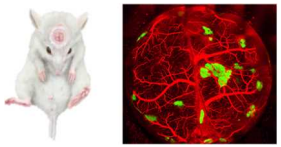
Bio-stimulants, considered as agricultural "medicine" for plants, are anticipated to replace pesticides. AI is utilized to suggest potential organic compound candidates that can serve as effective bio-stimulants. Additionally, experiments are conducted using prototypes of micro-robotic tools to test them, and AI is employed to evaluate the reaction of the stomata to the organic compounds. This method can be widely applicable as a method to measure the electrical characteristics of cells.

(2) Regeneration power of plants (Sato-PI)



Plants possess a remarkable ability for regeneration. By unraveling the mechanisms behind this regenerative capacity, we can make significant contributions toward addressing global food challenges. In this project, AI is used to identify the positions of root cells and track the locations of cells during cell separation. Robots are then employed to collect individual cells one by one. This method has broad applicability, including gene expression analysis of cells in both animals and plants.

(3) Mechanisms of intractable diseases (Takebe-PI)



There are unknown diseases with high fatality rates that pose challenges for modern medicine. However, by harnessing organoids, commonly referred to as mini-organs, we can research these enigmatic conditions. AI is leveraged to detect subtle changes in organoids, and a robot selectively collects cells from regions exhibiting these changes. Furthermore, research focuses on enabling robots to autonomously execute microscopic manipulations, ensuring precise experimentation with limited samples.

2. Progress

As an example, a method has been developed where AI identifies promising compound candidates from literature and compound structure data. A robot performs precise experiments to create and evaluate these candidate compounds, while AI observes the degree of aperture in the microscopic structures called stomata (Fig. 1).

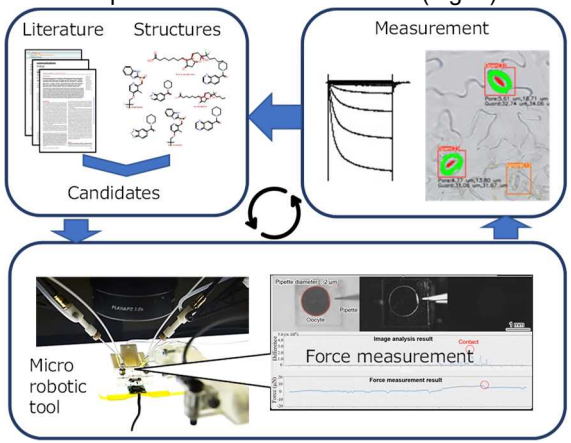


Fig.1 Automated exploration of bio-stimulant candidates

Furthermore, a method has been developed to accurately identify root cells using AI, simulate the position of each cell during separation, and control a micro-robotic tool to collect them (Fig. 2). This enables the correlation of the original cell locations with the analysis of the collected cells.

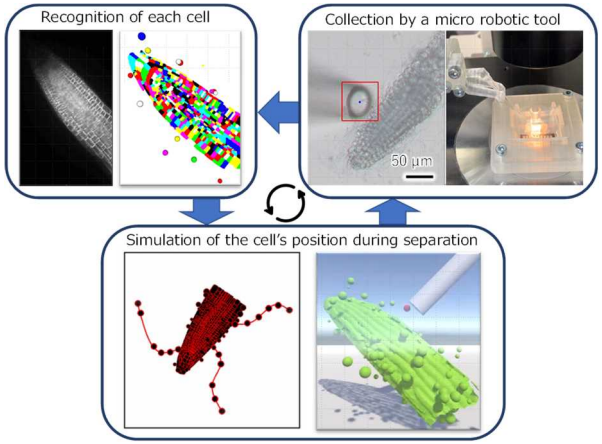


Fig.2 Single-cell collection for gene expression analysis

3. Future work

We have begun applying prototypes of AI-robot technologies using real objects and data encountered in actual scientific exploration. It is essential for future societal implementation to conduct advanced research on AI-robot technologies while understanding the challenges of real scientific exploration. Moving forward, we will continue to apply the progress of research and development in AI-robots to examples of scientific exploration. Our aim is to demonstrate new discoveries achieved by AI-robots conducting experiments that were previously beyond the capabilities of human scientists.

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