Automated Column Chromatography Using Open Hardware: Applications in Past Climate Reconstruction

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Organic biomarker analysis has been an essential tool for reconstructing the evolution of Earth's climate, such as the last ice age. However, accurate reconstruction of Earth's temperatures using biomarkers is a tedious procedure that requires isolating organic fossil molecules of different polarities, known as column chromatography, to prevent co-elution when measured on Gas chromatography-flame ionization detection. These manual lab practices not only require extensive use of toxic chemicals with health hazards but are also time-consuming, significantly limiting scientists' ability to reconstruct past climate changes. To overcome this challenge, we developed a prototype to automate the "columning" procedure. This machine consists of nine components. The first component is the embedded system, which can control nine stepper motors: four periscopic pumps, three carousels, and two linear actuators. Each periscopic pump is used for contactless transference of compounds. The first carousel is used for sample delivery. The second carousel carries a column that allows for each compound to be separated. The third carousel collects compounds of different polarities. The machine is programmable through Python and can be adjusted based on the different chemical compounds used in various procedures.

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