Design of a Low-Cost in situ Gas Exchange System for CO2 Assimilation and Photosynthesis Measurements

Chana, Naveera (School: Tesseract Homeschool)

This project designed a cost efficient system to measure the CO2 assimilation and calculate photosynthetic rate of different outdoor plants. The air pump, flow meter, leaf chamber, reference and sample cells were connected via silicone tubes. CO2 sensors, a flow sensor, temperature and humidity sensors, and a motor control chip were connected to the microcomputer. A leaf was placed in a sealed leaf chamber and the CO2 levels, flow rate, temperature and humidity were measured in regular intervals. Net photosynthesis is calculated using both the reference and sample CO2 levels, as well as the leaf area and flow rate. Testing between the prototype and the commercial system showed that the prototype could easily be calibrated against the commercial system's reference CO2 and could easily track changes in the commercial system's reference CO2 level. Comparable photosynthetic rates were also obtained with the prototype and commercial systems when simultaneously measuring leaves of the same plant. The measurements taken of outdoor plants in situ were found to be comparable to the results obtained in previous literature. Weather conditions such as rain, cloud cover, and amount of sunlight were found to influence the photosynthetic rate. The final prototype was less than the price of a low end laptop and met all of the required design criteria to measure the photosynthetic rate. The design could be adapted to measure insect respiration, soil flux, and photosynthesis in fruit and stems. The results can be easily replicated and the prototype can be improved by the open source hardware community.

Awards Won: