technische universität dortmund

computer science 12

Bachelor/Master Thesis

Construction of a Low-Cost Spectral Sensor

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Spectral sensors have various applications in natural sciences, as for instance in plant science, in order to identify conditions of plant leafs by their spectral reflection. Commercial spectral sensing devices, however, are extremely costly, which limits a permanent and automated usage of these sensors. In consequence, high amounts of manpower need to be invested in order to conduct measurements.

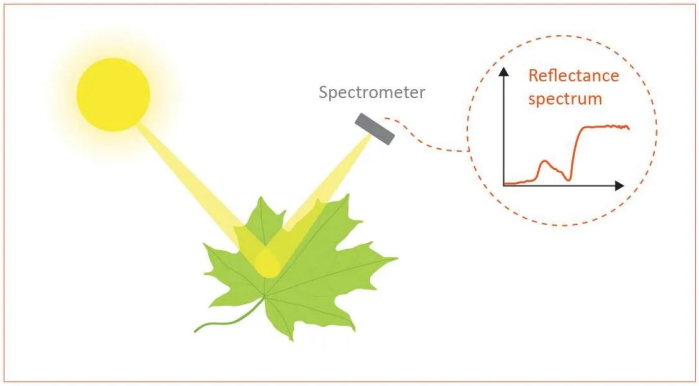

Figure 1: Spectral Sensing Illustration (https://www.specim.com/wp-content/uploads/2023/03/Spectral-sensor-2-1-600x340.jpg)

The basic required electronic components (i.e. full spectrum LEDs, spectral sensor ICs and microcontrollers) are relatively cheap to acquire, even though the precision may not be able to compete with commercial sensor solutions. This motivates us to construct a low-cost spectral sensor from the basic components. Even though the precision is lower, this sensor can be easily and cheaply reproduced and permanently attached to different leafs of a plant. This allows automatic recording of sensor values on short time intervals (e.g. every minute), which promises to compensate the loss in precision.

The construction of the sensor will cover 3 main areas. First, a microcontroller has to be programmed in a way, that it can drive the LEDs and read out the sensor values. The microcontroller further should be implemented to commit the recorded sensor data to a measurement database over Wi-Fi. In the second are, the circuit for driving the LEDs and reading the spectral sensor has to be designed and laid out on a PCB, such that the electronic components can be integrated on a small scale. In the last area, a case for the sensor has to be designed by 3D printing. The case should isolate the sensor from any other light disturbance. Furthermore, the case should integrate one sensor and LED on the same side, in order to record the reflection of the light of a leaf. In addition, one LED should be placed on the opposite side of the sensor in order to record the transfection of the light. Finally, the case should be designed mechanically movable by a servo engine, such that it can be attached to a leaf for conducting a measurement and detached afterwards automatically.

In this thesis, students should get familiar with the basic required concepts first. This includes the programming of the considered microcontroller, especially including the Wi-Fi communication. Students should get familiar with the electronic characteristics of the LED and the sensor and get familiar with the circuit and PCB design required. Students should then get familiar with 3D printing and how to design the required case. After getting familiar with the basic background, students should build a working spectral sensor, including all mentioned areas. The sensor should finally be intensively tested and software should be adopted to serve for automation purposes.

Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.

Required Skills:

- Knowledgeable of C and C++ programming
- Experience in electronics and circuit design