CO2 sensor data

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***Abstract*—Cultivating plants is necessary for survival. Monitoring the plant environment can help optimize plant growth. For this one can use a CO2 sensor, in order to get an idea off how much(good) photosynthesis is going on inside the plant. We will set up a CO2 sensor to read data.**

I. Introduction

The human population is getting to large for traditional farming to feed everyone. In order to avoid food shortages we must either change what we eat or find new better ways of making food so that we can meet these new demands. If not, we will face a big problem and many may very well die of starvation.

One way of solving this problem is to optimize plant growth. The concept is to construct the ideal growing conditions for the chosen plant. This will include perfect lighting, temperature, humidity and amount of watering. The growing environment also has to be clean and sheltered. This will hopefully enable us to produce even more food than today and prevent wasting as much food and energy as we do today. It will also make the negative effects from global warming considerably smaller.

The idea is nice, but there is a problem. How do you decide what is perfect lighting conditions, or perfect anything? It depends on what algorithm one chooses to apply for optimization, but it also depends on the data that gets fed into the algorithm. So noisy or corrupted data could end up negating the optimization process. If every major country adopted this plan, corrupted data could cause starvation in the worst cases.

We have chosen to use a CO2 sensor to measure the photosynthesis in plants. This will give an impression off the well being of the plants. The CO2 sensor we chose for this project is the Telaire T6613 sensor. It is used for many different industrial purposes, such as heating equipment or ventilation.

II. The problem

We need to find a way to measure significant data in a way so that we get the foundation to optimize plant growth. Among all the data we could collect there are some more important than others. To find out what is interesting to measure we look at maybe the most important process in plants, the photosynthesis. We see that plants uses water and CO2 to produce O2 and glucose with light(energy) as a catalyst [10]. It is shown that plants are quite good at regulating its own use of water, it is also hard to measure exactly how much water is being used. CO2 is something we could try and measure to get an idea of how many times this process is conducted. High amount of CO2 in the atmosphere could mean low photosynthesis and little plant growth. It is necessary to have a benchmark, samples taken from thousands of different farms could make up some statistics that could give us a benchmark. The problem undertaken in this paper is the process of actually setting up a sensor and read CO2 measurements.

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III. My idea

In this paper the focus is on collecting CO2 data with a CO2 sensor called Telaire T6613. The system will consist off a pc, arduino and a Telaire T6613. A generic PC with USB port and support for Arduino IDE is enough. Several arduino are capable of this task, the one chosen in this project is the "Arduino Due" [6]. It has both a native and a programming port and for this project we have exclusively used the programming port.

5v on arduino connected to pin1 on T6613 and ground on arduino to pin12 on T6613. Communication between T6613 and the arduino is connected on pin $10 -> $ RX1 19 and pin $11 -> 4$ TX1 18 respectively. The Telaire T6613 sensor was chosen because of its accuracy and because it's reliable. It is reliant on air moving trough it to make accurate readings since it is based on a sample process called "flow through sampling " [3]. This is a drawback and called for some assistance for reading data.

Since the arduino IDE has a plot feature we did not print the data, but simply used the plot feature to plot the data [7].

IV. Related work

russelcrowe [1] tried to make a similar setup with a different sensor, the MQ 135 [9] which is somewhat cheaper and is not CO2 specific. It is clear that the MQ 135 is not as well suited for measuring CO2 as the Telaire T6613 [2].

Another which used the Telaire T6613 is co2meters [8]. They chose another Arduino for their project and chose not to plot the data, but succeeded in their project. They had some

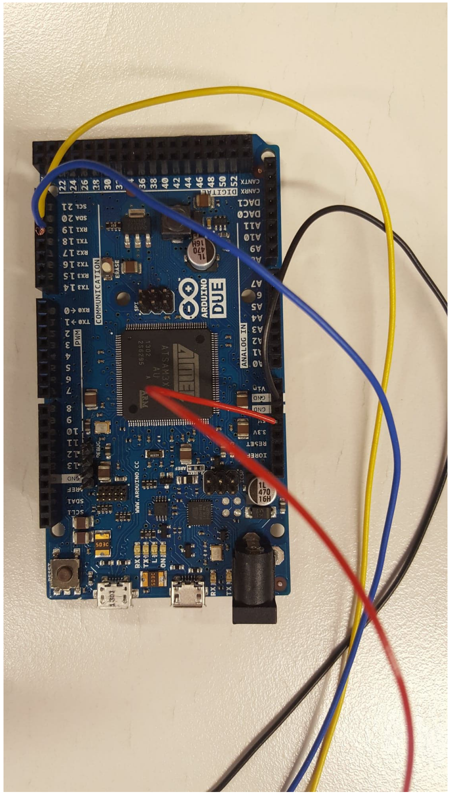

Fig. 1. The Arduino Due with wires connected.

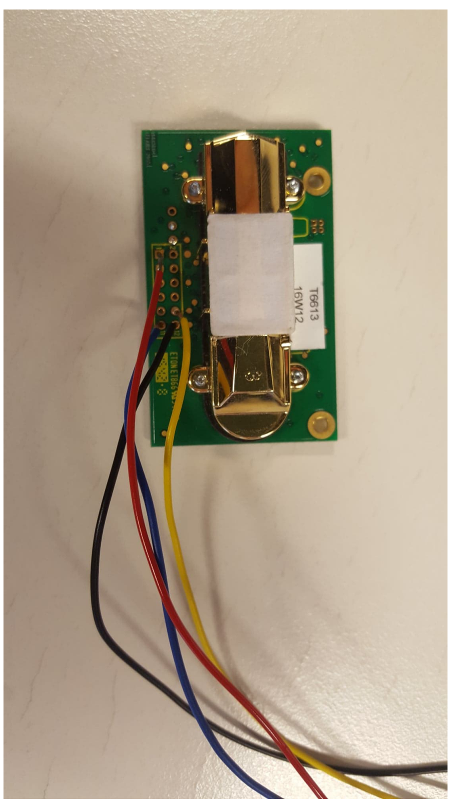

Fig. 2. The Telaire T6613 sensor with wires connected.

helpful instructions on how to connect the arduino to the T6613.
Bjrnar prytz [5] also had some helpful tips in his metathesis. He describes his setup in a straightforwardly way. His code was helpful even though it was a bit more complex since it had to include some extra features.

V. Conclusions and further work

The Telaire T6613 sensor reads fine, but need some assisting component that secure a consistent flow of air trough the sensor. Besides that and some communication errors in the start [4] the setup worked fine. The sensor communicated successfully with the arduino and the arduino communicated successfully with the pc. The arduino IDE successfully displayed CO2 data as a plot over time. The amount of CO2 was shown in ppm on the y-axis. Readings stopped if the flow of air was not rapid enough.
Future wok will consist of constructing the apparatus for growing plants and implementing an algorithm for utilizing the data collected by the Telaire T6613. This will include a fan for consistent flow of air since consistent readings is key for the project to work. The algorithm could for example adjust the lighting off the plants. This way electricity are not wasted on lighting. Remember that if we have a correct reading on the amount of CO2 consumed by the plants, we could give a good estimate on how much light is needed as a catalyst for plant growth.

Acknowledgment

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References

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[2] Telaire T6613 specs, http://domoticx.com/arduino-co2-sensor-t6613/
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[4] Arduino forum, Arduino due not in sync, https://forum.arduino.cc/index.php?topic=530807.0
[5] Inspirational CO2 reading code from Bjrnar prytz, https://github.com/bjornarprytz/led-action-framework/blob/master/source/arduino/libraries/T66CO2/T66CO2.cpp
[6] Arduino Due official site, https://www.arduino.cc/en/Guide/ArduinoDue
[7] Arduino Due intro, https://www.theengineeringprojects.com/2018/09/introduction-to-arduino-due.html
[8] CO2 reading code inspiration, http://co2meters.com/Documentation/AppNotes/AN157-T6613-Arduino-uart.pdf
[9] mq-135 specs, https://www.waveshare.com/mq-135-gas-sensor.htm
[10] photosynthesis, https://snl.no/fotosyntese

VI. Appendix

Source codefor the Arduino

```
byte readCO2[] = {0xFF, 0XFE,2,2,3};
```

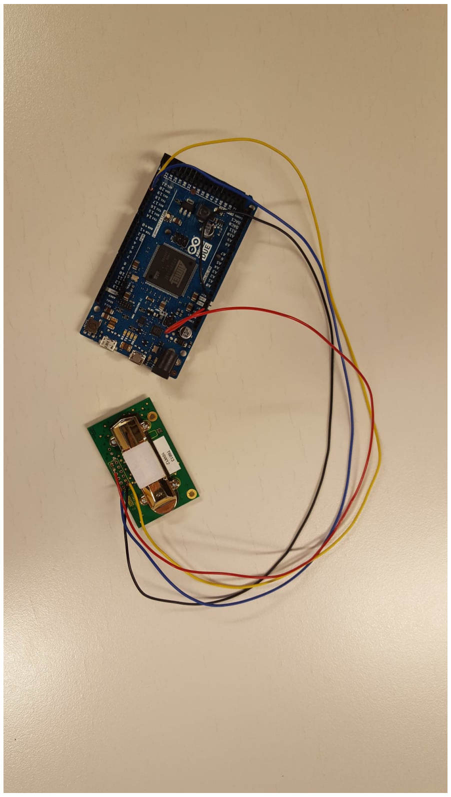

Fig. 3. Picture of the Arduino Due connected to the T6613 sensor.

```
byte response[] = {0,0,0,0,0};
void setup() {

 Serial1.begin(19200);
 Serial.begin(19200);
 Serial.println(" Demo of AN-157 Software Serial and T66 sensor");
 Serial.print("\n");
}
void loop() {
  sendRequest(readCO2);
 unsigned long valCO2 = getValue(response);
 Serial.println(valCO2);
delay(100);
}
void sendRequest(byte packet[])
{
 while(!Serial1.available())
 {
 Serial1.write(readCO2,5);
 delay(100);
 }
 int timeout=0;
 while(Serial1.available() < 5 )
 {
 timeout++;
 if(timeout > 10)
 Serial.print("Timeout");
{
while(Serial1.available())
Serial1.read();
break;
}
delay(50);
}
for (int i=0; i < 5; i++){
 response[i] = Serial1.read();
}
}
     unsigned long getValue(byte packet[])
     {
     int high = packet[3];
     int low = packet[4];
     unsigned long val = high*256 + low;
     return val;
     }
```