Date: 23/04/2024

1. **AIRFLOW SENSOR EXPERIMENT**

**1.1 EXPERIEMNT CONTEXT**

Mushroom growth is the backbone behind making forecast over mushroom yield. Several environmental factors like air temperature, relative humidity, compost temperature and so on are factors that effect this growth. Measuring air flow-one of the environmental factors- near the mushrooms is advantageous since mushroom growth depends on availability of air. Lack of air or excess of air contributes to mushroom density alongside its cap and stalk growth. Therefore, while collecting data over mushroom growth over time, air flow surrounding the mushrooms is taken under consideration. It is o9ijnbserved in the LMF farm that during pin set and growing phase mushrooms need more air than that of harvesting phase.

**1.2 AIM**

The objective behind the experiment is to

1. Select a suitable airflow sensor that can measure subtle airflow precisely
2. Establishing connection with computer
3. Reading data from the sensor
4. Evaluating the trustworthiness of the reading received from the sensor
5. Integrating the sensor with other environmental sensors

**1.3 EQUIPMENT USED**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Airflow sensor** | | | | | |
| **id** | **Sensor name** | **Type** | **Specification** | **Result** | **Comment** |
| 1 | D6F-02L2-000  (¬£99) | Volumetric flow  (thermopile based MEMS sensor) | 0- 10m/s; 20x62x20m  Resolution: +- 3FS | Acceptable | Might not be the first option to choose for the task .  *Low data risk* |
| 2 | FS3000-1015  (¬£49) | Flow velocity  (thermopile based MEMS sensor) | 0-15m/s;  20x22x5m  Resolution 0.05m/s | Satisfactory | OK for the task.  *No data risk* |
| 3 | Anemometer (Aicevoos H12)  (¬£40) | Tactile flow velocity  (electro-mechanical sensor) | 0-45 m/s; 165 x 66 x 38 mm; digital meter | Satisfactory | OK for the task  *No data risk* |

Three sensors listed above have been tested and compared with each other to finalise a suitable option to measure air flow.

Issues faced and fixed over D6F-02L2-000:

1. The sensor will not give desired reading unless and until it is properly connected according to its specified pin connection and communication protocol e.g. serial communication through analogue line.
2. It gives precise reading when the sensor head is placed in the direction of air flow
3. The sensor has calibrated voltage vs airflow conversion table what is required to have reading in terms of L/m. To get precise reading interpolation had to be made over the table.

Issues faced and fixed over FS 3000:

1. The sensor uses I2C protocol. Managing the wire length and pin connection took a bit of time to fix
2. The sensor does not work well on low baud rate so the baud rate was set to 219800

Aicevoos H12, anemometer was a compact meter that was used to evaluate air flow and it can be used as a sensor for air flow measurement.

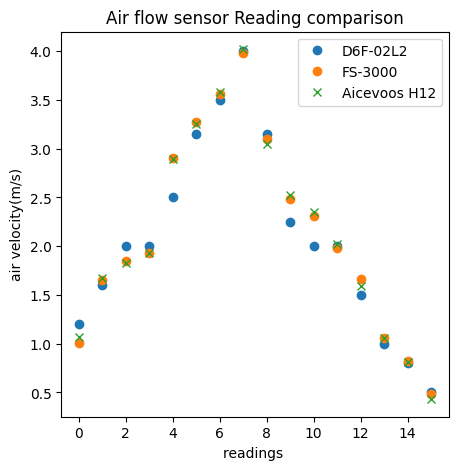
**1.4 RESULTS**

D6F, FS3000 and anemometer were tested with respect to a control air flow (a tiny regulated fan) and fresh outdoor. With regulated fan, each sensor reading were taken individually , once at a time, with a set of predefined voltage imposed to the fan. While being outdoor all three sensors’ readings were registered together placing side by side. It was made sure that the sensor head is in the direction of air flow. Once test period was over, all data were tabulated.

**1.4.1 Table of comparison**

|  |  |  |  |
| --- | --- | --- | --- |
| Sensor | **D6F-02L2-000** | **FS3000-1015** | **Anemometer**  (Ground truth) |
| **Reading** (m/s) | |  |  |  | | --- | --- | --- | | 1.2 | 1.01 | 1.07 | | 1.6 | 1.65 | 1.67 | | 2.0 | 1.85 | 1.83 | | 2.0 | 1.93 | 1.93 | | 2.5 | 2.9 | 2.89 | | 3.15 | 3.27 | 3.25 | | 3.50 | 3.56 | 3.58 | | 4.00 | 3.98 | 4.02 |  |  |  |  | | --- | --- | --- | | 3.15 | 3.10 | 3.05 | | 2.5 | 2.48 | 2.52 | | 2.0 | 2.31 | 2.35 | | 2.0 | 1.98 | 2.02 | | 1.5 | 1.66 | 1.59 | | 1.0 | 1.06 | 1.06 | | 0.8 | 0.82 | 0.81 | | 0.5 | 0.48 | 0.43 |  |  |  |  |  | | --- | --- | --- | --- | |  | Subtle air flow (Expected in tunnel) |  | moderate air flow (not expected) | | | |
| **Accuracy** (**%**) | 85 | 97-100 | 100 |

**1.4.2 Graphical comparison**



The above result has been tested both with indoor and outdoor air flow. Anemometer was considered to be the most reliable of all three acting as a ground truth for D6F and FS. D6F reading did not change until there happens to be more than 0.3L/m air flow difference in the flow whereas FS responded very precisely to minute changes and gave closer reading (94-100%) to that of anemometer

One more thing to note, D6F reading was needed to be converted into velocity flow e.g. m/s in order to compare with other sensors unlike FS3000 what gave m/s unit because D6F was giving volumetric flow e.g. L/min. Below is the formula was used in the conversion-

**N** L/min **= ((N/60) \* 0.001 / A)** m/sec

**N** L/min -> **(N/60)** L/sec

(N/60) L/sec -> **(N/60) \* 0.001** m3/sec

A= Cross section(m2) of air flow sensor filter inlet surface

(N/60) \* 0.001 m3/sec -> **((N/60) \* 0.001 / A)** m/sec

**1.5 DISCUSSION AND SELECTION OF SENSOR**

In general, the airflow sensors were subtle and needed to be handled with care. A good wiring without interference in signalling. They needed twisted wiring with short in length which has been handled properly. Baud rate-D6F needed 9600 whereas FS worked on 11520- needs to be adjusted depending on sensor and so is for communication protocols.

As it seems, D6F would not be the best option amongst the three taken under consideration due to its precision adaptation in reading. FS-3000 seems to be perfect for the application to measure the flow so is the anemometer. Anemometer and FS-3000 can be used interchangeably. If a person is ready to take readings for air flow manually holding the anemometer and going close to the sections of the bed throughout the whole shelf, it would be best otherwise, for automatic and repetitive reading taking, FS-3000 would be preferred best

Two important lessons learnt over fixing air flow sensor were, firstly, baud rate needs to be taken care of wisely and secondly, interface wiring needs to be done as per communication protocol

**1.6 CONCLUSION**

Choosing a suitable air flow sensor has been tricky since it is more or less dependent on sensor sensitivity to air and its mechanical and electrical properties what differs from sensor to sensor even batch to batch of a same sensor product, for example FS3000 was claimed to be better than its other varieties or batches.

Performing critical analysis and real-time raw-data-test including field and home environment, FS-3000 gives reliable readings and works smoothly as compared to the anemometer. Nevertheless, as stated above in the discussion section, if manual data-register is considered, [anemometer](https://amzn.eu/d/7TMhZJR) will go first over [FS-3000](https://www.sparkfun.com/products/18768) which seems to be used best in case of automated reading registration.