Sample time:

Our while loop waits for 500ms in every iteration. That means we read the data from sensor every 0.5 sec. So each of the following messages represents 0.5 seconds elapsed.

**Scenario 1: when the system first starts, no inhaling or exhaling, humidity is around 59-61% with slightly decreasing or no-changing.**

restart...

humidity: 61 | temperature: 24 | pressure: 101737

humidity: 61 | temperature: 24 | pressure: 101734

humidity: 60 | temperature: 24 | pressure: 101737

humidity: 60 | temperature: 24 | pressure: 101738

humidity: 60 | temperature: 24 | pressure: 101736

humidity: 60 | temperature: 24 | pressure: 101734

humidity: 60 | temperature: 24 | pressure: 101737

humidity: 59 | temperature: 24 | pressure: 101736

humidity: 59 | temperature: 24 | pressure: 101737

humidity: 59 | temperature: 24 | pressure: 101736

humidity: 59 | temperature: 24 | pressure: 101736

humidity: 59 | temperature: 24 | pressure: 101735

humidity: 59 | temperature: 24 | pressure: 101735

humidity: 59 | temperature: 24 | pressure: 101735

humidity: 59 | temperature: 24 | pressure: 101739

humidity: 59 | temperature: 24 | pressure: 101737

humidity: 59 | temperature: 24 | pressure: 101735

humidity: 59 | temperature: 24 | pressure: 101736

humidity: 59 | temperature: 24 | pressure: 101738

humidity: 59 | temperature: 24 | pressure: 101739

\* end of a cycle \*

**Scenario 2: when an individual is breathing, there must be some increasing in the humidity values. The increasing periods are highlighted below. These are caused by the exhalations. When inhaling, the humidity will slightly decrease. And, when exhaling, the humidity never goes down.**

restart...

humidity: 64 | temperature: 24 | pressure: 101729

humidity: 65 | temperature: 24 | pressure: 101733

humidity: 65 | temperature: 24 | pressure: 101731

humidity: 64 | temperature: 24 | pressure: 101732

humidity: 64 | temperature: 24 | pressure: 101732

humidity: 64 | temperature: 24 | pressure: 101733

humidity: 63 | temperature: 24 | pressure: 101730

humidity: 65 | temperature: 24 | pressure: 101733

humidity: 66 | temperature: 24 | pressure: 101731

humidity: 66 | temperature: 24 | pressure: 101730

humidity: 65 | temperature: 24 | pressure: 101732

humidity: 65 | temperature: 24 | pressure: 101730

humidity: 64 | temperature: 24 | pressure: 101730

humidity: 64 | temperature: 24 | pressure: 101731

humidity: 64 | temperature: 24 | pressure: 101729

humidity: 64 | temperature: 24 | pressure: 101732

humidity: 64 | temperature: 24 | pressure: 101732

humidity: 66 | temperature: 25 | pressure: 101731

humidity: 67 | temperature: 25 | pressure: 101732

humidity: 68 | temperature: 25 | pressure: 101732

\* end of a cycle \*

restart...

**Scenario 3: when an individual stops breathing, the humidity values start falling back to 59-61%, with possibly slight fluctuation. But the increase will never greater than that when exhaling.**

restart...

humidity: 67 | temperature: 25 | pressure: 101726

humidity: 68 | temperature: 25 | pressure: 101724

humidity: 67 | temperature: 25 | pressure: 101724

humidity: 66 | temperature: 25 | pressure: 101722

humidity: 65 | temperature: 25 | pressure: 101724

humidity: 65 | temperature: 25 | pressure: 101726

humidity: 65 | temperature: 25 | pressure: 101722

humidity: 65 | temperature: 25 | pressure: 101723

humidity: 65 | temperature: 25 | pressure: 101723

humidity: 65 | temperature: 25 | pressure: 101722

humidity: 65 | temperature: 25 | pressure: 101723

humidity: 65 | temperature: 25 | pressure: 101724

humidity: 65 | temperature: 25 | pressure: 101723

humidity: 65 | temperature: 25 | pressure: 101720

humidity: 65 | temperature: 25 | pressure: 101722

humidity: 65 | temperature: 25 | pressure: 101722

humidity: 65 | temperature: 25 | pressure: 101723

humidity: 64 | temperature: 25 | pressure: 101722

humidity: 64 | temperature: 25 | pressure: 101723

humidity: 63 | temperature: 25 | pressure: 101719

\* end of a cycle \*

restart...

**Algo1 – Increasing Detection:**

From the observations, we know when we are breathing, there must be inhalations and exhalations. So the humidity goes down and up periodically. And the **exhalation causes greater impact on the humidity** than the inhalation do. So we decide determining whether there is breath by spotting out the exhalation.

We know that when the value goes up for few seconds and the difference accumulates to a certain value, there must be an exhalation. And we know that when we are not breathing, there is no any significant increasing on the humidity or there would be slow decrease or no changing. So this algorithm is to find the **contiguous increasing periods** on the humidity, or say the exhalations.

|  |  |  |
| --- | --- | --- |
|  | Increasing | Decreasing |
| Inhale | N/A | -0.0 ~ -3.0 |
| Exhale | +3.0 ~ +6.0 | N/A |
| Stop | +0.0 ~ +1.0 | Back to normal |

1. Start the measurement cycle
2. Collect the humidity data into a sample buffer
3. Find out whether it is increasing or decreasing by compare current and previous sample
4. If in an increasing period, calculate the **deltas (sample[curr]-sample[prev])**

Add them up, because we have to capture the **accumulated deltas**

Typically, when they sum to 3.0 increasing, means that the person is exhaling

Then reset the timer, because there is a breathing

1. If in a decreasing period, we zero the accumulated increasing

(because we use it to spot out the exhalations, there is no exhalation in decreasing period)

1. Increment the timer, when it goes to 10s, means there is no exhalation (breathing) for 10s.
2. Stop the measurement cycle

The highlighted messages are the increasing period.

restart...

time: 0 | humidity: 64 | temperature: 25 | pressure: 101759 -> exhaling...

time: 1 | humidity: 66 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 66 | temperature: 25 | pressure: 101760

time: 2 | humidity: 65 | temperature: 25 | pressure: 101759

time: 3 | humidity: 64 | temperature: 25 | pressure: 101761

time: 4 | humidity: 67 | temperature: 25 | pressure: 101758 -> exhaling...

time: 1 | humidity: 69 | temperature: 25 | pressure: 101758 -> exhaling...

time: 1 | humidity: 70 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 69 | temperature: 25 | pressure: 101759

time: 2 | humidity: 68 | temperature: 25 | pressure: 101758

time: 3 | humidity: 66 | temperature: 25 | pressure: 101761

time: 4 | humidity: 66 | temperature: 25 | pressure: 101759

time: 5 | humidity: 67 | temperature: 25 | pressure: 101759

time: 6 | humidity: 69 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 70 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 70 | temperature: 25 | pressure: 101759 -> exhaling...

time: 1 | humidity: 70 | temperature: 25 | pressure: 101762

time: 2 | humidity: 69 | temperature: 25 | pressure: 101760

time: 3 | humidity: 67 | temperature: 25 | pressure: 101758

time: 4 | humidity: 66 | temperature: 25 | pressure: 101759

time: 5 | humidity: 68 | temperature: 25 | pressure: 101759

time: 6 | humidity: 70 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 72 | temperature: 25 | pressure: 101764 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101763

time: 2 | humidity: 69 | temperature: 25 | pressure: 101759

time: 3 | humidity: 68 | temperature: 25 | pressure: 101760

time: 4 | humidity: 67 | temperature: 25 | pressure: 101760

time: 5 | humidity: 69 | temperature: 25 | pressure: 101761

time: 6 | humidity: 70 | temperature: 25 | pressure: 101759 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 70 | temperature: 25 | pressure: 101760

time: 2 | humidity: 68 | temperature: 25 | pressure: 101761

time: 3 | humidity: 67 | temperature: 25 | pressure: 101759

time: 4 | humidity: 67 | temperature: 25 | pressure: 101760

time: 5 | humidity: 70 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101758 -> exhaling...

time: 1 | humidity: 72 | temperature: 25 | pressure: 101759 -> exhaling...

time: 1 | humidity: 73 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101758

time: 2 | humidity: 70 | temperature: 25 | pressure: 101760

time: 3 | humidity: 68 | temperature: 25 | pressure: 101760

time: 4 | humidity: 68 | temperature: 25 | pressure: 101763

time: 5 | humidity: 71 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 73 | temperature: 25 | pressure: 101762 -> exhaling...

time: 1 | humidity: 73 | temperature: 25 | pressure: 101762 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101760

time: 2 | humidity: 69 | temperature: 25 | pressure: 101762

time: 3 | humidity: 68 | temperature: 25 | pressure: 101762

time: 4 | humidity: 68 | temperature: 25 | pressure: 101761

time: 5 | humidity: 71 | temperature: 25 | pressure: 101762 -> exhaling...

time: 1 | humidity: 72 | temperature: 25 | pressure: 101760 -> exhaling...

time: 1 | humidity: 72 | temperature: 25 | pressure: 101761 -> exhaling...

time: 1 | humidity: 71 | temperature: 25 | pressure: 101760

time: 2 | humidity: 68 | temperature: 25 | pressure: 101761

time: 3 | humidity: 66 | temperature: 25 | pressure: 101762

time: 4 | humidity: 65 | temperature: 25 | pressure: 101759

time: 5 | humidity: 65 | temperature: 25 | pressure: 101762

time: 6 | humidity: 65 | temperature: 25 | pressure: 101762

time: 7 | humidity: 64 | temperature: 25 | pressure: 101762

time: 8 | humidity: 64 | temperature: 25 | pressure: 101764

time: 9 | humidity: 63 | temperature: 25 | pressure: 101763

time: 10 | humidity: 63 | temperature: 25 | pressure: 101765

time: 11 | humidity: 62 | temperature: 25 | pressure: 101761

time: 12 | humidity: 62 | temperature: 25 | pressure: 101760

time: 13 | humidity: 62 | temperature: 25 | pressure: 101764

time: 14 | humidity: 62 | temperature: 25 | pressure: 101763

time: 15 | humidity: 62 | temperature: 25 | pressure: 101765

time: 16 | humidity: 62 | temperature: 25 | pressure: 101766

time: 17 | humidity: 61 | temperature: 25 | pressure: 101763

time: 18 | humidity: 61 | temperature: 25 | pressure: 101765

time: 19 | humidity: 60 | temperature: 25 | pressure: 101764

stop breathing for 10s!

\* end of a cycle \*

restart...

time: 0 | humidity: 59 | temperature: 25 | pressure: 101763

**Algo2 – Decreasing and No-Changing Detection:**

From Scenario 1 and Scenario 3, we found that when the person is not breathing. The humidity either remains the same as initial value or constantly decreases. That is, we can use this as a start condition of 10 seconds counting.

1. When power on, the system runs **5 seconds** to sample the **initial value (IV)** and store the value in a variable.
2. The humidity fluctuates in the range between **IV-2** and **IV+2**. When the fluctuation is in the range, we consider this as no breathing, so the timer starts to count (or keeps counting).
3. When the value falls out of the range, we stop and reset the timer.
4. Another counting condition is **when the value goes down** (or fluctuates between -1 and +1), the timer starts to count.
5. Until the timer reaches 10 sec, it triggers an alert.