Powder flow rate tracking - Software Documentation

Table of Contents

[2 Key Features 2](#_Toc145344956)

[3 User Guide 2](#_Toc145344957)

[3.1 User Interface Overview 2](#_Toc145344958)

[4 Technical Specifications 4](#_Toc145344959)

[4.1 Data acquisition pathway 4](#_Toc145344960)

[4.2 Data processing 4](#_Toc145344961)

# Key Features

The key features and functionalities of the software are described in **Table 2**:

Table 2

|  |  |
| --- | --- |
| **Features** | **Description** |
| **Data simulation** | 1. Automatic generation of scale weight measurement data for two scales representing the drop in weight for powder feeder 1 and 2. |
| **Settings for data processing** | 1. Settings for the processing of the data can be adapted by the user. |
| **Data processing and live data visualisation** | 1. The data obtained by the software is processed using several filter methods before the powder flow rate is calculated. 2. Plots of live data help the operator track the powder flow rate during the spray. |
| **Saving of raw data** | 1. The raw scale weight data generated during the cold spray operation can be saved in the form of a csv file. |

# User Guide

## User Interface Overview

The dashboard is divided into two main windows. In the top window the user can select the filter settings **(1)**, and the powder feeders in use **(2)**. The data recording can be started and stopped using the respective buttons (Start and Stop). Previous data recording can be deleted using the Reset button **(3)**. Raw data can be saved clicking the “Save” button **(4)**. In the bottom window the powder flow rate is displayed live in the form of a scatterplot, where the y-axis (vertical) represents the powder flow rate in kg/hr and the x-axis (horizontal) represents the time represented in seconds **(5), (6)**. **Figure 1** shows the software interface. **Figure 2** shows the live powder feeder flow rate as a scatterplot.

A screenshot of a computer

Description automatically generated

Figure : Powder flow rate tracking software interface

A graph showing a number of powder flow rate

Description automatically generated

Figure 2: Live powder feeder flow rate - scatter plot.

# Technical Specifications

## Data acquisition pathway

In the present version the program uses simulated scale weight data that represent the weight of powder in two powder feeders used for cold spray additive manufacturing The start weight for powder feeder 1 is set to 3 kg and the start weight for powder feeder 2 is set to 4 kg. The program adjusts the respective starting weight iteratively by subtracting a random number within the range (-0.0001 kg to 0.0003 kg), creating variations in the generated values. The negative value of -0.0001 kg is selected to simulate erroneous scale weight readings. For each reading a time stamp is taken by the software.

## Data processing

Incoming data consists of the two scale weight readings for powder feeder 1 and 2 and the time stamp taken for each reading. The timestamp values are converted into a formatted string representing the time in the "hour:minute:second" format (e.g., "14:30:45"). Each data point is saved in an array.

Before the powder flow rate is calculated the incoming raw data arrays are processed using several filter methods:

1. Raw data filter

**First raw data filter:** Data array is filtered out if:

1. The difference between previous reading and current reading for a selected scale weight (1, 2 or 1+2) is smaller than 0.
2. The current reading for a selected scale weight is smaller than 0.
3. The time stamps of the previous reading and current reading are the same.

**Second raw data filter:**

Based on a user-selected **Window size** **NR** the average and standard deviation of the last NR recorded scale weight values are calculated. The calculated standard deviation is weighted with a user-defined **Standard deviation factor.** If the difference between the calculated average of the last NR scale weight readings and the current weight scale reading exceeds the weighted standard deviation, the current scale weight reading is discarded.

**Figure 3** shows the settings for the second raw data filter that can be specified by the user.

A screenshot of a computer

Description automatically generated

Figure : User defined Window size and Standard deviation factor for raw data filtering.

1. Moving average calculation

Base on the filtered raw data a moving average is calculated as follows:

Based on a user-selected **Window size** NM the average of the lastNM scale weight values is calculated. If the difference between consecutively calculated moving averages exceeds a user defined **Max allowed change**, the most recent (current) calculated moving average is filtered out.

**Figure 4** shows the settings for the calculation of the moving average that can be specified by the user.

A screenshot of a computer

Description automatically generated

Figure : User specified settings for moving average calculation.

1. Powder flow rate calculation

The powder flow rate in kg/hr is determined based on the user specified **window size NPF** for the calculated moving averages using the following formula:

Powder flow rate =

Where:

MAi: moving average calculated at position i in kg

MAi+NPF: moving average calculated at position i+NPF in kg

Ti: time stamp at position i in seconds

Ti+NPF: time stamp at position i + NPF in seconds

**Figure 5** shows the settings for the calculation of the powder flow rate that can be specified by the user.

A screenshot of a computer

Description automatically generated

Figure : User specified settings for powder flow calculation.