February 2020

POWDER RATHOLES DETECTION SYSTEM FOR 3D PRINTING SYSTEM

HP INC

Powder Ratholes Detection System for 3D printing system

Abstract

Disclosure to explain a system that will enable rat-hole detection inside a 3D printing build Unit. One of the main problems observed when using different kind of powders is the flowability these kinds of powders have. This powder flowability and consistency differences make the current system to have problems to ensure powder feeding to Archimedes. For instance, TPU powder properties is showing several cases of rat-holes, which is the name under which this phenomenon is known. Powder cannot flow, not covering feeding areas and therefore not supplying powder to archimedes screws:

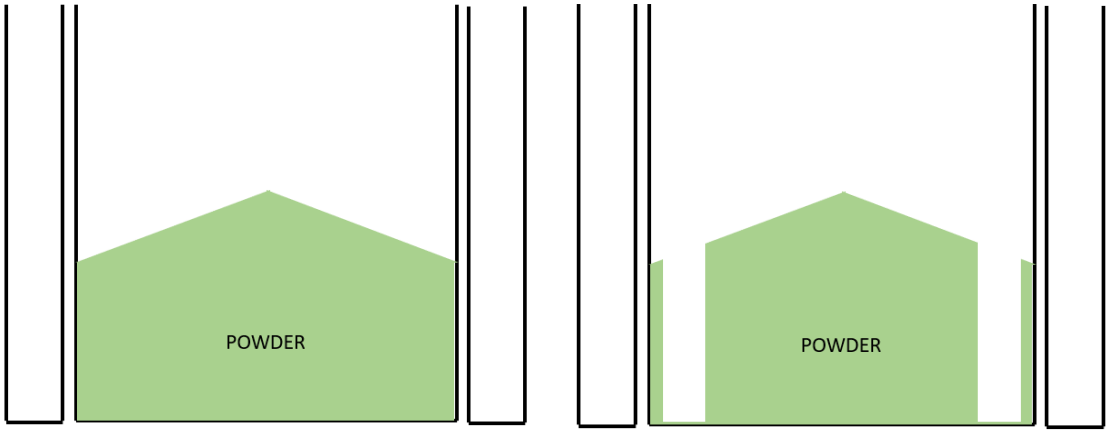
This disclosure will present a system that will provide real time feedback that will help to monitor the existence of these rat-holes.

The presented solution solves the following problems:

- Powder rat-holes detection

Description

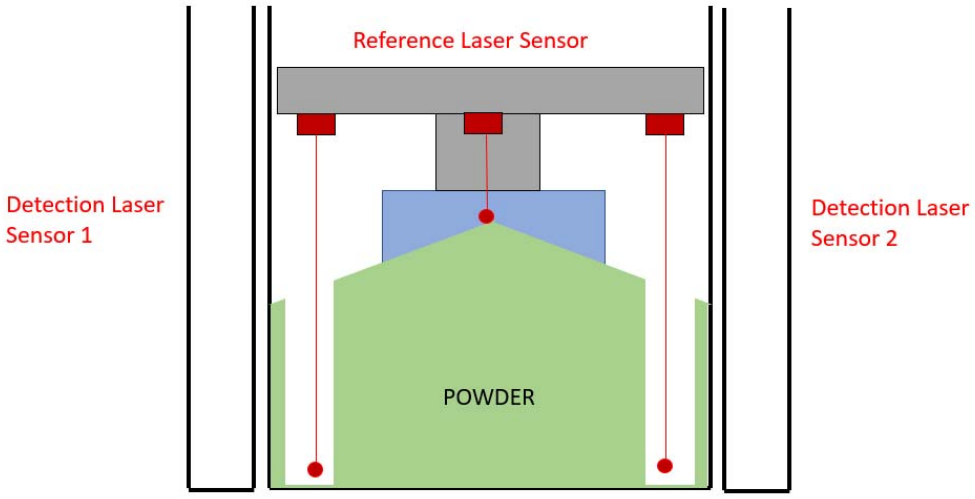
In order to detect the existence of rat-holes inside the Build Unit and provide real time feedback this disclosure will present three alternative solutions. The three of them are based on the fact that, after rat-holes appear, powder configuration inside the Build Unit radically changes:



1. **Laser Distance Sensor**

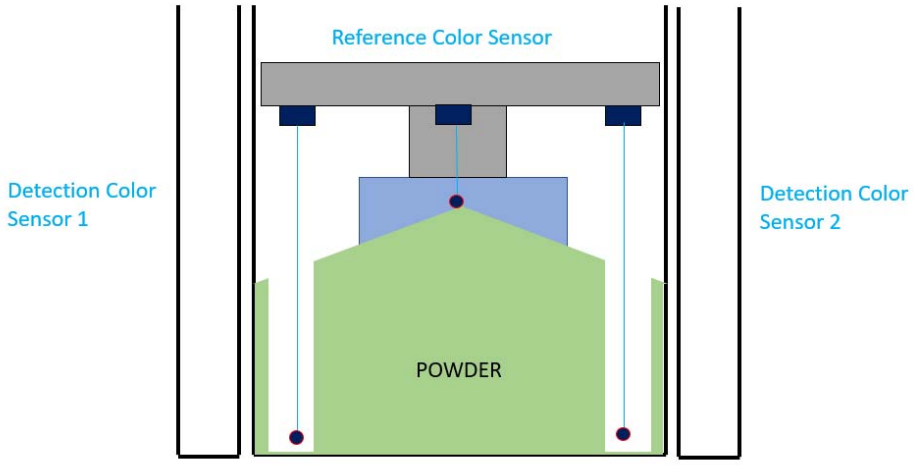
The first proposed solution will take advantage of this powder configuration in order to monitor the distance from powder to platform. By having characterized these distances in both powder configurations (with Rat-holes and without) and knowing the height of the platform at any time, it is very easy to monitor real time if there is any problem with Rat-holes. A central distance sensor extra can be used as reference sensor in order to monitor the distance of a NO rat-holes known area and make

more robust any comparative measurement the required control algorithm would make. If the system detects any rat-hole it will increase vibration system frequency in order to mitigate the problem.

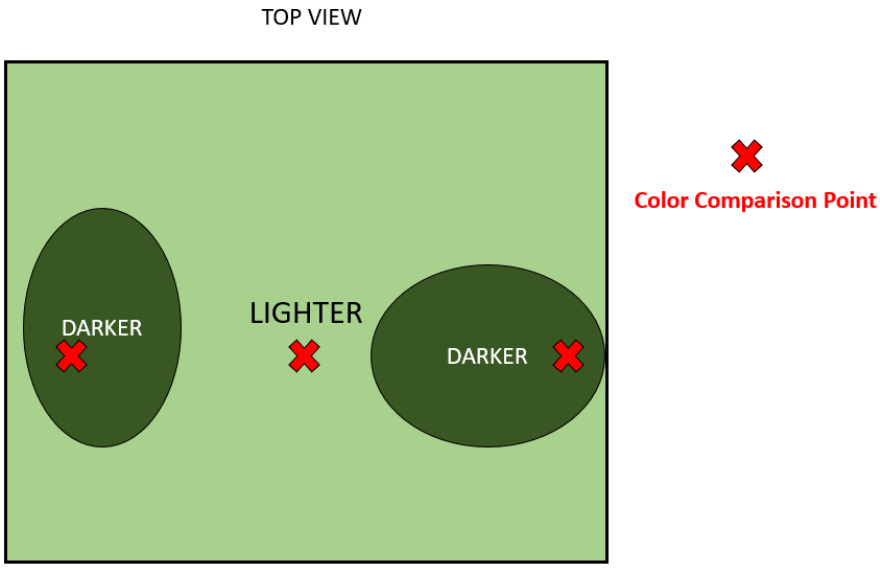


2. Color sensor

Taking advantage of this same powder configuration with Rat-holes, it is very easy to detect if there is any powder issue by color comparison. When powder cannot flow to Archimedes, a huge column of NO powder remains inside the Build Unit, so it is very easy to appreciate any color change. Therefore, this solution proposed to use again 3 sensors, this time color sensors. In this configuration the central reference sensor is compulsory in order to compare the color of a known NO ratholes areas with the other two locations that need to be compared. In this case the control algorithm would be even easier, only needing to compare central sensor with the other 2:



Simplifying how a top view of this system would be, it is very easy to understand the operation principles of this solution:

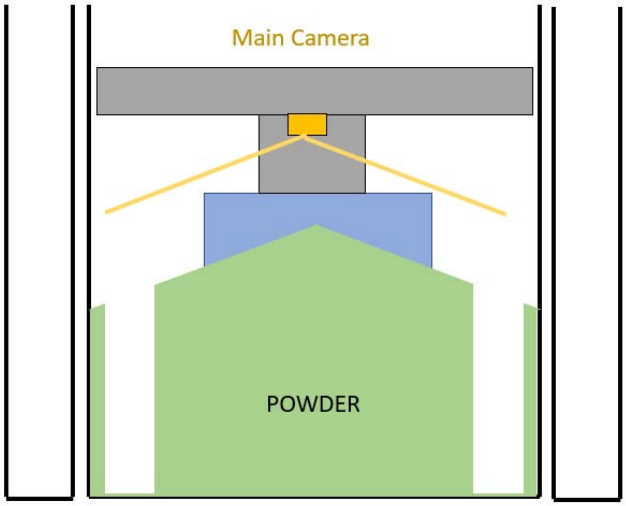


Sensors are pointing at both sides (where rat-holes appear) at the middle, where no rat-holes appear. By quickly comparing color in this area, control algorithm will understand if rat-holes issue is present, and if so, will increase vibration system frequency in order to mitigate the problem.

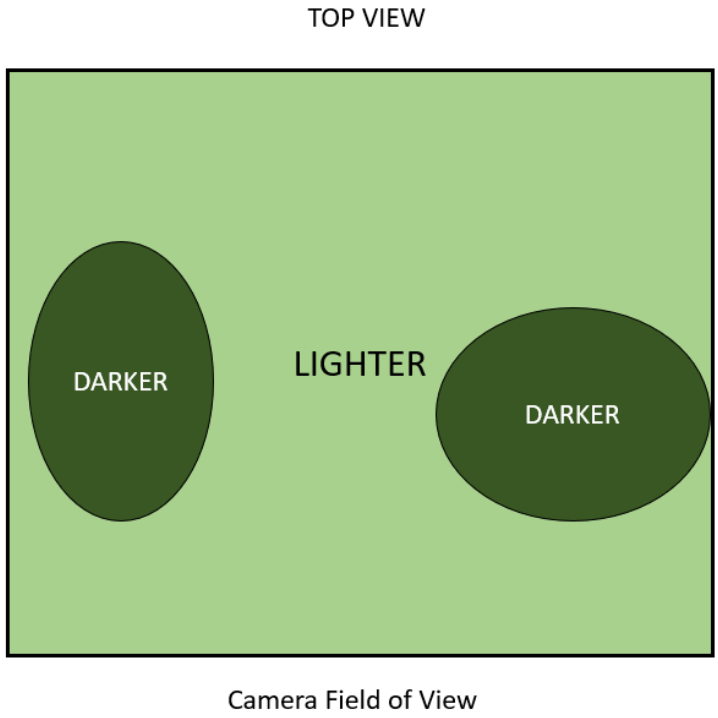
3. Camera Control/Image Processing

This solution uses the exact same principles than previous one but is more robust since does not rely in one single point measurement but can analyze the full are. A simple a cheap camera would be located beneath the platform, and its field of view would capture all print bed area. By simple image processing

algorithms, the system will know at any time if any rat-hole is present and will again increase vibration system frequency in order to make rat-holes disappear:



Looking from a simplified top view, the system would be able to see and process at any time powder configuration inside the bucket:



Advantages

- Powder rat-holes are detected and fixed

Prior solutions

No prior solutions to detect and mitigate powder rat-holes inside the bucket

Disclosed by Guillermo Moliner; Marc Julià; Eduard Galdeano, HP Inc.