SCS 4124 – FINAL YEAR PROJECT IN COMPUTER SCIENCE

DEFINING AN ALGORITHM TO IDENTIFY OVERHANGS IN 3D PRINTNG

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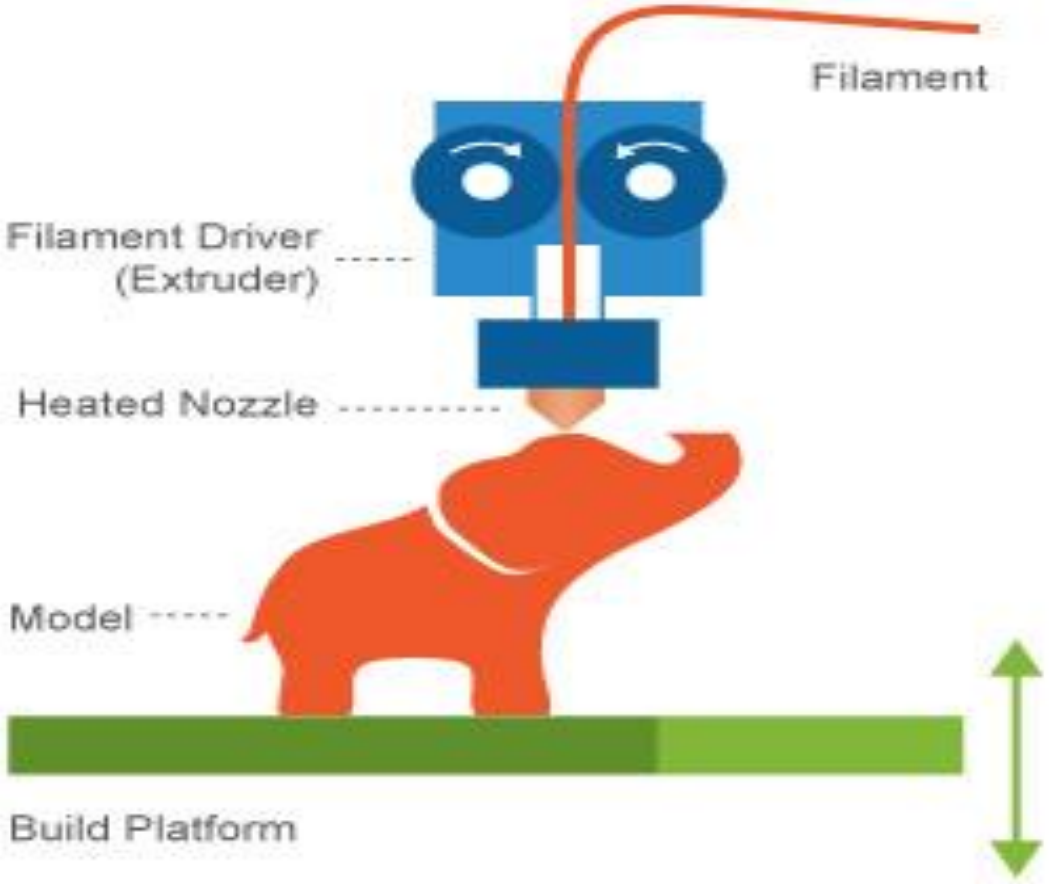
Introduction

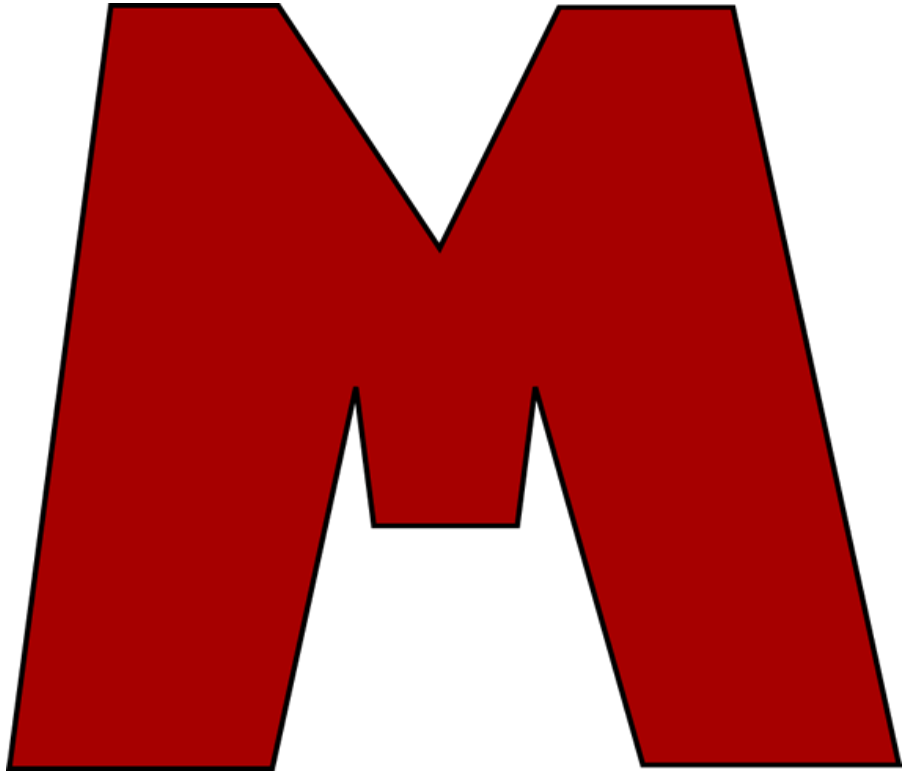
- The use of the Rapid Prototyping (RP) systems in manufacturing industry has grown tremendously over the period of last two decades.
- 3D printing technology made its way to the Technological world in the year 1986.
- 3D printing process is an Additive manufacturing process.

Fused Deposition Model (FDM)

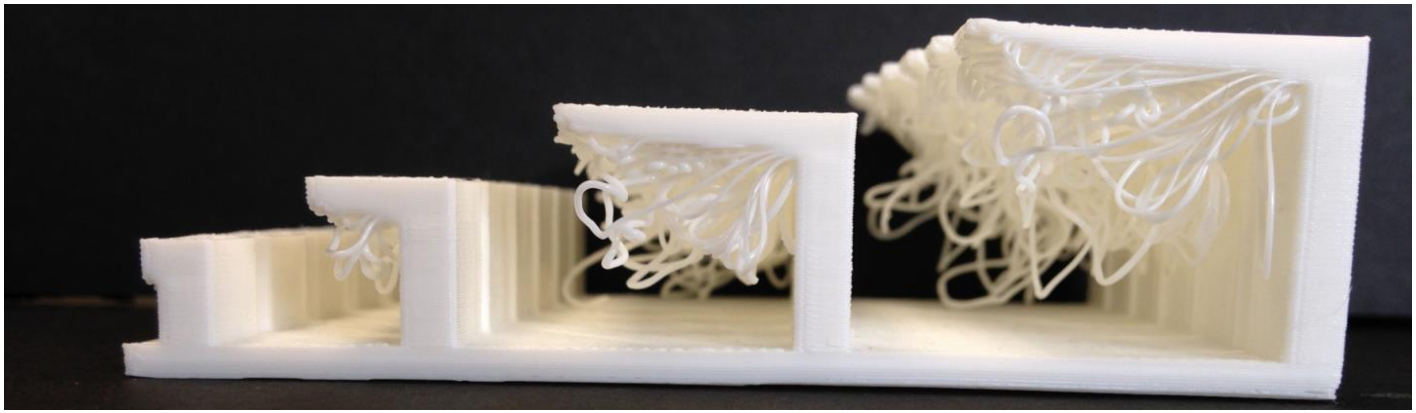


Fused Deposition Modeling (FDM)

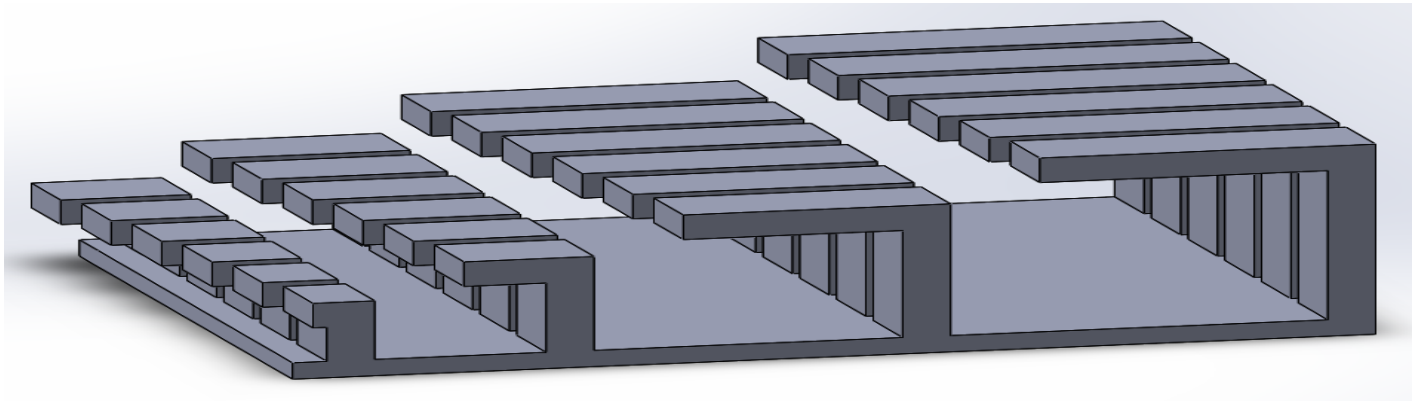
Overhang Problem in 3D Printing



Failed Overhangs



Failed horizontal overhangs



CAD model of the 3D object

Statement of the Research Problem

- This research focuses on identifying overhang parts of 3D objects defining a set of points in need for support (a set of overhang points).
- In order to identify overhang points I will define an algorithm which takes 3D object models (CAD models) as input and output a set of overhang points which need to be supported.

Related Work

- A first family of approaches consider the down – facing facets of the input mesh having an angle too steep to print correctly.

Related Work Cont.

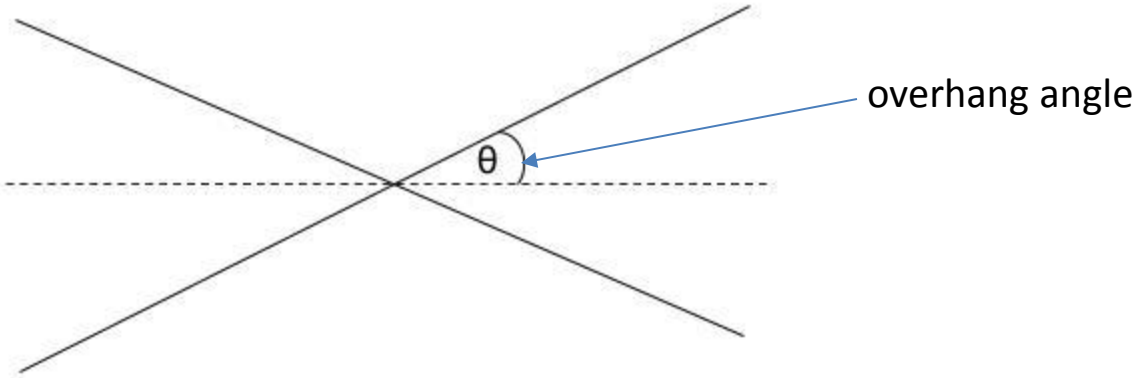
- A second family of approaches consist in performing a Boolean difference between two successive slices.

Weaknesses of the Related Work

- Determination of the convergence percentage
  - Build material
  - Build speed and cooling time of the material
- Determination of the minimum canceling distance
  - Build material
  - Build speed and cooling time of the material

Our Approach

- Define minimum overhang angle



Our Approach Cont.

- Derive Boolean difference between two layers
- Derive Canceling Distance
- Defining algorithm for overhang detection
- Interpret the solutions found in the research
- Test the results of the research

Why Our Approach is Better

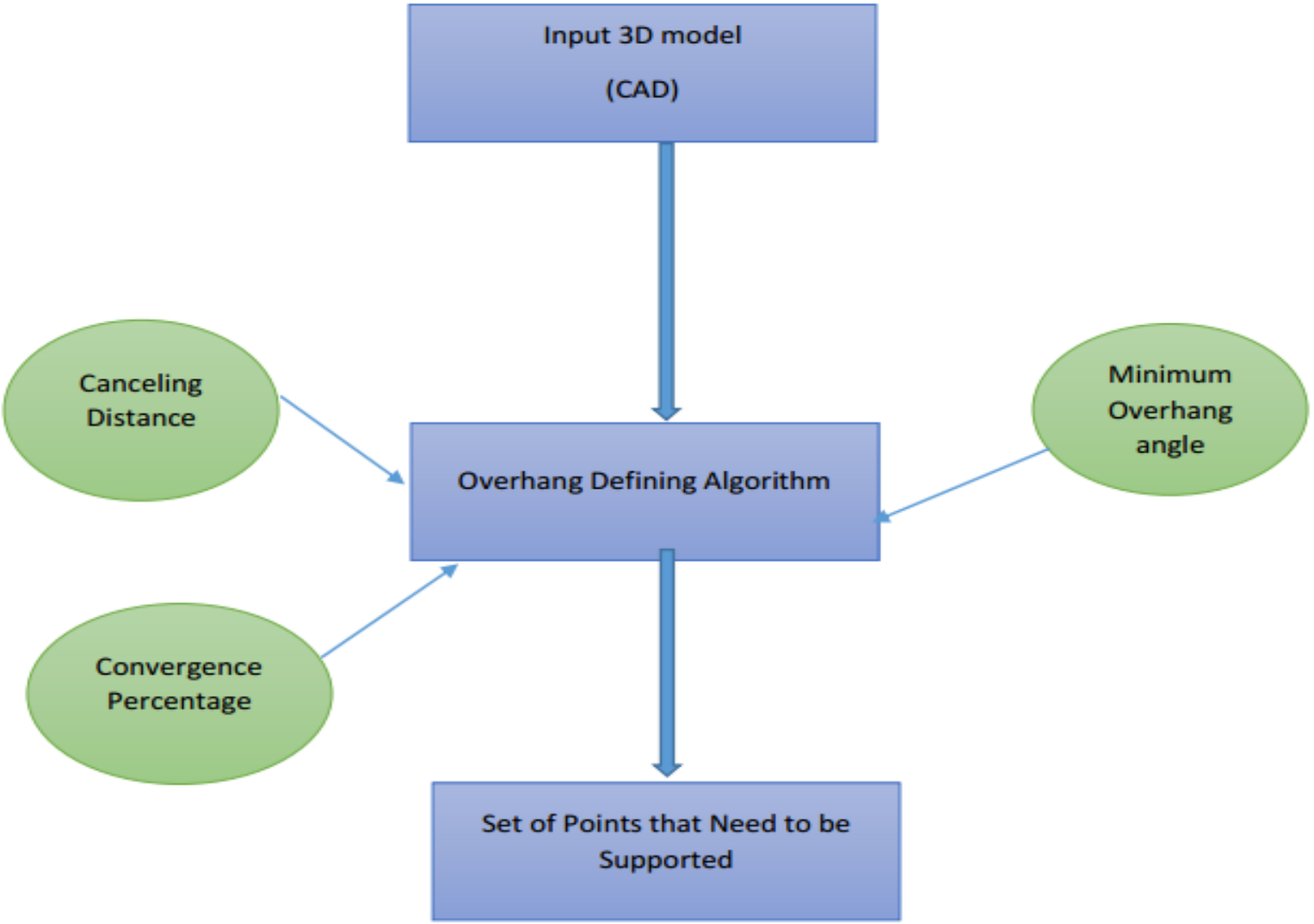
- We define minimum overhang orthogonal to the built direction considering build speed, material used and cooling time of the material as parameters (rather than predefined)
- Our solution can be generalize among various scenarios
- Reduced complexity of the number of support points

Prototype of the Algorithm

Input: Array of paths $\mathcal{P}$, stored as array of points, ordered by Z $\nearrow$.
Output: Set of points $\mathcal{S}$ to be supported.

```
1  foreach perimeter perim ∈ P do
2      foreach u ∈ perim do
3          if isUnsupported(u) then
4              if ∄v ∈ S s.t. v ∈ perim and C(u, v) < τ then
5                  S ← S ∪ {u}
6  foreach non perimeter path ∈ P do
7      foreach u ∈ path do
8          if isUnsupported(u) then
9              if ∄v ∈ S s.t. z(v) ⩽ z(u) and ||u − v|| < τ then
10                 S ← S ∪ {u}
11 return S
```

Research Design (high – level diagram)



Goal and Objectives

- Objectives
  - Define a Minimum overhang angle considering the material, build speed and cooling time of the material as parameters.
  - Derive Boolean difference convergence percentage from the Minimum overhang angle
  - Derive Canceling distance from the Minimum overhang angle
  - Define the algorithm using above parameters to determine the overhang points

Significance of the Research

- Reduce material and time wastage.
- Identification of points which are in need for support is a huge step towards widening the range of 3D objects that can be printed by FDMs.
- Reduce the complexity of the support structure.

Scope and Delimitations

- Scope
  - The scope of the research is to identify overhang parts in 3D object model and out put a set of points that need to be supported
- Delimitations
  - Support structure
  - Build orientation
  - Part stability

Thank you