## Internship Report

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**Internship Title** : RSIP Career Basic ML 246

**Project ID** : SPS\_PRO\_305

**Project Domain** : Machine Learning

**Project Title** : 3D Printer Material Prediction using Watson Auto AI

**Submitted by** :

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**1. INTRODUCTION**

**1.1 Overview**

3D printing is also known as desktop fabrication or additive manufacturing. It is a prototyping process whereby a real object is created from a 3D design. The digital 3D-model is saved in STL format and then sent to a 3D printer. The 3D printer then prints the design layer by layer and forms a real object.

Many different materials can be used for 3D printing, such as ABS plastic, PLA, polyamide (nylon), glass filled polyamide, stereolithography materials (epoxy resins), silver, titanium, steel, wax, photopolymers and polycarbonate, but we have to be aware that many of the 3D printing materials only mimic true thermoplastics. Choosing the right material allows us to improve the shape, quality and function of the 3d printed part. Hence, selection of the correct 3D printing material is highly essential. To identify the type of material required after a 3D model is designed is a complicated task.

**1.2 Purpose**

Selecting a 3D printing material isn't always that easy or straightforward. We must think critically about the purpose of the part we want to print and its high priority material requirements.

Material properties such as chemical, optical, mechanical, thermal, or electrical characteristics reflect how a specific material will behave under certain conditions.

Using these properties and various others, we can make the right material decisions.

The aim of the project is to determine the best material which will be perfect for the given use case. This is very much important for Mechanical and Civil Engineers, among other users, since it can affect the future prospects of developments. There are eleven setting parameters and one output parameters. Based on these input parameters we have to predict the best material for the 3-D model. This model will predict whether to use ABS or PLA.

**2 . LITERATURE SURVEY**

**2.1 Existing Problem**

Some of the common problems faced are:

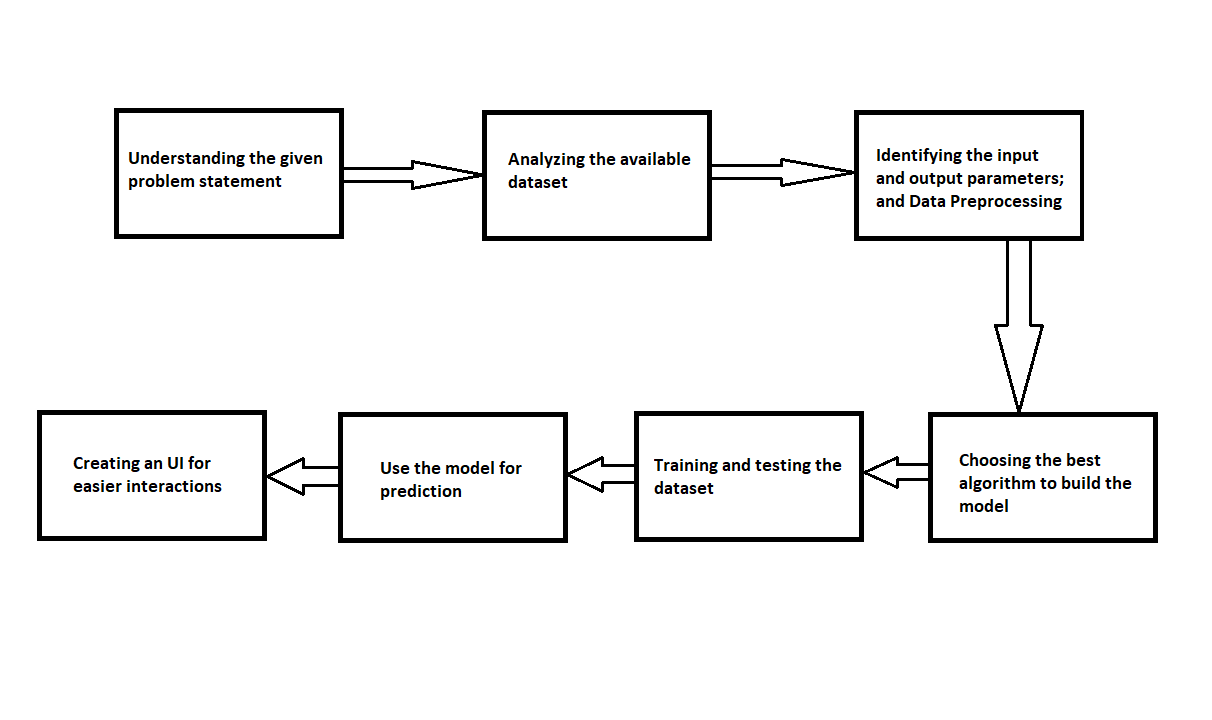
1. First level adhesion problem, this problem refers to a condition where the first layer of the print does not stick to the bed. This is one of the most common problems in 3D printing encountered by 3D printer users.
2. Infill is an important parameter to consider while printing. If not carefully managed, it can cause problems in 3D printing. The infill density and pattern play an important role in the strength of the parts. It also dictates the stability & shape of the model. So, it is important that the infill is carefully selected and used.
3. Warping is caused when the deposited material cools quickly. While cooling, the material contracts and this causes the ends to be lifted up thereby causing warping. Warping also leads to cracks in the print.
4. Wall thickness is a major reason of 3D printing issues, All of the 3D printing materials have their own minimum wall thickness, for flexible or rigid parts.

**2.2 Proposed Solution**

We are using IBM Watson AutoAI Machine Learning to build a model that predicts the best material to use while printing a 3D model. The model is deployed on IBM cloud to get scoring end point which can be used as API in mobile app or web app building. We are developing a web application which is built using Node RED service. We make use of the scoring end point to give user input values to the deployed model. The model prediction is then showcased on User Interface, created using Node RED. This model is used to predict the best material to be used for building 3D models.

**3 . THEORETICAL ANALYSIS**

**3.1 Block Diagram**



**3.2 Hardware / Software Designing**

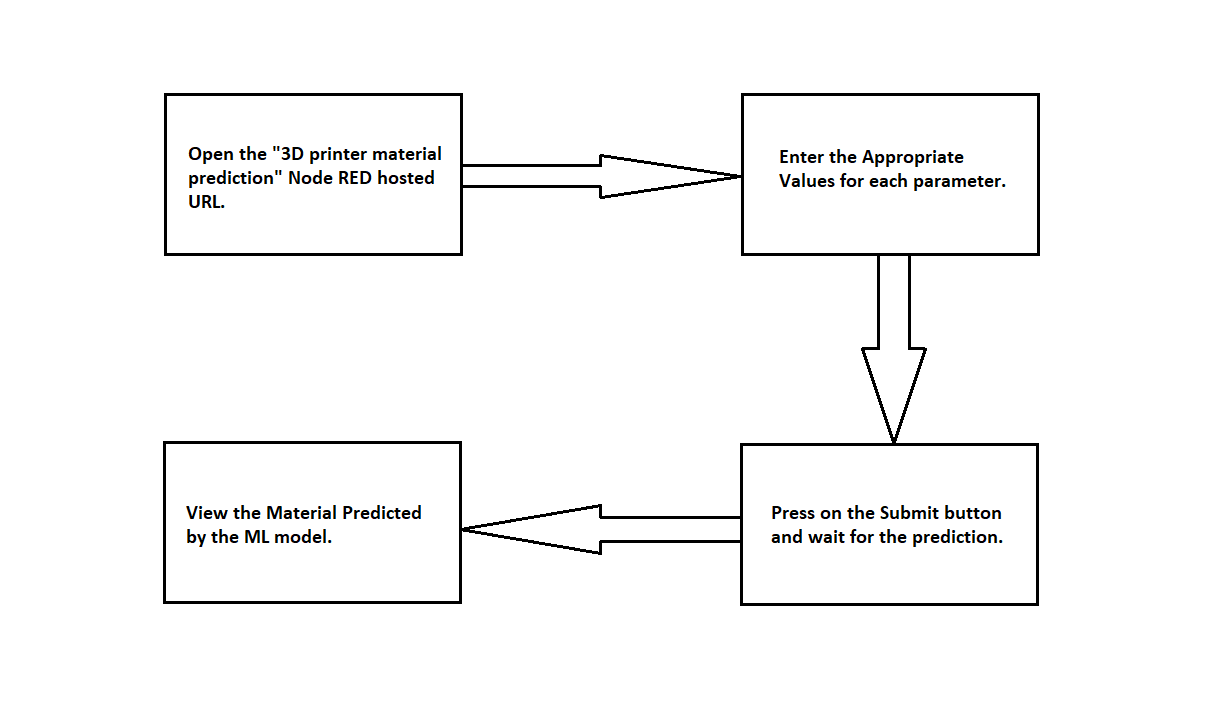
The software services used in the project include:

1. **IBM Watson Studio Service** : Watson Studio provides you with the environment and tools to solve your business problems by collaboratively working with data. You can choose the tools you need to analyze and visualize data, to cleanse and shape data, to ingest streaming data, or to create and train machine learning models.
2. **IBM Machine Learning Service**: The AutoAI graphical tool in Watson Studio automatically analyzes your data and generates candidate model pipelines customized for your predictive modeling problem. These model pipelines are created iteratively as AutoAI analyzes your dataset and discovers data transformations, algorithms, and parameter settings that work best for your problem setting. Results are displayed on a leaderboard, showing the automatically generated model pipelines ranked according to your problem optimization objective. Using AutoAI, you can build and deploy a machine learning model with sophisticated training features and no coding.
3. **IBM Cloud Object Storage** : IBM Cloud Object Storage makes it possible to store practically limitless amounts of data, simply and cost effectively. It is commonly used for data archiving and backup, for web and mobile applications, and as scalable, persistent storage for analytics. IBM Cloud Object Storage is designed to support exponential data growth and cloud-native workloads.
4. **Node-RED App**: Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

**4 . EXPERIMENTAL INVESTIGATIONS**

1. During the process of understanding the problem statement, and analysing the input and output parameters, we understood the importance of choosing the correct material that is crucial while building a 3D model.
2. We found out the parameters that adjudicate the best material to be used.
3. Throughout the development process, we gained useful insights on using IBM Cloud services such as Watson Studio and AutoAI.
4. We learnt how to use the Node Red app and its dashboard effectively, experimenting while creating UIs and making the necessary changes to suit the user.

**5 . FLOWCHART**



**6 . RESULT**

The model is trained with a good amount of dataset, thus making the model pretty accurate. There are altogether 11 parameters that affect the output of the model. The parameters have been well established and is in accordance to the scientific specifications. A well designed UI allows the Engineers or specified users to enter their required values. The model accepts the values, and based on these, it predicts the best material that is ought to be used, while printing the 3D model.

**7 . ADVANTAGES & DISADVANTAGES**

**Advantages:**

1. Simpler and faster methodology of selecting materials.
2. Materials are accurately decided based on the given input parameters.
3. Eliminate the time required for trial and error in selecting appropriate materials.

**Disadvantages:**

1. The model is unaware of the correctness of the Input parameters.
2. Trained only for limited types of materials.

**8 . APPLICATIONS**

Thismodel can be used for the following purposes:

1. To choose the best material based on the input parameters given by appropriate users.
2. Easily categorize the available materials for use, depending on requirements.
3. Building well designed and printed 3D model, based on accurate selection of materials.

**9 . CONCLUSION**

The 3D Printer Material prediction model is developed using the features of IBM Cloud. The dataset is provided to the AutoAI Service. The AutoAI service is available under the Machine Learning Service of IBM. The model has a high level of efficiency and meets the required objectives. The model solves the tedious task of selecting the right material for printing the 3D model. The graphical user interface, created using the Node-RED service, allows the engineers and other users as well, to give the inputs as per their specifications.

**10 . FUTURE SCOPE**

The project has a vey vast scope in future. It can be deployed on internet, making it accesible to everyone who wants to quickly and accurately predict the best material. People of various other fields can also access and use it based on their necessity.

We would like to improve the user experiece by making it more interactive.

Also, we hope to train the model to predict variety of other materials and also to predict any other necessary factors, involved in 3D model printing, thus saving more time and improving accuracy.

**11 . BIBLIOGRAPHY**

1. https://www.3ders.org/3d-printing.html
2. https://formlabs.com/blog/how-to-choose-the-right-3D-printing-material/
3. https://3d.formlabs.com/webinar-how-select-right-3D-printing-material.html
4. https://manufactur3dmag.com/common-problems-in-3d-printing-how-to-resolve-them-part-i/

**12 . APPENDIX**

**A. Source Code**

**Flows.json (Node-RED)**

[{"id":"a44d2f5c.6a4dd","type":"tab","label":"Flow 2","disabled":false,"info":""},{"id":"4defa215.87165c","type":"function","z":"a44d2f5c.6a4dd","name":"PreToken","func":"global.set(\"lh\",msg.payload.lh)\nglobal.set(\"wt\",msg.payload.wt)\nglobal.set(\"id\",msg.payload.id)\nglobal.set(\"ip\",msg.payload.ip)\nglobal.set(\"nt\",msg.payload.nt)\nglobal.set(\"bt\",msg.payload.bt)\nglobal.set(\"ps\",msg.payload.ps)\nglobal.set(\"fs\",msg.payload.fs)\nglobal.set(\"rg\",msg.payload.rg)\nglobal.set(\"ts\",msg.payload.ts)\nglobal.set(\"eg\",msg.payload.eg)\n\nvar apikey=\"CS5tZB4Whlro4R01vSmKw-GNg-ZrRAQcZxgP5UtmXv2\_\";\nmsg.headers={\"content-type\":\"application/x-www-form-urlencoded\"}\nmsg.payload={\"grant\_type\":\"urn:ibm:params:oauth:grant-type:apikey\",\"apikey\":apikey}\nreturn msg;","outputs":1,"noerr":0,"initialize":"","finalize":"","x":300,"y":400,"wires":[["15ce21f9.c3e2be"]]},{"id":"15ce21f9.c3e2be","type":"http 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**B. UI Output Screenshots**

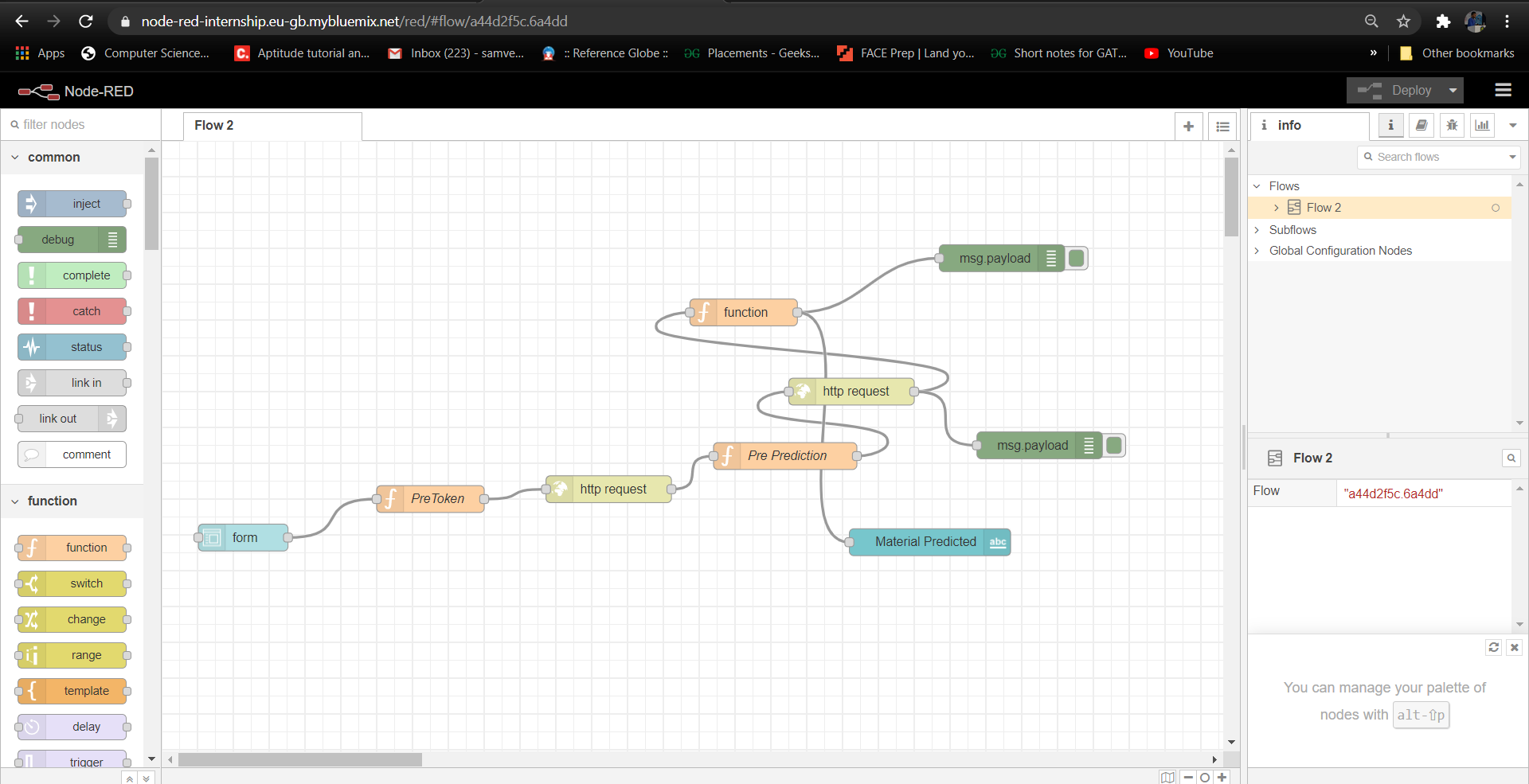


Fig 1 : Node-RED Flow Editor

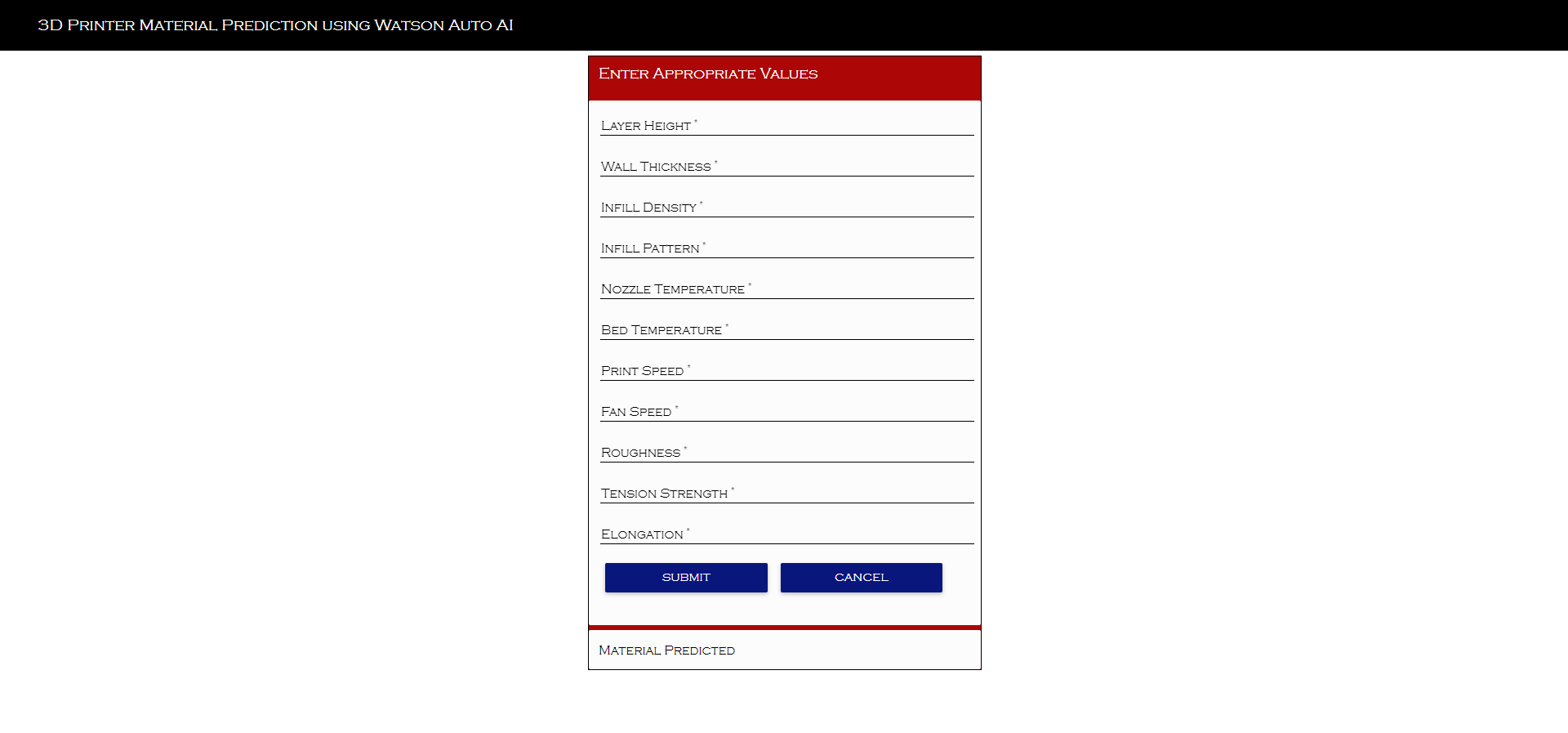


Fig 2 : Deployment UI

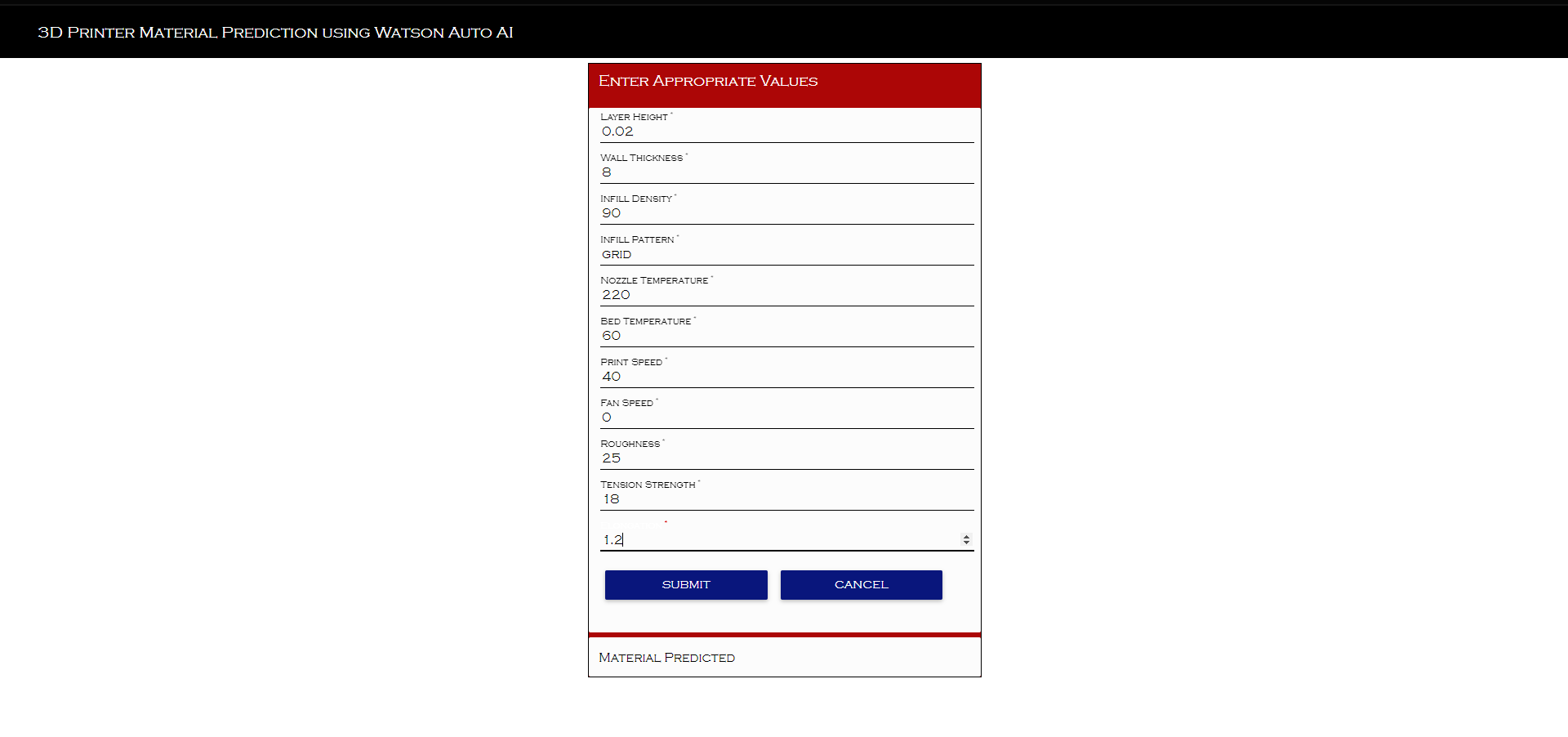


Fig 3 : Appropriate values entered

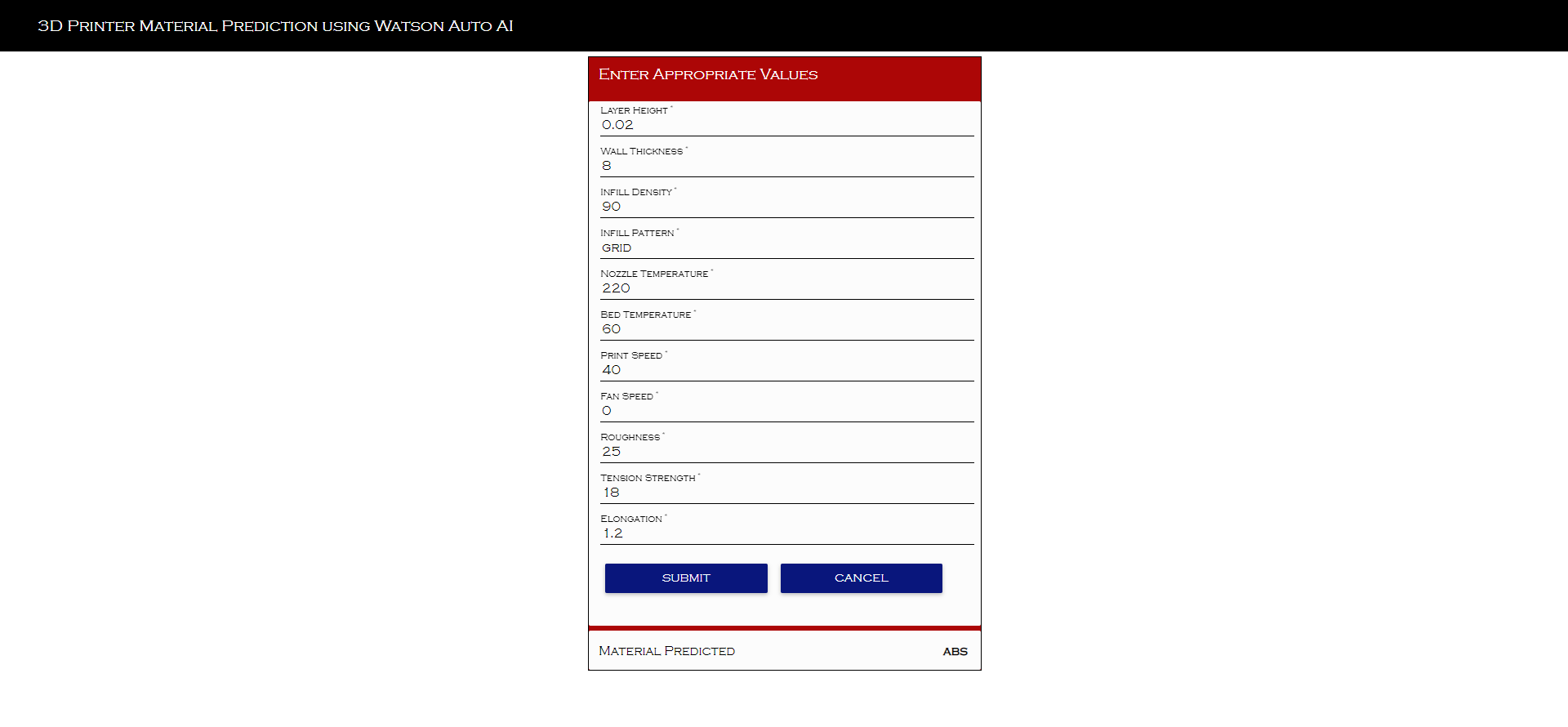


Fig 4 : Material Prediction