Phygital Claying System

Paper on the research, implementation, and evaluation of a visual-based co-creative system for generating 3D sculptures

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For Computational Creativity 2021, a course taught by Rob Saunders

16-10-2021

System can be accessed via the following link:

https://editor.p5js.org/romanguerin/full/QCVskRFB_

1. Research Co-creativity

In this paragraph, we discuss from our perspective gained throughout the course what we identify as a co-creative system. We highlight two requirements for the development of a co-creative system. Namely the system must have an intrinsic motivation and the system must allow an interplay consisting of multiple feedback loops between the user and the system itself. Both arguments are reflected by the means of artworks. In the final section of this paragraph, we describe our brainstorm on how we could use both requirements for our own co-creative system whilst keeping our own intrinsic motivation in mind.

We consider co-creativity as a process between humans in which they both play an equal part in making something creative. In the ideal situation, two humans would co-create together if they practice brainstorming, negotiating, and designing in collaboration with each other keeping in mind their different narratives towards the desired outcome. A narrative or so to say intrinsic motivation is formed by both humans' individual past experiences, interests and working method. We would argue that an intrinsic motivation is required for both parties, as this is what distinguishes one from the other. In a co-creative process both humans work collaboratively towards the desired outcome, but although working together, can never fully understand each other due to their different narratives. This differentiation makes the process highly interesting as they together need to build upon their narratives to eventually create only one output. Therefore, it is of merit for our co-creative system to have intrinsic motivation.

Regarding this narrative requirement of our co-creative system, we found the Perception Engines of Tom White fitting. The system represents everyday objects and creates images through the eyes of the system. An article about Tom White for Medium magazine gives the following description of Perception Engines: *"An architecture called perception engines is introduced that is able to construct representational physical objects and is powered primarily by computational perception. An initial implementation was used to create several ink prints based on ImageNet categories, and permutations of this technique are the basis of ongoing work."* [1]. White plays with the question if the created images appear meaningful to humans. In theory, White has turned around the relationship a designer can have when using a computer tool, as the system makes and decides its own creative outputs. It thus has its own intrinsic motivation, to quote White: *"I've designed the constraint system that defines the form, but the neural networks are the ultimate arbiter of the content."*. Moreover, while White explains his system as more of a cooperative system, we do think the intrinsic motivation of the system is of merit considering how we define a co-creative system. However, what is missing in his artwork is the interplay between both parties. White and the system do not collaborate together towards the outcome of the process, he only defines the

This brings us to our second argument of how we define a co-creative system and that is what we call a conversation between the user and the system in question. Considering again that a co-creative process consists of a collaborative brainstorm, negotiation and designing phase

[1] https://medium.com/artists-and-machine-intelligence/perception-engines-8a46bc598d57

between two parties, we are convinced the parties need to react to each other in a conversation-like style. Party one says something, party two responds, party one responds etc. The requirement of parties to be able to respond to each other requires them to get into each other's minds and combine their narratives. We see this as the opposite of cooperation wherein both parties develop their individual process and only combine the results in the end. This collaboration was for us a guideline as to how we see our human- computer collaboration.

Considering the second requirement, we looked at Ivano Salonia, an artist who used machine learning to create his Synthetic Sensuality series.[2] The machine learning system he created is trained on explicit, sensual, images that were found online, and using these the system generated images of abstract shaped and body textures. The goal of the system was to capture an early stage of the learning process and to question whether sensuality can be found in these images. Reflecting on the artworks of Salonia, we would rather call the collaboration cooperation instead of a co-creation. The artist specifically chooses which hundred images that the system created to present on social media. In sight of our argument, the conversation between the user and the system is missing. A feedback loop could make the process co-creative.

In the end, we don't desire the system to be mirroring a human's view or action. We want the system to contribute with its own interpretation, created by its limitations and intrinsic properties. We want to translate our idea of a co-creator as if you'd brainstorm with a peer human for input and inspiration. We looked for a way to find connections between human interests and wishes from a creative system. This led us to ask a very important question: when would *we* want to co-create with a system? The start of the project came forth from our personal experiences and preferences. Roman travels often and works with image recognition from laptop webcams. For him, a desired co-creator would be a system that works with input from a webcam which does not require much input and is not stationary. Iris spoke about 3D modeling in programs like Cinema 4D and Rhinoceros, and how she sometimes finds it hard to evaluate when a 3D digital shape is good enough to produce. She'd like to have a creative system for helping her to create three-dimensional shapes. For Floor a co-creator should be like a creative companion, which would come in handy at the start of a project in the exploratory phase, to help kick-start a process. This led to the conclusion that our co-creative system would be designed for the beginning of a creative project where visual or three-dimensional models and prototypes are easily generated to quickly create different ideas using live two-dimensional webcam images as input.

2. Implementation Co-creative System

For the creation of our desired co-creative system, we started off with setting up a flowchart of how our desired co-creative system would work (See figure 1). The desired goal of our co-creative system is to co-create a STL 3D print object based on user input and a system

[2] https://opensea.io/collection/synthetic-sensuality

input. To meet the goal, we did many test trials and figured with the available time to create the co-creative system it would be more feasible to save a CSV file of a 3D point cloud as our prototype goal.

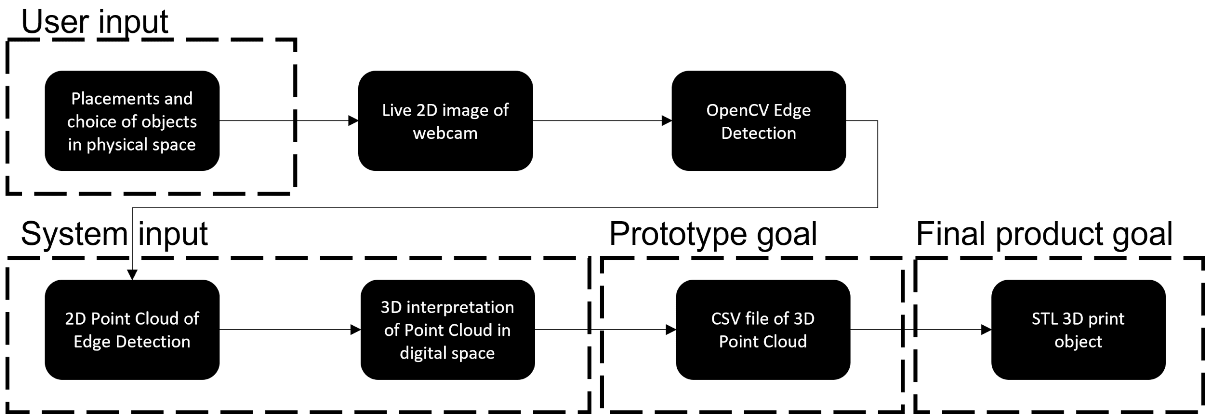


Figure 1, flowchart of the workability of the co-creative system

While looking at how we could implement our co-creative system, we did some tests with OpenCV. The edge detection seemed a good start as it only needed a simple camera as input. We chose this because we did not want the system to be an enormous installation with a big Kinect sensor as input. But rather a system that you could bring everywhere with you as it runs on a website and therefore written in p5js. Secondly, we like the system to be playful with the input and we found the translation of a Kinect too corresponding regarding the expectations of reality as seen by humans.

The translation between the user input and the system input starts with the website capturing the video from the camera, the edges of objects get a white silhouette. The system then places a grid on top of this and detects specific lines that cross the grid. A red circle lights up when this detection happens and indicates that the system uses this point. Objects with a plane background work better than if a lot of noise is apparent on the background, as the camera will track the background too. All of this happens on the left side of the layout, as seen in Figure 2. We refer to this process as the translation between the user input and the system input, as both parties do not have any influence on this process. The only input from the user at this point is positioning the camera and placing objects in its view.

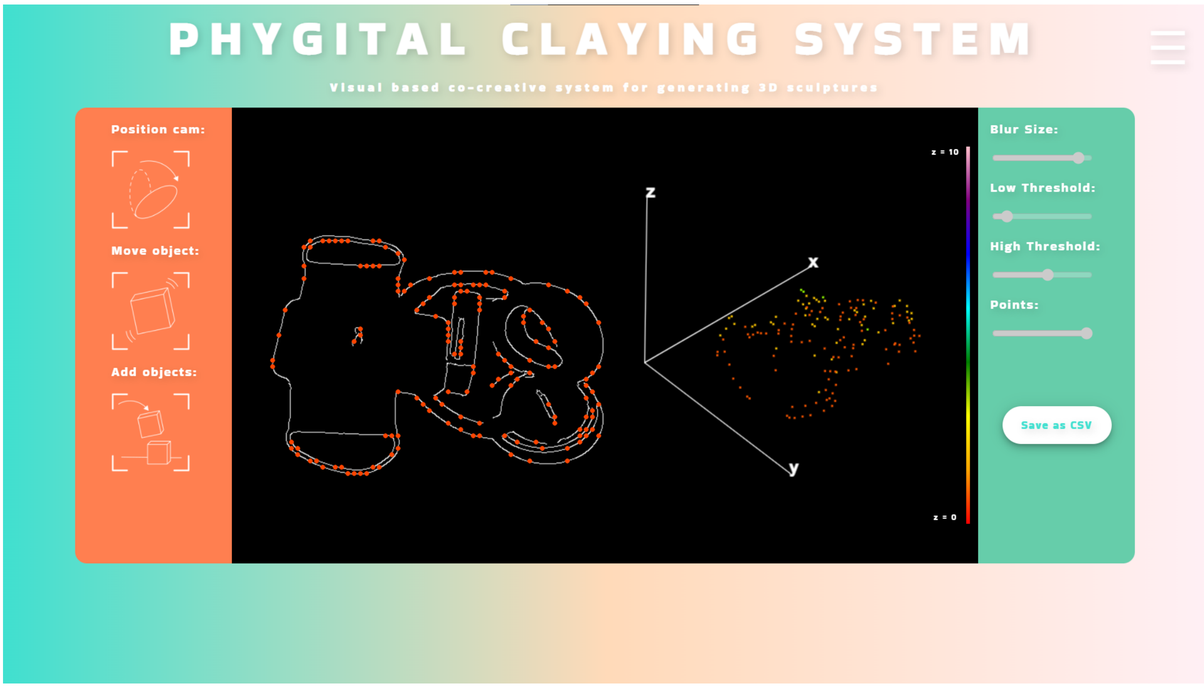


Figure 2, screenshot of the final prototype; from webcam input to 3D point cloud

After all of this, on the right side, two things happen. First, the system has a number points-based system that scores on the number of details it detects. The system will place the point into the 3D array and give it a height and color on each point it receives. The generation of the 3D sculptor is now about to begin. Meanwhile, the code system starts playing with this input by slightly mutating the blur size, low threshold, and high threshold (these are the first three slides on the system). However, when too many points get placed in the upper layer of the 3D array, the system automatically reduces the number of edge points it detects, which will slightly affect the mutations. You don't influence this as a user, but you can still play what the co-creative system is actually trying to see. Only playing with the objects, replacing them and moving the camera can provide a different outcome, but after this, the system works independently. And in the end, this abstract view of the world can then be saved to a CSV file and used in other 3D modeling programs as a way to initialize your new view of an object. In Figure 3 a screenshot of our desired co-creative can be seen, here the co-creative system creates an abstract 3D sculpture as end result.

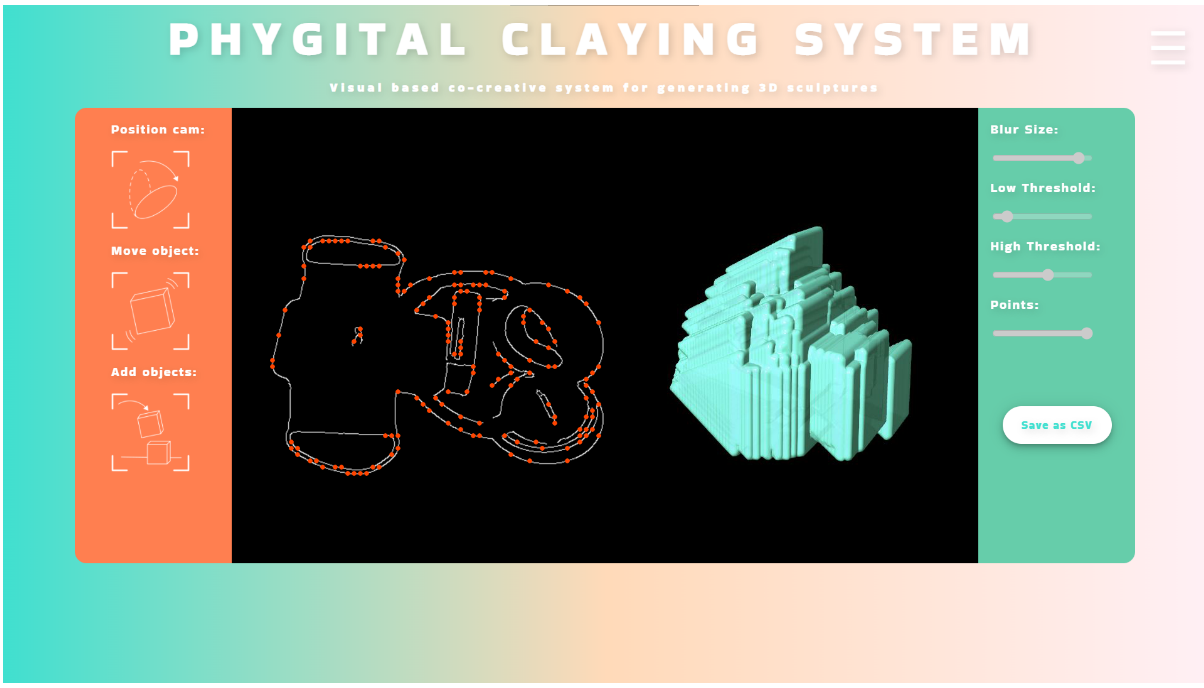


Figure 3, screenshot of the desired final product: from webcam input to 3D printable object

3. Evaluation Co-creative System

The evaluation of the prototype is split into two sections. In the first section, we will elaborate on the evaluation by others and in the second section a description is given of our own evaluation of the system.

3.1. Evaluation by others

For the evaluation of the prototype of our co-creative system by others, we used a qualitative method. This method consisted of interviewing our subjects while they were interacting with the system. Consequently, the method allowed us to get direct feedback from which design features and technical functionalities do not work as desired. The feedback consisted of four concise aspects that could be and are improved for the final version of our prototype. The most fruitful aspect others discovered for our prototype is that it feels more like a supportive system than a co-creation system, due to the interface of the system. The user feels in control of the system while interacting, creating a master-slave relationship rather than the argued colleague-colleague relationship. By analyzing this matter using the flowchart discussed in Figure .., we discovered a flaw in our initial prototype. As said in the research section above, we are convinced it is of high relevance for both parties (user and system) to have intrinsic motivation. The targeted intrinsic motivation of the system is to create an 'interesting but matching' three-dimensional point cloud out of a live two-dimensional webcam image. And of the user to create an 'interesting input via placing and moving objects in front of the webcam'. In our initial prototype, we gave the user the optionality to play around with the settings of the system, giving them control over the intrinsic motivation of the system which conflicts with the findings of our research towards a co-creative system. See the initial prototype with the four sliders in Figure 4 below.

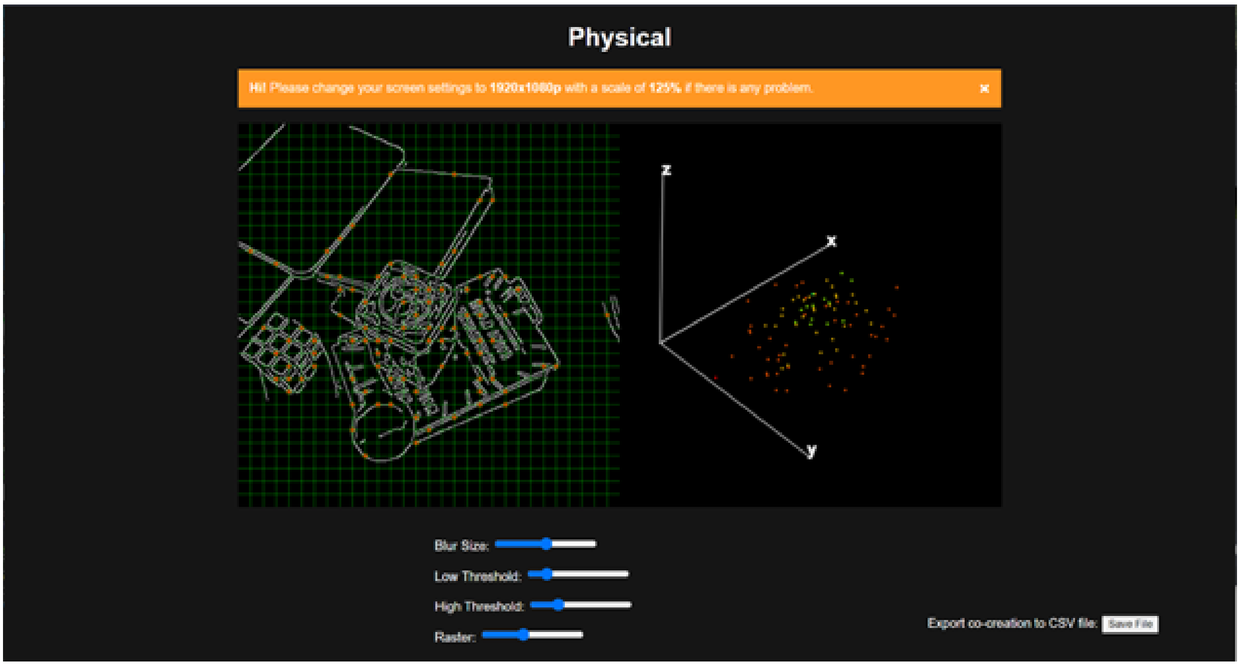


Figure 4, screenshot of the initial prototype

Additionally, these sliders became the central point of attention for the user. Mainly because the user is accustomed to interacting with the interface of a webpage once visiting a webpage, nowhere in our visualization it is made clear to the user that he or she needs to interact by means of webcam input. Hence, we decided to give the control of the settings of the system back to the system and include icons for the users to nudge people to meet the desired motivation, as further explained in the previous paragraph and seen in Figure 3.

Finally, the most unexpected but in the end obvious observation we often got was the disconnection between the camera input and the point cloud. Multiple subjects confirmed this disconnection, as quoted by one of the subjects: “I cannot see how these data points could be represented as the object in front of the camera”. Though we could argue that this issue was due to our limited set up, since the background of our set up also got captured in the point cloud, we do know our prototype could be considered as highly conceptual. While we made the conscious decision to make the prototype conceptual, as in the end the user is ‘phygitally’ claying with the system of our prototype, we could have incorporated more features to make the process of the conceptualization more clear. For example, by showcasing which part of the processed webcam image represents which part in the point cloud by using the already existing colors. Or for example, relate the decisions of the system back to an inspirational set of images consisting of abstract sculptures scraped from Pinterest. In the end, both these examples allow the user for a better reference of how the system makes its decision. For now, we solved this issue by addressing the functionality of the system in the info section of the web application once the user clicks on the info button (See top right icon in Figure 3).

3.2. Evaluation by ourselves

The system we build could be categorized more as a creative support tool than a computer colleague. According to Shneiderman[3], creative support tools are distinguished into two kinds of tools. The first one is a productivity support tool, which is characterized by a clear task with known requirements, well-defined success metrics and a known and relatively well-understood set of users. The second one is a creativity support tool. Here the domains are ill-defined and the requirements are unknown. The success measures are vague and there is an unpredictable user base. [bron] For the evaluation done by ourselves, we also discussed how we could improve the system to create a colleague-colleague relationship between the user and the system. An important question to ask is when the point cloud is valid. As mentioned in the first paragraph (*1. Research co-creativity)* artist Ivano Salonia set a number of hundred images to create with his system. We thought about different scenarios wherein our system could have more influence in the decision-making of the outcome.

An idea could be to create an inspiring set from Pinterest images of sculptures with textures (See Figure 5). The system could validate possible images based on the inspiring set. An important note here is that the images from Pinterest are two dimensional and the shapes our system creates are three-dimensional. Thought this might create an interesting idea that fits our concept.

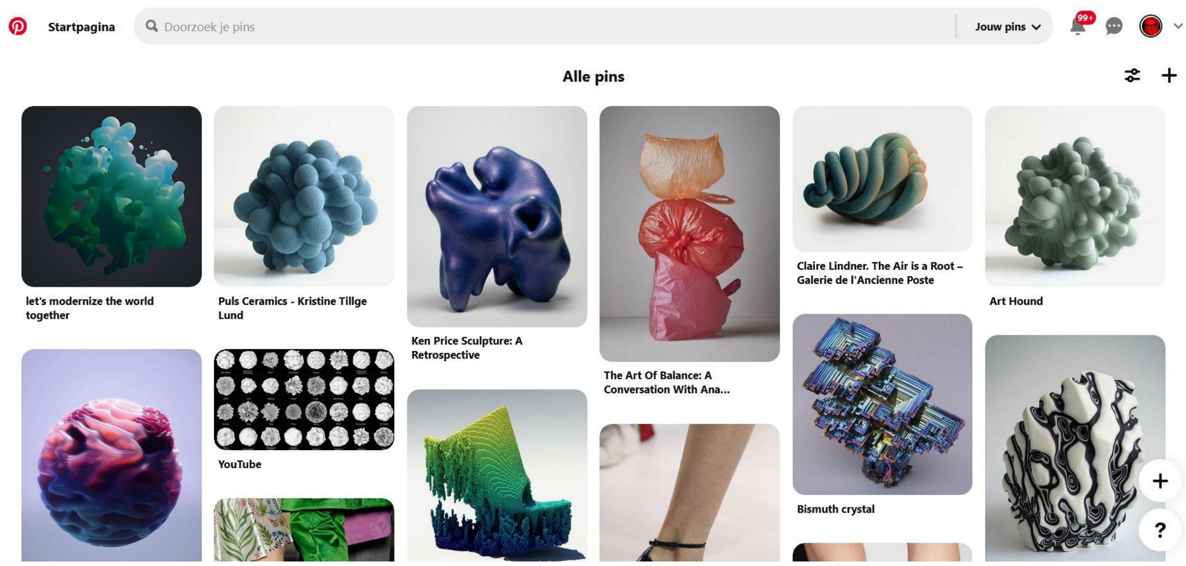


Figure 5, screenshot of recommended images on Pinterest

Negotiating is an aspect of equal collaborations. As an adjustment for our system, an interplay with sliders could be used to represent the negotiation. The user may adjust the sliders, while the system would suggest a different value. A value in the middle might be an outcome of this negotiation. Also, when the ‘Get CSV’ button is pressed it might be used not

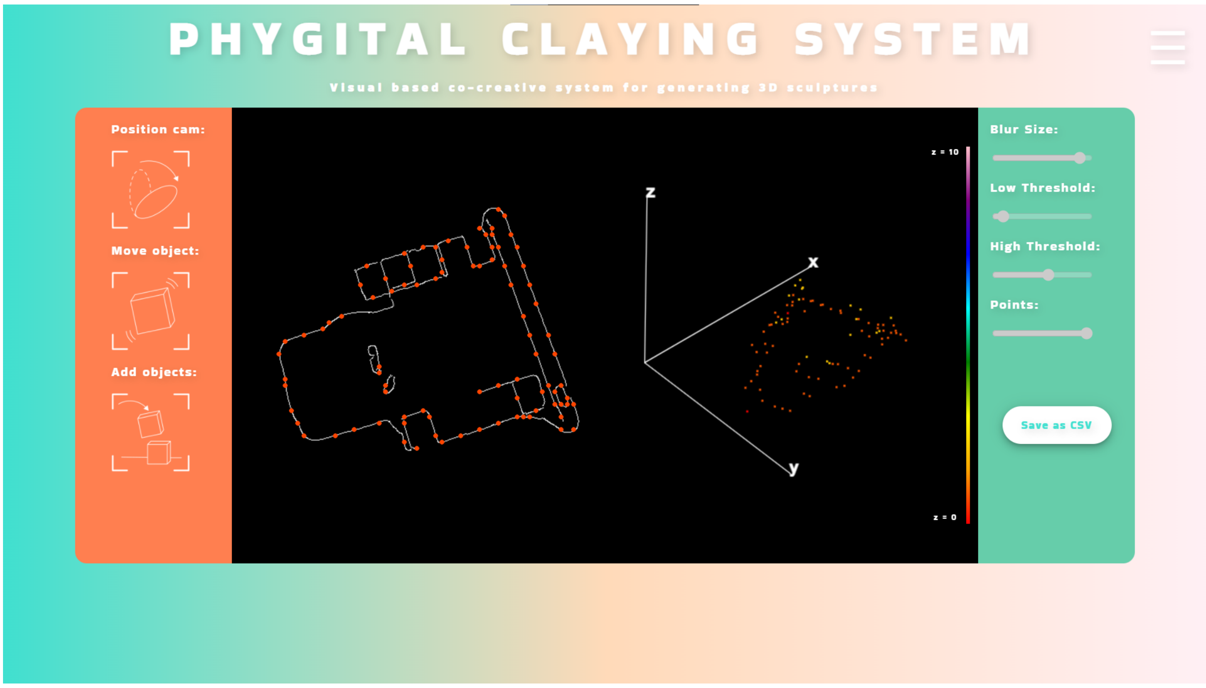
[3] Ben Shneiderman. 2007. Creativity support tools: accelerating discovery and innovation. *Commun. ACM* 50, 12 (December 2007), 20–32. DOI:https://doi.org/10.1145/1323688.1323689

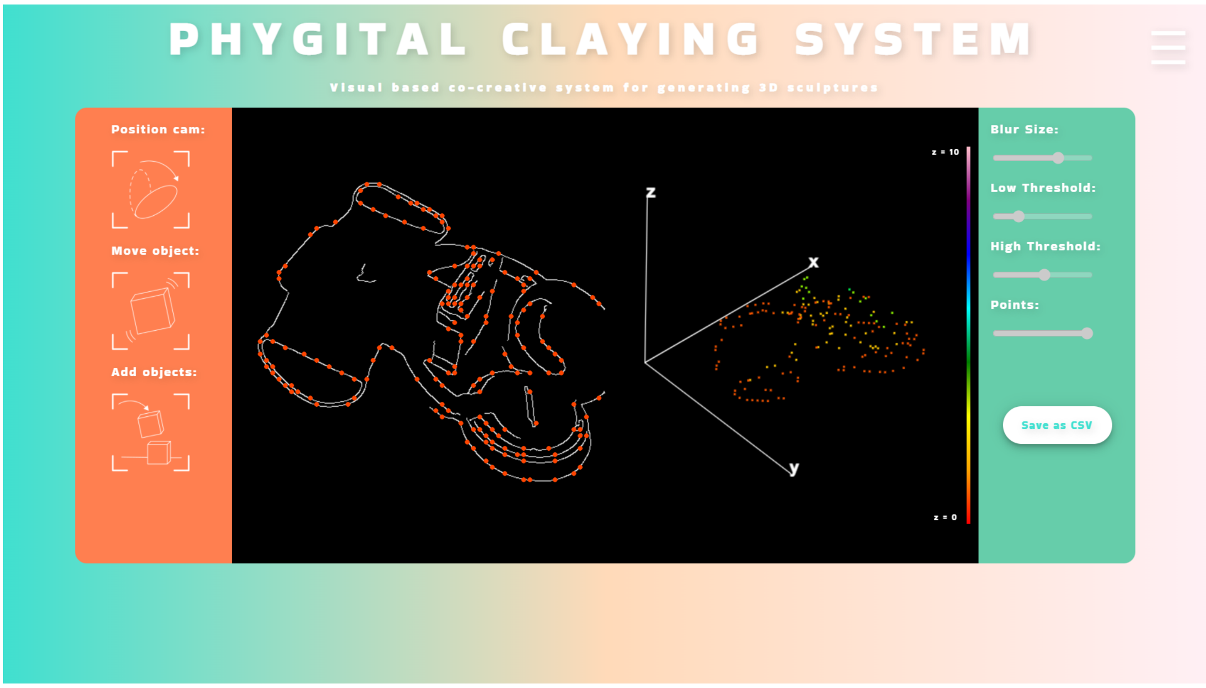
only by the user but also by the system, where it decides when a point cloud is ready to be exported.

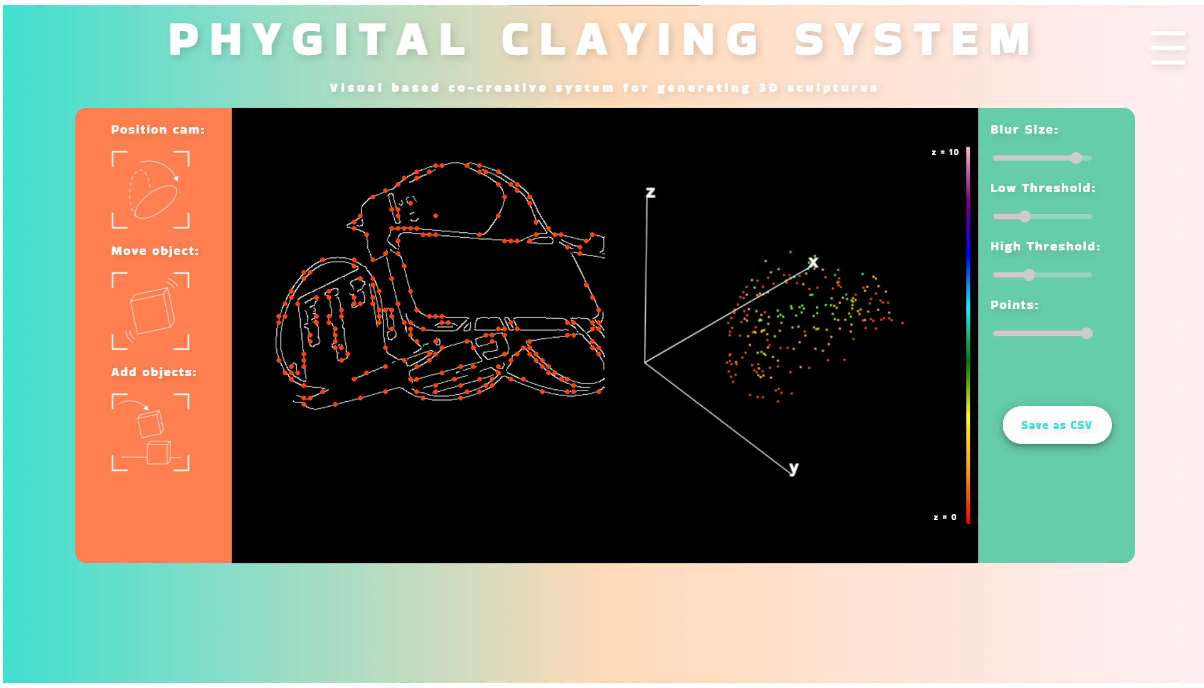
Overall, we believe our system needs further development to become a co-creative system. Nevertheless, we met some aspects of our initial requirements that we stated in the first paragraph, and we are convinced our prototype could help us with exploring designs for abstract sculptures.

APPENDIX

In this appendix three screenshots are provided to showcase various possible outcomes once interacting with our co-creative system.






PHYGITAL CLAYING SYSTEM
Visual based co-creative system for generating 3D sculptures
Position cam:
Move object:
Add objects:
z
x
y
z = 10
z = 0
Blur Size:
Low Threshold:
High Threshold:
Points:
Save as CSV