

A gameified application to represent hand-drawn level curves in augmented reality

Hengst, Pauline; De Bruijn, Abel; Dur, Rens; Van Der Kris, Julia; Van Gelderen, Beryl

DOI

[10.1145/3611314.3616062](https://doi.org/10.1145/3611314.3616062)

Publication date

2023

Document Version

Final published version

Published in

Proceedings - Web3D 2023

Citation (APA)

Hengst, P., De Bruijn, A., Dur, R., Van Der Kris, J., & Van Gelderen, B. (2023). A gameified application to represent hand-drawn level curves in augmented reality. In S. N. Spencer (Ed.), *Proceedings - Web3D 2023: 28th International Conference on Web3D Technology* Article 27 (Proceedings - Web3D 2023: 28th International Conference on Web3D Technology). Association for Computing Machinery (ACM).
<https://doi.org/10.1145/3611314.3616062>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.



A gamefied application to represent hand-drawn level curves in augmented reality

Pauline Hengst*

p.f.hengst@student.tudelft.nl

Delft Institute of Applied

Mathematics

Delft, Zuid Holland, The Netherlands

Abel de Bruijn

A.deBruijn-3@student.tudelft.nl

Delft Institute of Applied

Mathematics

Delft, Zuid Holland, The Netherlands

Rens Dur

R.C.M.Dur@tudelft.nl

Delft Institute of Applied

Mathematics

Delft, Zuid Holland, The Netherlands

Julia van der Kris

J.vanderKris@student.tudelft.nl

Delft Institute of Applied

Mathematics

Delft, Zuid Holland, The Netherlands

Beryl van Gelderen

B.E.VanGelderen@tudelft.nl

Delft Institute of Applied

Mathematics

Delft, Zuid Holland, The Netherlands

ABSTRACT

We present a mobile application designed to enhance students' understanding of directional derivatives and level curves in first year's calculus. The application offers visual tools and gamified learning to provide an engaging educational experience. Using novel technologies such the application is able to take a users drawing, generate a corresponding 3D model, and display this to the user. Through this presentation, attendees will gain a comprehensive understanding of the application's features and the benefits it offers to students in comprehending directional derivatives.

ACM Reference Format:

Pauline Hengst, Abel de Bruijn, Rens Dur, Julia van der Kris, and Beryl van Gelderen. 2023. A gamefied application to represent hand-drawn level curves in augmented reality. In *The 28th International ACM Conference on 3D Web Technology (Web3D '23)*, October 09–11, 2023, San Sebastian, Spain. ACM, New York, NY, USA, 2 pages. <https://doi.org/10.1145/3611314.3616062>

1 INTRODUCTION

The presented application is called LavaFlow and is hosted at <https://lava.ewi.tudelft.nl/>. Given level curves drawn by a user, it is able to scan these and convert them to a 3D model of a mountain. As a game, users have to predict the direction of a flow of lava along the slopes of the generated mountain, earning more points for more accurate predictions. This application is to be used in first-year's calculus courses, with the goal of giving a student a better intuition for the relationship between level curves and directional derivatives.

*Corresponding Author.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

Web3D '23, October 09–11, 2023, San Sebastian, Spain

© 2023 Copyright held by the owner/author(s).

ACM ISBN 979-8-4007-0324-9/23/10.

<https://doi.org/10.1145/3611314.3616062>

2 CORE FEATURES

This section highlights the most important pages of the application, giving a detailed overview of what the application has to offer. Each page description is accompanied by one or more screenshots.

2.1 Image capturing

The image capture page within LavaFlow enables users to capture an image of their hand-drawn level curves. The intention of this step is to facilitate collaboration between students as the same-level curve drawing can be scanned by different devices. Users are provided with options to review and retake the captured image if necessary.

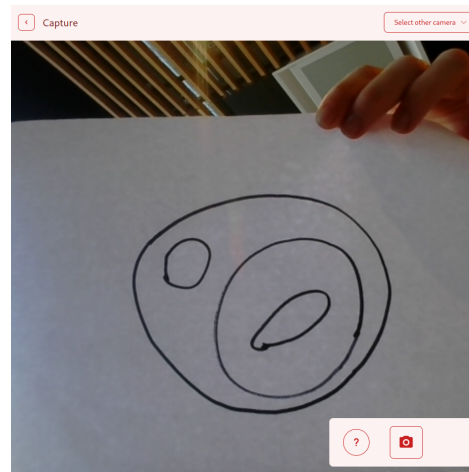


Figure 1: Capturing an image of hand-drawn level curves.

2.2 Isolating the level curves

The drawing isolation page in LavaFlow allows users to isolate the drawn level curves from the background of their image. The image captured on the previous page is processed to emphasise drawn lines and shown to the user. The user must then drag the corners of a box around their drawing for it to be processed correctly, a

selection cannot contain excessive noise or incomplete level curves or a model cannot be generated.



Figure 2: Isolating the level curves in the captured image, with the help of a preview in the top-right corner of the GUI.

2.3 Model preview and AR

The 3D model viewing page in LavaFlow allows users to explore the generated mountain model before being asked to place steam turbines. To make this step more engaging, a regular and an augmented reality (AR) view are implemented, which uses the user’s camera to project the generated model onto a surface in front of them. In both viewing modes, users can interactively rotate, zoom, pan, and analyze the model from various angles, facilitating a thorough examination of its topography and surface features.

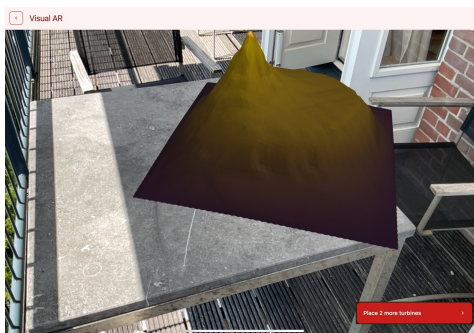


Figure 3: The model generated from the default level curves, without lava in AR.

2.4 Steam turbine placement

The turbine placement page in Lavaflow engages users in the process of predicting the direction of the lava flow along the slopes of the generated mountain model. A user is asked to place two or more steam turbines in positions they expect lava to flow. The source of the lava (the crater) is the point with the highest altitude on the model, which is shown to the user along with the processed level

curves. Steam turbines can be placed clicking a desired position, and be removed by clicking the same position again. Up to 10 steam turbines can be placed.

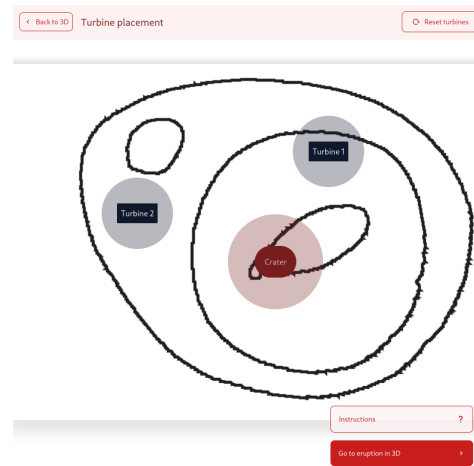


Figure 4: Placing turbines on the level curves.

2.5 Generating Lava and earning points

Once the turbines have been placed, one can return to the model preview and start the lava eruption. The lava is generated from the crater, and takes the steepest route down the mountain, dividing where gradients in different directions are similar. If a user has been accurate in their prediction, their steam turbines will be activated by the lava and they can expect a high score. Else they can try again by going back to the turbine placement page and changing the positions of the steam turbines.



Figure 5: The model with user-placed turbines and lava. The amount of points a user has scored is shown in the bottom right.