Semantic Weaponry: A Modular Approach to Text-to-3D Model Generation

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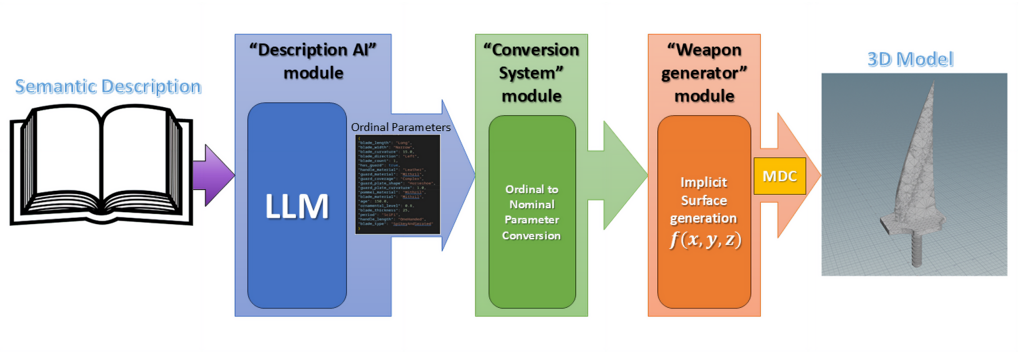

Figure 1: *Overview of our system prototype, demonstrating the logical flow of data through the three system modules, from semantic description to the 3D weapon model.*

Abstract

We present a modular approach to AI assisted Text-To-3D content generation that takes a semantic description of a 3D model, taking advantage of the semantic nature of of Large Language Models, to create a set of parameters which are then fed into an implicit surface function, the results of which can then be remeshed for use in 3D Digital Content Creation applications.

CCS Concepts

• ***Computing methodologies*** → ***Natural language processing; Shape modeling;*** • ***Applied computing*** → ***Media arts;***

1. Introduction

The rapid development and popularisation of Large Language Model (LLM) based AI systems and, specifically, their generative content creation capabilities can be felt across the creative industries, where, more recently, this has also expanded into the domain of computer graphics and 3D content creation [LZC*24].

We have developed a modular proof-of-concept prototype that generates a 3D model of a weapon from the description of the character using it (Figure 1).

The motivation for this project was for the design and choice of type of weaponry utilised by a character to be able to tell a story or contribute to a narrative without ever being used – considering the idea that 'Chekhov's Gun' (a well-known dramatic principle) could be important without ever being fired, simply by being present.

2. Implementation

Our prototype system makes use of three distinct stages, each encapsulated within a distinct, exchangeable module: A "Description AI", which converts a semantic description to a set of ordinal parameters, a "Conversion System", which converts the ordinal parameters to a set of nominal parameters, and a "Weapon Generator" that applies the nominal parameters to an implicit surface function to generate a surface in 3D resembling a sword or a spear.

2.1. "Description AI" module

The first stage of the process is carried out by the "Description AI" module that converts the semantic description into a set of ordinal parameters stored using a standard JSON format. This is largely dependent upon prompt crafting to have the output generated in the correct format.

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Our prototype system implements this using the “Llama-3.2-1B-Instruct” [Met24] model, however, the system is designed such that any LLM could be used. This is achieved by having the module simply output the prompt, which can then be fed to the user’s LLM of choice.

2.2. “Conversion System” module

The second stage’s“Conversion AI” module converts the ordinal parameters from the “Description AI” into nominal parameters that are compatible with the “Weapon Generator” module. For our prototype we implemented two modules, each using a different approach.

The first version of the module employs an LLM [Met24] for mapping the parameters, using the system prompt to provide context about the functionality and limits of both ordinal and nominal parameters to the model.

The approach implemented in the second version of the module does not use AI and instead performs ‘manual’ per-parameter mapping, where each of the ordinal parameters is converted to a series of mathematical operations on a certain group of nominal parameters to adjust them according to the design of the ordinal parameters.

2.3. “Weapon Generator” module

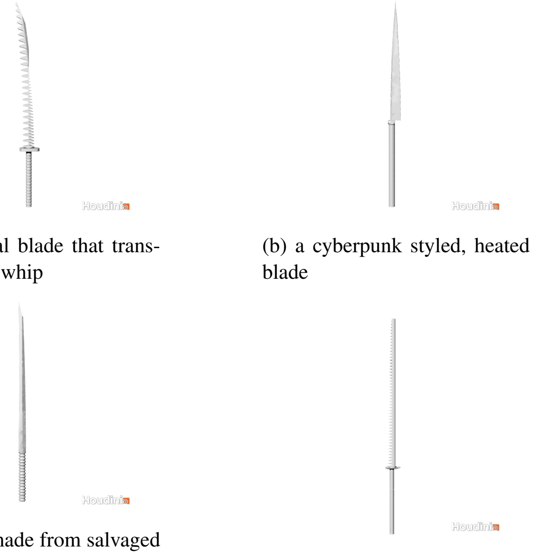
The implicit surface function [BB97] that we developed for our prototype’s “Weapon Generator” module defines a sword by splitting it into three distinct sections that are individually parametrised: The “Hilt” which takes the form of a cylinder with a patterned grip along the length of the cylinder and an optional pommel at the bottom, a “Guard” designed to protect the wielder’s hand from harm and a “Blade” in the form of an elongated plate with at least one sharpened edge.

The module converts resulting implicit surface 3D models are converted to a conventional boundary-representation 3D mesh using the “Manifold Dual Contouring” algorithm [SJW07], as it is known to handle sharp details and edges well.

3. Results and Discussion

Using the non-AI “Conversion System” module, our prototype is able to produce weaponry models with varying degrees of success: where figure 2a demonstrates the ability to adapt the the implicit surface function for a goal, Figure 2b shows an impressive ability for the system to adapt to the clean and simple aesthetics of the “Cyberpunk” genre [SYZ24] and Figure 2c shows the ability to understand the function of the blade (a strong weapon with purely offensive capabilities). Figure 2d, however, shows the system struggling to map the parameters given to a weapon to fit the original prompt.

That said, the “Conversion System” module implemented using the LLM approach did not live up to expectations due to two shortcomings of this approach: Firstly, the constraints of one parameter can be modified by another parameter, which could in turn apply constraints to the first parameter. To avoid this reciprocal causation, parameters need to establish a ranking to determine which will take precedence. Secondly, the nominal parameters are rather abstract and unable to be properly understood without exposing the entire implicit surface function to the LLM, however, doing this can potentially overload the LLM with information, leading to inaccurate end results.



(a) a magical blade that transforms into a whip

(b) a cyberpunk styled, heated blade

(c) cleaver made from salvaged metal in a post-apocalyptic world

(d) a regal blade wielded by a protector of a magical realm

Figure 2: *A set of images showing the 3D models resulting from various prompts given to the semantic weapons system, all using the ‘manual’ (non-AI) module for the conversion stage*

4. Conclusion and Future Work

Overall, we consider this project to be a success. Our prototype has demonstrated the ability to convert a character description to a 3D model with decent consistency.

Future work would be to build a system which is capable of building the implicit surface function as well, this would open up further adaptability of this system to other modelling needs.

References

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