StoryTube - Generating 2D Animation for a Short Story

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Abstract — **Many adults and children often prefer watching videos instead of reading books as reading requires more attention than watching videos. This paper aims at producing a rough 2-dimensional animation from the short story texts for a better understanding of the short stories by the user and for the animation creators to develop the videos from story write-ups. The model developed visualizes an English language story, which is given as input, using 2-Dimensional Animation, to make learning and consuming content much easier and more efficient. Extraction of essential information from the story is done to create an animation using PyGame. Simple short stories are fed as input and the output is a rough visualization of the text in video format. The user inputs the story to the model, the story gets pre-processed, and intermediate output is generated. This is done through a module that extracts dialogues and assigns them to the respective subjects. The information extracted is then passed to the animate module which animates the subject accordingly, along with the appropriate dialogue.**

Keywords —Animation Generation; Story Analysis; Subject-Verb; PyGame; Natural Language Processing; Artificial Intelligence; GUI; Sprite Set; Tkinter; Coreference Resolution; Visualization.

I. Introduction

A survey [1] conducted by Harris Poll, "Global market research firm", states that 59% of those surveyed mentioned YouTube as their most preferred learning tool and 47% chose reading.

Children like to watch narrative cartoons rather than listen to or read them as they can absorb a lot of information in a short period. A video can also help book authors promote their books and filmmakers create video versions of the same content. StoryTube aims to create a video using the short story text as input by the user.

The model proposed in this paper extracts information from the story and aims to visualize it in the form of animation that will increase the appeal of the story. The input is in the form of simple short stories written in English. The model can recognize and extract dialogues in quotes and create audio for it. The model uses PyGame, a simple and easy-to-use 2D animation library. The output is

a rough visualization of the text along with respective dialogues as audio.

The model has three major components - pre-processing, video generation, and audio generation. The given short story is processed by the Natural Language Processing (NLP) module. The video generation engine spawns a static environment and animates the objects. The audio generation phase extracts dialogues using regular expressions.

The goal of the model is not to produce a finished or polished product but to produce an intermediate result that the filmmakers and designers can work upon. The output is meant to be an intermediate step.

The rest of this paper is structured as follows. Section 2 features related work. Section 3 contains details on the dataset. Section 4 delves through our methodology in significant detail. Section 5 contains the findings and discussions. Finally, Section 6 highlights future work and concludes the paper.

II. Related Work

A lot of research has been conducted in the field of text-to-video in recent years, which aids in the ability to interpret information in a variety of ways.

The research paper by Shady Y. El-Mashad, El-Hussein S. Hamed [2] presents a model to generate a 3D cartoon from text input. The procedure proposed uses NLP for the purpose of evaluation of the input corpus by a coreference resolution solver to remove pronouns and
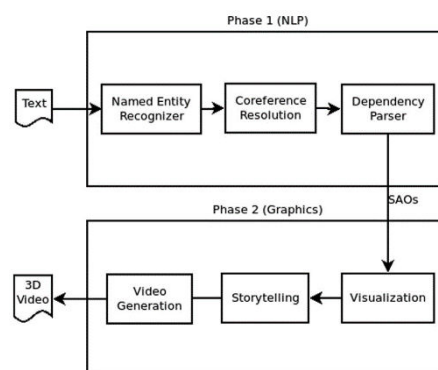

Figure 1: Pipeline of system architecture [2]

replace them with their appropriate nouns, which is followed by a dependency parser to find subject-action-object [2] (SAO) relations in the resolved text. Using the Unity game engine [2] platform, a 3D animated video cartoon is made in the graphics phase by visualizing each SAO.

CARDINAL [3] is software that aids in writing movie scripts with computer assistance. CARDINAL offers a way to see a script from several angles, for both editing and interpretation in 2-D and 3-D representations of the story. The timeline view gives the author an overview of the interactions in the plot, and the visualizations enable them to grasp their story from a spatial viewpoint. The results of the user study show that system users were confident and at ease when using it. CARDINAL's structure, components, and characteristics.

The model proposed by Yeyao Zhang et al. [4] generates animation for a given screenplay. This model also uses a new text-to-animation system that is capable of handling complex sentences. This is achieved by using a set of linguistic transformation rules to simplify complex sentences. Information extracted from the simplified sentences is used to generate a rough storyboard and video depicting the text. 68% of participants thought this system generated reasonable animation from the input screenplay in the survey conducted by the authors.[4]. The model can be separated into three components: Script Parsing Module, NLP Module, and Animation Generation Module. The drawback of this model is it processes the sentences independently, and any discourse information is lost.

Ma and McKevitt [5] create multimodal 3D animations using single sentences. These models are based on synthesized stories. The principles of cinema are used to define the camera location. The temporal relationships between human motions are determined by object and non-conflict animation channels. The system makes use of both static and dynamically generated objects. The system must adjust each character's movement speed, especially when multiple objects communicate with one another.

The approach developed by Hanser et al. [6] uses flash animations that last 30 seconds to enhance the reading of news articles on websites. This paper attempts to create a short video that represents the article as a 2D visualization. This works only for news in the football domain. To improve the verbal and semantic processing of emotions, more verbs and adverbs are required.

III. DATA

The data required in the making of the animation involves the characters with their action sets and the background images.

The characters and their actions are still framed images called sprites. Sprite sets of the current characters have been downloaded from the free set available on the website https://www.gameart2d.com/freebies.html. The database consists of sixteen characters and their respective available actions such as, walk, run, die, jump, and attack. Each character consists of actions as folders and respective images to form the animation. As a result of the limited number of character Sprite sets available, the number of characters allowed in the story has been restricted.

The different background images for each weather have been downloaded from the free images available on https://www.google.com as assets beforehand and loaded into the animation module as and when it is encountered.

TABLE 1: INFERENCES DRAWN FROM RELATED WORK

| S. No.	Paper	Conclusion	Limitations
1	Automatic creation of a 3D cartoon from natural language story [2]	A system for creating a 3D cartoon from text input is proposed using NLP techniques and graphics techniques.	Very limited scenes and characters. Specific hardware configurations are required.
2	CARDINAL - Computer Assisted Authoring of Movie Scripts [3]	It provides a means of viewing a script through various perspectives, for interpretation and editing.	Accuracy of visualizations based on the description provided. It fails to understand "suddenly" and so on.
3	Generating Animations from Screenplays [4]	Proposes a new text-to-animation system that uses linguistic text simplification techniques.	Does not take the context of the sentence into account. The animation generated might be lacklustre if the input is complicated.
4	Virtual Human Animation in Natural Language Visualisation [5]	Combines pre-created and dynamically generated animation. Simulates grasping accurately. Low-cost lip-syncing is implemented.	Simultaneous actions are not synchronized. It is focused on the accuracy of visualization rather than storytelling.
5	Emotional visualization of news stories [6]	Extracts emotion-bearing words from football news. These are processed and animated as abstract animations in the background.	Very limited verb detection and animation. Works only for news in the football domain.

Figure 2: Character Actions
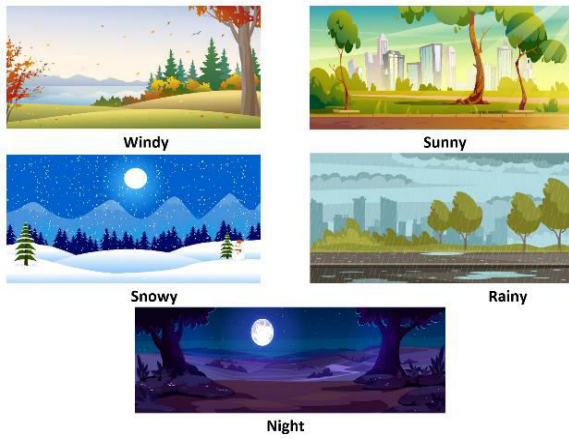
Figure 3: Background Images

IV. METHODOLOGY

This chapter comprehensively details the methodology used to implement the solution to solve the problem at hand.

A. Overview

The model focuses on the creation of animation from a brief narrative. The input is a succinct story with a restricted set of characters and actions, and the output is a two-dimensional animated representation. The co-reference resolved text is passed on to extract subject-verbs doublets [3], after which, appropriate actions (verbs) are assigned to the character. The extraction of dialogue is performed utilizing a regular expression, which is subsequently transformed into an audio file and played during the relevant moment. The final animation is produced using PyGame.

B. Natural language processing (NLP) Phase

The Natural Language Processing module encompasses the steps of dividing the input story into individual, straightforward sentences for the purpose of recognizing the subject and verb in each sentence using ClausIE [12]. This is accomplished following the completion of the coreference resolution on the specified text.

The dialogue extraction is performed on the text separately and is incorporated with the SVs. The output of the NLP module, presented line by line in the form of a list of lists that contain the SVs as tuples, is passed to the animation phase.

1) Coreference Resolution: Coreference resolution involves determining linguistic expressions that refer to the respective real-world entity in natural language [2]. This is the initial task in the pipeline and serves to aid in subject detection as the narrative is processed sentence by sentence, without retaining the context of previous sentences. The AllenNLP [9] module is employed for coreference resolution.

Eg: "Once upon a time there lived a dog. It was walking." is converted to "Once upon a time there lived a dog. Dog was walking." This is done to help in the extraction of the subject for each character line-wise/scene-wise.

2) Dialogue Extraction:

a) Dialogue recognition: The dialogue is extracted by a regular expression r"([\"\'])(?:(?=(\\?))\2.)*?\1"", the regex extracts all the words within a pair of double quotes, which is then used to make the character speak its respective dialogues.

$$r"([\backslash"\backslash'])(?:(?=(\backslash\backslash?))\backslash 2.)*?\backslash 1"" \quad (1)$$

b) Dialogue audio file: The audio file (mp3) is generated by gTTS (google-text-to-speech), which is then saved and played over the animation at the appropriate time.

c) Voice modulation: A unique accent is assigned to each dialogue, which is selected randomly from a pre-determined list.
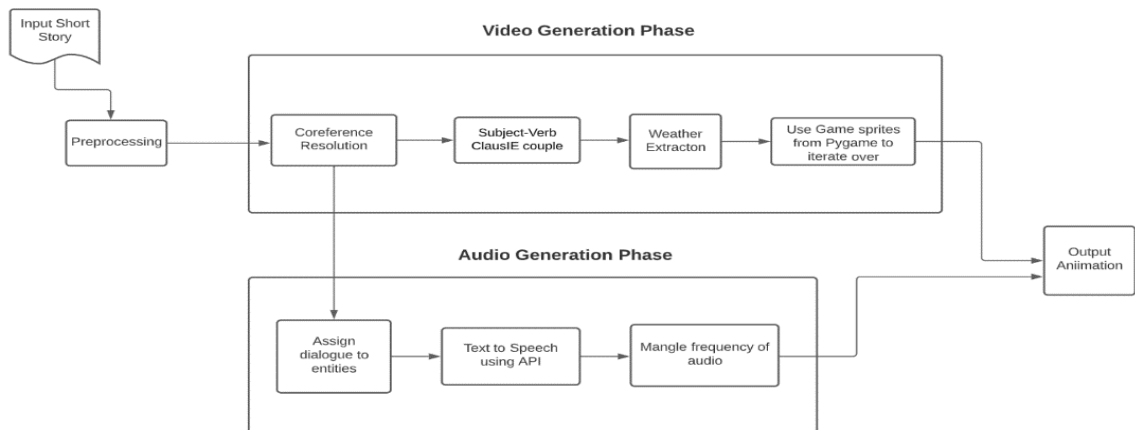

Figure 4: Overview of the StoryTube Animation System

3) Subject-Verb Extraction: This constitutes the intermediate representation, signaling the completion of the Natural Language Processing phase and indicating readiness to move on to the animation phase [3]. The subjects and verbs are detected using Clause-Based Open Information Extraction (ClausIE) [12]. ClausIE is an open information extractor that finds and extracts relations and their arguments from natural language text. The output from ClausIE provides an explicit description of a set of actions being done in a sentence that will be utilized to send information to the animation phase about the subject, and the action being performed by the subject.

The Subject-Verb (SV) [3] model utilizing the ClausIE module is comprised of two components. The initial part of the SV model commences by dividing the input text into individual sentences. The subject and verb in each sentence are identified using ClausIE [12]. Any sentence containing text within double quotations, which is regarded as dialogue, is ignored. The SV [3] appends the dialogues to the tuple with the verb "said", which is then utilized by the animation engine to play the generated and saved audio file of the dialogue. The second part of the SV model removes stop words and lemmatizes the words detected as subjects and verbs to match the available characters and actions accordingly. The WordNet dataset and the WordNetLemmatizer are utilized for the elimination of stopwords and the lemmatization process, respectively.

4) Weather Extraction: Additional information pertaining to the scene is extracted for the purpose of adding a background to the video [7]. The module is responsible for detecting the weather mentioned in the narrative text. There are five different weather conditions and times of the day in the database: Sunny, Rainy, Windy, Snowy, and Night. These words in the story are matched with the database available and displayed. Whenever the weather is given in the input text, it will be detected, and the corresponding weather will be presented promptly. A change in weather mid-story is also reflected in the animation accurately to adhere to the scene created in the story.

C. Video Generation Phase

The animation module is executed subsequent to the completion of the Natural Language Processing phase. The module employs a cross-platform collection of Python modules for game creation, known as PyGame. PyGame encompasses libraries for sound and computer graphics specifically designed for use with the Python programming language. This module entails comprehending the intermediate Subject-Verb duo [3] and instructing the characters to perform their respective actions in accordance with the sequence of the story. In this module, the sprites, in the form of PNG images, of each character-action pair are executed in a sequential manner. The characters and their actions were downloaded from an online source to make a database. The actions are performed by iterating over the lines of the story to produce the effect as stated by the story. The background image is inserted based on the weather which is described in the story.

Firstly, the action's direction and coordinates in the PyGame window are taken into consideration as a starting point for the animation. Each character-action pair is selected from the list of subject-verb pairs and the respective action frames are loaded into a list. The frames in the list are played at a certain speed to produce the output animation. In the event that an action is not present in the actions database, the idle frame for that character will be displayed. If the character is absent from the database, the line involving that character will be disregarded. If the character's action involves movement, the X-coordinate of the character is gradually increased as the frames are rendered. If the action is jump, the Y-coordinate is increased for half the length of the animation and decreased for the rest. If there are multiple characters in the sentence, and one character finishes animation before the other, the last frame of animation for that character is played until the other characters finish the animation.

However, there are some constraints. Multiple dialogues are not detected in a single line. The SV (subject-verb) [3] extraction is not perfect. There is a limited set of characters and actions supported. The SV module does not find the nearest verb if an action is not supported.

a) Graphical User Interface (GUI):

The Graphical User Interface (GUI) module uses the Tkinter library from Python. The GUI window is partitioned into three parts. The first part of the window is utilized by the user to enter a short simple story of 5 to 7 lines adhering to the restricted list of characters and actions mentioned in the help box. The button "Submit Story" starts the execution of all three modules to get the finished animation with the dialogue audio.

The second partition of the window displays a list of intermediate Subject-Verbs (SVs), consisting of characters and actions found in each sentence, in the order in which they must be executed to animate the story. Additionally, it displays the amount of time taken for StoryTube to complete its iteration through the entire story and finish the pipeline process. The third partition of the window presents the first six frames of the animation in the form of screenshots, displayed in the order of the story. The graphical user interface will remain accessible until the window is closed. Multiple stories can be entered in the
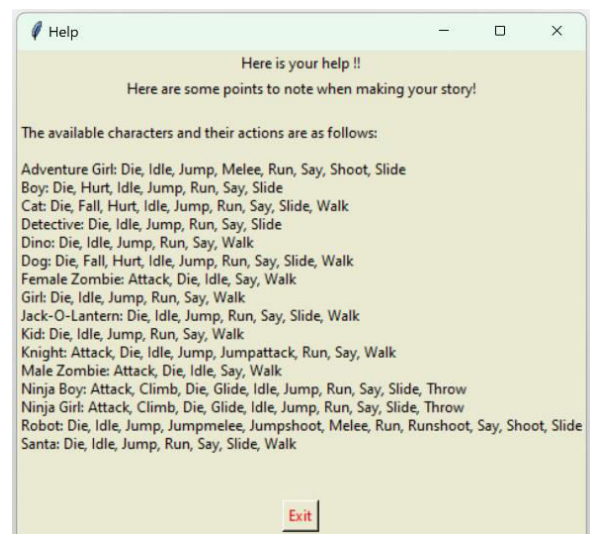

Figure 5: The help box with the Subject and Actions list.

Figure 6: GUI to enter story along with intermediate representation.

Figure 7: Two characters in action from a story displayed in PyGame window.

GUI after displaying the animation and clearing the previous story. The frames displayed in the third partition will be updated accordingly for each respective story.

After the story is entered in the first partition of the GUI window, the story gets converted into an intermediate representation and is passed to the PyGame animation module to convert it into an animation. The PyGame animation window is opened separately in a new window for demonstration.

V. RESULTS AND DISCUSSION

In this section, a comprehensive summary of the major findings from the preceding section is presented, accompanied by a corresponding clarification for each result.

A. Natural Language Processing (NLP)

The Natural Language Processing module has partitioned the input short story into discrete, unambiguous sentences to facilitate the identification of the subject and verb in each sentence. This identification process has contributed to generating an intermediate result.

1) Coreference Resolution: AllenNLP [9] has been used to perform coreference resolution. Eg: "Once upon a time there lived a dog. It was walking." is converted to "Once upon a time there lived a dog. Dog was walking." This helps in the extraction of the subject of each line.

2) Dialogue Extraction: The process of using regular expressions for extracting dialogues and subsequently converting them to audio format via gTTS is implemented to assign them to a specific character.

3) Subject-Verb extraction: An intermediate form of a list of Subject-Verb pairs is generated, which comprises all the necessary information required by the animation engine to produce an animation. This intermediate representation holds all the relevant details for the successful creation of the animation.

B. Animation

The module produces the ultimate output of the model by performing an analysis of the intermediate Subject-Verb pairs. This analysis necessitates the characters' actions to align with the predetermined sequence of events in the story. Each character and action pair's sprites are displayed here in a sequence as PNGs. To create the database, the characters and their actions were retrieved from an internet source. The actions are carried out by repeatedly reading the story's words to create the desired results. The weather that is stated in the story is used to determine the background image.

C. Graphical User Interface (GUI)

The final graphical user interface (GUI) has been developed using the Tkinter library in the Python programming language. The design of the GUI is intuitive

and straightforward, catering to a younger user demographic. The GUI display integrates the input story, the intermediate representation, and the output frames within the same window, providing a seamless user experience.

D. Time Efficiency

The execution time of the program is contingent on the intricacy of the story and the number of lines. As the constraints and terms to be processed increase, the duration for analyzing story and loading instances into the PyGame animation window becomes longer and more variable.

VI. CONCLUSION AND FUTURE WORK

In an effort to address the challenge of text-to-video conversion, numerous approaches were evaluated and tested as part of this work. The current architecture for text-to-animation has demonstrated effective results in transforming short story texts into 2D animation videos.

One of the approaches considered during the early stages of the development of StoryTube involved using the Unity game engine [2] to generate video from intermediate NLP output. This approach required a comprehensive character description from the story, as characters had to be created from scratch based on the description [10]. Obtaining such a level of detail and description for characters in a short story is challenging. Furthermore, the Unity [2] game engine requires a powerful hardware setup.

Another approach involves the utilization of an open-source framework for 3D rendering called Panda3D [7], which necessitates the use of Mixamo (by Adobe) for characters and animations. This process involves using design and creation software, such as Blender, to convert the character file into a format compatible with Panda3D. This process of selecting the characters and animations and converting them to a file type suitable for Panda3D cannot be automated and hence, is not feasible.

StoryTube uses PyGame to generate 2D animations with eye-catching characters and actions in minimal time. It provides audio accompaniment to the animation and includes variations in audio to represent different characters. The current model inputs simple sentences and recognizes a dialogue per sentence. If the actions specified in the sentence are not supported, the character is animated as being idle. The model currently includes sixteen characters with limited action options.

In terms of future developments, the model can be enhanced by incorporating more characters and animations to increase its versatility. ChatGPT [8], a highly promising software, can be utilized to create stories and improve subject-verb detection. The addition of lip-syncing for the characters would bring a more realistic aspect to the generated animation [11].

Potential areas for improvement in the current story-to-animation model include incorporating object detection functionality. The integration of object detection, placement, character placement, and movement will add more precision to the output and give more depth to the model.

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