Exploration of Dance Annotation Tool Representation Models and Searchability of Annotations

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ABSTRACT

This research paper reviews dance annotation tool implementations for storing and searching dance media content and the usability aspects of the tools. We aim to investigate how the addition of annotations to dance media content can be used to search dance media within an archival system. The dance annotation tools develop and implement a dance representation model. We further explore the various storage methods of these annotations, while considering how annotations will be retrieved based on the type of query submitted by users. Furthermore, the usability aspects of dance annotation tools are reviewed to highlight usability considerations when developing annotation tools in general. Each dance annotation tool implements a different dance representation model, which is developed through collaboration with dance experts and the use of general movement terminology. The dance representation models provide a controlled vocabulary for which to identify and annotate dance concepts. Dance representation models are then used in conjunction with storage methods of annotations, which in turn is used to complement the querying of dance media content through the use of annotations. Subsequently, the usability aspects need to be considered during the development of annotation tools as annotating is a time-consuming and tedious process. Annotation tools should, therefore, be developed with these factors in mind, i.e. through the simplicity of the dialogue used and the annotation process steps. Dance annotation tools have, hence, used annotations as a manner of adding semantic content to media objects for organization within an archival system and utilizing it for efficiently retrieving dance media content.

CCS CONCEPTS

• Information systems → Information Retrieval • Human-centered computing → Human computer interaction (HCI) • Applied computing → Annotation

KEYWORDS

Annotation Tool, Dance Annotation Tool, Video Annotation, Dance Representation Model, Movement Descriptors, Dance Concepts, Ontologies, Database Schema, Usability, Usability Testing

1 Introduction

The capabilities of technology today have allowed for the ease of storing and retrieval of dance media objects. The methods of storing these dance media objects include the memories of people, dance notations and digital archives [14]. Dance has been stored within the memories of people and passed down from generation to generation. Through this method of dance storage many dance productions could have been lost, as storage is limited to the memories of people. When compared to the storage of dance using dance notations, this method of storage allows dancers to archive dance productions, which provides us with a method of documenting and storing dance. The two most prevalent dance notations are Labanotation and Banesh Movement notation [16]. Although these notation systems provide a method for documenting and storing dance, experts within the field are required to translate the abstract representations of the dance movements to dancers, who are not able to decipher the meaning of the abstract notations. Lastly, digital archiving has provided us with an easy method for storing dance, while preserving the cultural heritage of dance. However, due to the rich semantic content of dance videos, and the volume of dance media available, it becomes a challenge to search a database for specific dance content [7] [8] [9] [13] [14].

Dance media files are organized based on the archival system within which it is stored. The need arises for the organization of these media objects to allow choreographers and dancers to easily browse and/or retrieve dance media objects within dance archival systems.

This paper investigates approaches taken to solve this problem of browsing and retrieving dance media objects through the utilization of various annotation tools, which are used specifically for semantically annotating dance, and how these tools implement a search mechanism for dance archival systems. The dance annotation tools that are reviewed make use of manual or semi-automatic annotation processes, which allows choreographers and dancers to express their creativity when annotating dance media objects through the manual process [8] [14] and provides a controlled vocabulary for annotating within a semi-automatic process [7] [8] [9] [13] [14]. Furthermore, the paper reviews the usability of annotation tools to highlight existing innovations and issues regarding the annotation process.

The result of this literature review will assist us in investigating the best implementations of dance annotation systems for the purpose of browsing and retrieval of dance media objects. Furthermore, the research will be used in developing a dance annotation system to improve the searchability of stored dance media objects within a mobile application environment.

This review proceeds to explore the dance representation models implemented within a number of dance annotation tools and how they were developed in section 2, while in section 3 the exploration of how annotations can be utilized for searching a dance archival system is presented. Furthermore, section 4 presents the various aspects of usability of dance annotation tools and recommended strategies to use when developing annotation tools. Section 5 then constitutes a discussion of how dance representation models are developed and implemented within the annotation process, as well as the limitations of the various annotation tools. Also, included in this section is a discussion of the usability strategies to consider when developing annotation tools and how it can be implemented and verified within the development process of an annotation tool.

2 Dance Representation Models of Annotation Tools

Many dance annotation tools have been developed over the years and each developed for a specific reason. These tools aim to enrich dance media objects for the purpose of preserving the cultural heritage of dance and to improve the findability thereof. Consequently, this allows choreographers and dancers to browse and/or search specific dance content within an archival system, while supporting dance education. Each of these annotation tools make use of a semantic representational model for dance concepts. We will now explore the various semantic representational models used by these tools and how it is implemented within the annotation process.

Each annotation tool adopts a different approach to modelling the semantics of dance concepts. Some of the annotation tools use similar approaches in modelling when considering the types of models used, while still varying in the specifics of dance concepts.

Some annotation tools allow users to annotate using free-text, e.g. Choreographer's Notebook [15] and ANVIL [10]. The reason for this seems to be that these tools were only used to annotate video content freely, without any relation between annotations and for the purpose of enriching media content for educational or research purposes. This shows that not all dance annotation tools utilize a conceptual dance/movement model to organize annotations.

Semantics of dance are conceptualized in many different ways. Due to the magnitude of dance semantics and its humanistic aspect it can be a challenge to develop a conceptual framework. Many dance annotation tools, however, have attempted to conceptualize dance semantics based on generic dance movements and/or specific genre vocabularies [7] [8] [9] [13] [14]. The aim of many dance annotation tools is to enrich dance media content for many purposes, including searching and filtering, and this is achieved by annotating dance media content [7] [11] [13] [14].

When developing a conceptual framework for dance, the dance annotation tools tend to use an approach that is specific to the tool. A particular approach that was used throughout annotation tools is using descriptors for dance movements. These descriptors, however, were used differently within each annotation tool. The Web-based Movement Library (WML) [7] used generic movement descriptors, which were categorized into *Action, Movement Principle* and *Movement Quality.* These descriptors encompass generic actions, with the corresponding direction of the action and the fluidity of the action. For each category there is a list of labels that can be used to describe the movement descriptor. *Action* includes labels such as *Arm Gesture, Leg Gesture, Jump, Turn,* etc. *Movement Principle* includes labels such as *Symmetrical/Asymmetrical, In/Out of Balance, Still, Aligned,* etc. *Movement Quality* includes the following *Direct/Indirect, Fluid/Rigid, Heavy/Light,* etc. When annotating using WML, users are able to annotate by segmenting the media file, based on start and end time. The details of the annotation would be inserted by the user. The annotation details are filled in by the user selecting the category of the movement descriptor, labels for the movement descriptor selected and the body part involved within the dance movement. BalOnSe [8] uses a model that categorizes movement into using *Generic Movement Concepts* and *Specific Movement Vocabularies.* These categorize movements into generic movements that are known to non-experts of the dance field and movements that are specific to the dance genre, in the case of BalOnSe it is Ballet. BalOnSe allows users to annotate using free-text and by using dance concepts defined within the dance representational model implemented. Within the annotation process, users select the segment of the media file based on the start and end time. Next, the user selects whether they would like to use the free-text option to add annotation details or use the provided vocabulary, i.e. *Generic Movement Concepts* and *Specific Movement Vocabularies.* The *Generic Movement Concepts* propose the following actions to be included: *Arm Gesture, Leg Gesture, Turn, Bend, Extend, Jump, Balance, Fall, Walk, Run, Position* and *Stillness.* The *Specific Movement Vocabularies* include vocabularies of dance genres. In the case of BalOnSe it is a *Ballet Movement Vocabulary,* which is further categorized into *Arabesque, Assemblé, Attitude and Balancé.* These ballet movement categories are further divided into specific dance movements, which are not explicitly specified within [8]. These movement descriptors within the *Generic Movement Concepts* and *Specific Movement Vocabularies* categories provide users with dance concepts to annotate dance movements within media files. These annotation tools are only two examples of how dance movements can be conceptualized. However, in each example the annotation details added by users differ, which can be attributed to the fact that the tools implement different dance representational models and the method of annotation provided by the annotation tool, i.e. manual annotation process within the WML tool and semi-automatic annotation process within the

BalOnSe tool. Most other annotation tools make use of generic movement descriptors [9] [13] [14], while some make use of both generic and specific vocabulary descriptors [8] [11].

Other annotation tools conceptualize dance semantics as events and objects partaking in events. The events in each annotation tool depict different aspects of a dance video. An event within the DMAR system [14] represents dance concerts or dance clips, and the objects represent dancers/instruments partaking in the events. The starting point for the annotation process begins by the user selecting the category of the dance media object being a dance concert or a dance clip. Afterward, the user annotates the media file using movement descriptors defined within the DMAR system. In comparison, the DVCM model [13] depicts events to be video segments of a dance video and dancers as objects within events. The objects in each annotation tool, DMAR and DVCM, contain attributes which include movement descriptors for dance steps/movements.

With each of these conceptualizations being used within the tools mentioned, it provides a vocabulary for users to annotate dance media objects. By providing users with a dance vocabulary they are able to enrich dance media objects by adding metadata using attributes of each annotation, where the annotation is an event, object and/or a movement concept of an object within an event. Another model that can be used for dance representation is an ontology. Since an ontology is a domain specific model that reasons about objects within the domain and their relationships, it serves as a novel conceptual model for representing dance semantics [11]. Within the dance ontologies of BalOnSe [8], DanVideo [9], TDAT [11] and DMAR [14] annotation tools the dance concepts are arranged according to a hierarchical taxonomy. These ontologies were developed using generic movement terminologies and communicating with experts in the field of dance. Each node represents a dance concept and associations between those concepts. Dance concepts can be categorized according to generic dance movements or specific dance movements of dance genres, as mentioned previously. The ontology is used to arrange these dance concepts according to the associations between them. Each ontology differs with respect to it representing generic dance media concepts or specific dance genre vocabularies. TDAT [11] is a system that captures a pre-built ontology into the annotation module. This allows the annotation vocabulary to extract concepts from the captured ontology. This tool uses an innovative approach to annotation tools as it allows users to use genre specific vocabularies for the planned use of the annotation system, instead of using a pre-built ontology that does not correspond with the content for which the annotation tool will be used.

These conceptual dance models are used to provide a vocabulary for dance concepts for the annotation of dance media. Since dance media is usually in the format of visual and/or audio files these annotations can be used to enrich the media content, therefore making it searchable. In the next section we will further explore how dance representation models used for annotating can be used to retrieve content within a dance archival system.

3 Searching Annotations

Within the context of dance media objects, being in the format of video and/or audio, it proves a challenge to organize dance media based on semantics contained within the content of media objects. Dance representational models have provided a means of enriching dance media objects through annotations. Through the enrichment of dance data by using annotations, it presents an opportunity for dance media objects to become searchable. In order to use annotations for the purpose of searching dance media objects, we have to explore the methods used for storing annotations. Once we understand the various storage methods of annotations, we proceed to review the searching of dance media objects using annotations.

3.1 Archiving Annotations

Annotations of dance media content include metadata added by users through the use of attributes. Annotations, in the case of dance videos, are done by segmenting the video. Each segment containing a start and end time, of a dance video illustrates the creation of an annotation. The attributes of an annotation are determined by the dance representational model integrated with the particular annotation tool, as discussed in section 2. The metadata added to the annotation by users is the information that requires to be stored for retrieval.

Dance annotation tools store annotations in various ways. These methods include XML Schema [9] [14], Relational Database Schema [8] and specialized database tables [7] [10]. The method for storing annotations would most likely complement the search technique implemented for the annotation retrieval.

3.1.1 XML Schema. The choice of representing the dance media annotations using an XML Schema is based on the model's "simplicity and maturity" [14]. XML Schema is an established model used for representing the structure of data that is being stored. This model can be used to structure how annotation information is stored within a database, as shown within the DanVideo [9] and DMAR [14] annotation tools, for each dance media concept. Each dance media concept within the system is defined within the XML Schema. The XML Schema provides the attributes to be added to each dance concept, i.e. element within the XML Schema. This schema not only defines the structure of the annotation to be stored but validates the type of each attribute of the dance concept that is annotated. DanVideo [9] annotates media content by categorizing metadata into macro and micro dance media features. Macro features include dancer details, details of music, tempo, dance origin, dance type, context, and performance venue. Micro features include events, actors, agents and concept. Events refer to the name of a dance move and number of dancers, while actors partake in events. Actor attributes include the role of actors, the time span and the posture of the actor within the event. This is the metadata that is added to an annotation by users, through the use of attributes that are defined by the schema. The metadata added to annotations, within the DMAR system [14], are added to dance concerts and/or dance clips. These are the events within which dance concepts occur. Dance concerts are events that consist of a set of dance clips.

Dance clips are events that consists of a set of dance pieces. Dance pieces are the basic unit of dance as it constitutes a set of dance moves that are performed by dancers. Dance moves represent the action of a dance character and is defined within the model as a tuple <*Agent-Motion-Target-Speed*>. The dance move tuple does not represent genre specific dance moves. The *Agent* and *Target* represents body parts, where the *Agent* is the moving body part and *Target* is the spot at which the *Agent* body part moves towards; *Motion* represents static poses or gestures of the body parts; *Speed* describes the speed of the movement as low, medium, fast, gradual ascending or gradual descending. These are the attributes added by users during the annotation process. Both schemes used by DanVideo and DMAR are XML Schemes. However, the XML Schemes are used to store different aspects of dance media content and dance concepts. Subsequently, the XML Schema can be used for browsing or searching annotations based on the elements defined within the XML Schema.

3.1.2 Relational Database Schema. BalOnSe [8] makes use of a relational database schema for its database architecture. The schema is used to define the metadata to be added to dance media objects and to define the attributes to be contained within an annotation. Furthermore, it describes the relations between database tables and columns. In the context of dance annotations, it stipulates the correlation between various annotations and its relation to specific media objects, i.e. each media object (video) contains zero or more annotations. For the intention of annotating media content, structuring the database using a relational database schema is a suitable choice as it clearly defines the relationship between each video being connected to many annotations, i.e. a media object has a *one-to-many* relationship to annotations and annotations have a *many-to-one* relationship with media objects. This is the case for BalOnSe. The metadata to be added to annotations within the BalOnSe tool includes the start and end time of the video segment, the dance movement descriptors defined within the *Generic Movement Concepts* and *Specific Movement Vocabularies* categories, as mentioned in section 2. The metadata of the movement descriptors are defined by the ballet.owl ontology implemented within the system.

3.1.3 Specialized Database Tables. WML [7] annotation tool stores the annotations within "specialized database tables". These tables consist of columns corresponding to the attributes associated with each annotation. Within the database tables of WML and ANVIL [10], specifically for annotations, the columns include an identifier for each annotation, the segments indicating the lifetime of the annotation within a dance media object (*start time* and *end time*) and the rest of the columns indicating attributes relating to dance concepts, which are stipulated within the dance representation model. Dance concepts that are annotated using free-text are added to columns and named with the prefix of a '#' symbol followed by the annotation name to indicate that the annotation concept is user-defined [7].

Specialized database tables, in the context of dance media objects, can be useful when defining the structure of data being stored and no conceptual framework is implemented to relate columns and/or tables to other columns and/or tables within a database. In the event that annotations are user-defined [7], specialized database tables can be useful to note which attributes are user-defined and perhaps implement it as a standard attribute representing some user-defined dance concept for future work.

Each method of storing annotations vary from tool to tool. The method that each tool used would correlate to how each tool would use annotations for searching. XML Schema is used to categorize dance media objects based on elements of annotations which can be queried or used to filter dance media objects based on the attribute within the XML Schema. In comparison, the relational database schema would query the annotation attributes and return the media objects that are related to the annotation attributes queried. As mentioned previously, specialized tables store annotations with unique identifiers which can be used to query annotations. Since the annotation database tables in WML [7] and ANVIL [10] are unrelated to other database tables within the system, it could be proposed that a relational database schema be implemented to relate annotations of dance media objects to one another.

3.2 Utilization of Dance Annotations for Searching

The method of searching used to query and retrieve annotations within an archival system will depend on how the annotations are stored. As previously mentioned, dance media objects are usually in a visual and/or audio format which is a challenge to search as there is a lack of structured content to search. An approach was taken to annotate dance media objects to enrich the dance data and make it searchable. Dance annotation tools make use of search engines for the retrieval of dance media objects based on user queries. User queries can be in the form of filters, which categorizes content based on high-level annotation concepts, such as dance genre [7] [8] [14], as well as in the form of free-text queries [7] [8] [9] [13] [14]. The ranking of query results is imperative to the search functionality as it provides results based on its relevance to a user's query. Dance annotation tools provide users with a number of query formats, which will be reviewed in the following sections, including the proposal of domain specific ontologies to retrieve more relevant and better ranked query results.

3.2.1 Query Types. The querying of annotations within dance archival systems vary. Search functionality is mostly split into two within dance archival systems, i.e. browsing by categories based on system defined dance annotations and free-text queries. *Table 1* indicates the types of query functionalities offered by some of the dance annotation tools discussed in previous sections. Some annotation tools implement both search functionalities, whereas others implement either.

Dance annotation categories, for the purpose of browsing, are defined differently within each dance archival system. The DMAR [14] system allows the users to browse the following categories: *dance concert, dance clip, dance piece, dance movement, event, person, character, object, emotion, setting, song* and *lifespan,* and query media objects using free-text. WML [7]

allows users to only browse by *dance genre* and dance movement categories. In comparison to the previous annotation systems, DVCM [13] contains a separate module within its system called the *Query Processor*. This interface is presented to users with the categories and/or dance media concepts that users are able to search. Users then fill in each category based on the content that they are searching for or they would form a free-text query within another section of the *Query Processor* interface. The *Query Processor* then searches the archival system and retrieves all the relevant content based on the categories that were filled in by the user or the free-text query. Categories for browsing are different in each system. However, the search results are rendered in a similar manner. Each category that is selected by users to browse will list all content that is relevant to the selected category. The system searches and retrieves all dance media objects that are annotated with the relevant dance concepts/annotation category and listed as a result for users to browse.

Particular dance archival systems allow users to query content using free-text, summarized within *Table 1,* for dance annotation tools discussed within previous sections. A search engine is presented to users, in which they are able to insert free-text queries pertaining to dance media content. The queries might be free-text, but the keywords used to search would correspond to the vocabulary provided to annotate media objects within the specific annotation tool [9] [13] [14]. The free-text queries could, also,

consist of movement descriptors which can be used as keywords for searching dance archives [7] [8]. Within DanVideo [9], a query user interface, called the *Query Generator,* is presented to users to enter free-text queries, which are then processed to extract dance media concepts/elements, i.e. tokens. DanVideo implements a syntax for queries in the form of *<vg, actor, agent, speed>*, where each element within the tuple is replaced with a token that was extracted from the free-text query. The approaches of WML [7] and DMAR [14] are related in that keywords are extracted from the free-text and used to retrieve content from the archive. However, they do not mention the use of a syntax for the query that is processed to retrieve content. BalOnSe [8], in addition to the previously mentioned methods, applies a slightly different approach to the previous systems. BalOnSe restricts users' query to keywords that users are to enter into the search engine. These would include the keywords of the metadata annotated to dance media objects, such as *title, dancer name, etc*. The system, therefore, has to search metadata of annotations, in addition to the movement descriptors of annotations. Subsequently, text queries can include any generic or specific movement concept defined by the system and the results will include all dance media objects that contain these movement descriptors as annotations and their subclasses. This is not a free-text query, as the text entered for the query would refer to movement descriptors defined within the annotation tool's dance representation model.

Annotations that are queried within an archival system are related to other annotations based on the dance representation model implemented. This relation will result in all queried annotations and its related annotations to be rendered in the query results, depending on the representational model used. The relevance and ranking of queried results are discussed further in the following section.

Table 1: Indicates the types of query functionalities offered by dance annotation tools

Annotation Tool	Dance Category Query	Free-Text Query
Choreographer's Notebook	✕	✕
DMAR	✓	✓
WML	✓	✕
BalOnSe	✓	✓
DVCM	✓	✓
DanVideo	✓	✓

3.2.2 Query Result Relevance & Ranking. The information retrieval technique utilized by the archival systems mentioned previously is the keyword-based technique. This technique is one of the most predominant information retrieval techniques used when searching for content within an archival system [3]. Butavicius et al. [3] evaluates keyword-based information retrieval techniques and contextual information retrieval techniques to compare them. The experiments conducted used documents for context, and not dance media objects. However, since annotations enrich these objects with metadata the principles can be applied to the context of dance media objects. It was concluded that contextual information retrieval techniques provided more relevant and accurate results for users when compared to the convention of keyword-based search techniques [3].

Conceptual models, such as ontologies, are used to improve the relevance and ranking of user queries, especially when implementing free-text queries [8] [9] [11] [14]. Kannan et al. [9] and Ramadoss et al. [14] make use of a dance ontology constituting of concepts pertaining to dance genres/styles and generic movement concepts, and how these concepts are related to one another. The ontology was developed using generic movement terminology and collaborating with experts in the field of dance. Each concept is represented by a node, which contains a label unique to the concept it represents and a synonyms list. The synonyms list is a set of words that can be used to describe the concept that is labelled within the node using another word, i.e. synonym keywords for the node concept. This ontology is used to process user queries in the context of dance. The associations between concepts within the dance ontology will, therefore, assist in ranking the query results based on relevance. Additionally, the synonym keywords of concepts within the ontology can be used to match keywords to the user query. BalOnSe [8] implements an ontology with generic movement concepts and Ballet specific movement concepts. In comparison to the previous ontology used by Kannan et al. [9] and Ramadoss et al. [14], BalOnSe does not specify any use of synonym lists. However, the absence of

synonym lists does not imply that the Ballet ontology is less effective in providing context. It could be equally effective since it provides a context for users to search specific Ballet content. Lagrue et al. [11] uses pre-built dance ontologies as input for its annotation system. Each ontology that is uploaded to the system can be specific to a dance genre providing context for each dance genre for which the annotation tool would be utilized.

In the approach discussed above a context for search is provided through the dance ontologies implemented, as well as the annotations of digital objects. Ontologies, however, need to be developed through collaboration with experts in the field of dance to ensure that dance concepts are correctly associated with one another. Ontologies are a more established model used for searching and ranking relevant content within an archival system. Therefore, it makes it a novel conceptual model to use for querying.

4 Usability of Annotation Systems

As we have explored many aspects of dance annotation tools, we would include reviewing literature that evaluates the usability of annotation tools with regards to the annotation process. Many experiments and evaluations done on annotation tools were based on the usage of the interface and not specifically focusing on annotations and whether or not users were able to understand the terminology [1] [2] [4] [5] [7] [14] [15]. For this reason, usability of both dance annotations and general annotation tools will be explored to highlight potential innovations and problems relating to the implementation of annotation tools in various contexts. In order to evaluate the usability of annotation tools, we explore the usability fundamentals applied within various contexts of annotation tool development, i.e. usability engineering and usability testing [2].

4.1 User Involvement

The fundamentals of usability, as mentioned in [2], includes usability engineering and usability testing. Usability engineering ensures that there is a systematic way of creating and incorporating usability into a system. Along with this, usability testing is an important aspect of the development lifecycle as it allows the opportunity to obtain feedback from users.

In the development of many of the previously reviewed annotation tools there was minimal involvement of users. However, in particular instances users and experts within the field of dance were consulted.

The development of Choreographer's Notebook [15] involved an ethnographic approach to observing the dance production process. The team had observed and been involved in many dance productions. This approach was specific to the purpose of the tool that was to be developed, i.e. a tool to assist in the critiquing of dancers based on their rehearsals. In this case, the team needed to fully understand the general rehearsal procedures of choreographers and dancers. After developing the tool for implementation and testing, interviews were done to obtain feedback from users. In comparison to evaluation techniques used within [14], developers consulted with dance experts to develop the ontology that is implemented within the system and conducted performance evaluations, with end-users, on the annotation tool. The consultations done with dance experts ensures that the vocabulary used during the annotation process is in line with general dance concepts, and not developed by the team who might not have had a dance background or the expertise. Subsequent to this, the evaluation of the annotation tool with end-users allowed for feedback to be obtained and improvements to be made to problem areas highlighted during this process.

The aforementioned approaches of both development methods did not utilize a user-centered iterative design, as in the case of [7]. This approach would serve a better purpose as it involves internal user groups of the project at all stages of development. The advantage to this includes consulting the user groups at the beginner of the development lifecycle before any development or functional requirements have been established. By doing so, the interaction with users at the beginning will guide the development of the tool in the right direction. Consequently, engaging with users throughout the development lifecycle will highlight problem areas continuously keeping on track with the main purpose of the tool and accommodating for the usability of the tool.

4.2 Annotation Tool Usability Problems & Recommendations

The review of evaluations of the design of annotation tools are limited to the usability of the annotation tool dialogue presented to users and how annotations are visualized.

Burghardt [2] evaluates the usability of annotations tools and conveys general annotation usability problems by using a Heuristic Walkthrough (HW). A Cognitive Walkthrough (CW) is a structured manner in which to evaluate the usability of a system, by using a task-orientated approach. Evaluators of a CW complete a predefined list of tasks by solving problems using a system and identifying problems of processes within the system. A Heuristic Evaluation (HE) is the evaluation of usability problems of a system by using Nielsen's [12] ten usability heuristics. A HW is an evaluation strategy that combines aspects of both a CW and HE. The usability problems highlighted through the HW for annotation tools include 'feedback, user guidance & error messages', and 'user interface elements & design'. These are general categories which can refer to more specific problems within the context of dance annotation tools. The annotation of dance media objects is a complex task on its own and is time consuming, as mentioned by end-users [7] [14]. Within the user evaluations of both El Raheb et al. [7] and Ramadoss et al. [14] it is evident that users required some technical assistance while doing tasks or having to be trained to a certain degree on the functionalities of the tool. The WML dance annotation tool [7] was evaluated by usability and user experience experts through a task-based user evaluation. The user evaluation tasks to be completed were used to test the main functionality of the

annotation tool. These tasks mainly included searching and browsing the dance archival system. It was mentioned that the tool, while proving valuable to users, is complex and needed instructions before being able to complete tasks that were assigned to be completed within the evaluation. These problems that were highlighted during these evaluations fall into the 'feedback & user guidance' of [2]. It is recommended by Concejero et al. [4] to consider user training of annotation tools before users interact with the tool. Another recommendation to combat the complexity of annotation processes includes implementing a quick and easy method for annotating in a minimum number of steps. As for the 'user interface elements & design', this is evident as a problem area within the WML dance annotation tool [7] as the usability experts and the user experience experts could not clearly decipher the main purpose of the annotation tool during the user evaluation process. This can be resolved by devising a workflow that is more intuitive to users, as recommended by Concejero et al. [4].

To combat the particular problems within annotation tools we review general recommendations to consider when developing annotation tools. Since the annotation process is complex and time consuming, certain mechanisms can be implemented to assist reducing this complexity and the time it takes to annotate. Bianco et al. [1] suggests that the use of a semi-automatic annotation process be useful to reduce the time it takes for users to annotate. This requires an annotation vocabulary to be integrated into the tool, along with the vocabulary and dance concepts defined within the tool to be accurate and intuitive for both the annotation process and the user interface elements [5]. To relate to the matter of annotation complexity and usability of annotation tools, users should be allowed to edit and/remove annotations from the system [5] to reduce the mistakes made when annotating.

Burghardt [2] highlights general usability problems relating to annotation tools but mentioned that each annotation tool has specific positives and negatives. This is indicative of each dance annotation tool that was developed for its own specific purpose. The recommendations proposed to combat problems relating to annotation tools can be considered when developing annotation tools and assist in common problem areas of annotation tools that users are faced with.

5 Discussion

We have reviewed various dance annotation tools and the components that are essential to its functionality for the purpose of exploring how different dance annotation tools are built and implemented. The question we aimed to answer was the use of annotations for dance media objects and how annotations can be used for searching and retrieving dance media objects based on user queries. We, therefore, review various dance annotation tools such as Choreographer's Notebook [15], WML [7], DMAR [14], BalOnSe [8], etc.

We first explored dance representation models implemented by dance annotation tools and observed that each dance annotation tool developed and implemented a dance representation model. Each of these dance representation models included different dance concepts. This indicates that when developing dance annotation tools, a dance representation model has to be developed for the specificity of the dance application. The development of a dance representation model for a dance annotation tool should include collaboration with experts within the field of dance to ensure that dance concepts are correctly defined within the model. Furthermore, it is noted that dance experts have not agreed upon a standard dance representation model, which indicates the reason for various dance representation models being developed.

The purpose of dance representation models within dance annotation tools is to provide users with a controlled vocabulary for annotating dance. The advantage of this would be that non-experts and/or beginners of dance would be able to use a predefined dance vocabulary for annotating. However, some dancers and choreographers prefer to use their own annotation language for dance media content, so as not to hinder their creativity. This is the reason for user-defined annotations being an included functionality within dance annotation tools. The enrichment of dance media content through the use of annotations creates a structure for the storage of dance media objects, thus making it searchable. However, user queries are observed to include a vocabulary of dance concepts that are defined by the archival system. This indicates that users would have to familiarize themselves with the vocabulary implemented by the system before querying dance media objects. Although dance representation models are implemented within annotation tools to provide a vocabulary for dance, it is noted that when users annotate, using the dance concepts that were pre-defined, the tools do not ensure that users have correctly annotated dance media objects by using the correct dance concepts to annotate.

Lastly, we discuss the usability of dance annotation tools that need to be taken into consideration. Section 4 reviews the various usability problems, however, does not specifically relate to annotation tools developed within the environment of a mobile application. Therefore, these usability considerations might not be applicable in the context of mobile development. The one usability issue that was highlighted, that could be applied generally, is considering the complexity of the annotation process. The annotation of dance media content is time-consuming, as stated in section 4, and can be combated by simplifying the annotation process. This could be done by reducing the number of steps within the process and using a simpler dialogue. These are the main considerations of usability of the annotation process that can be used when developing dance annotation tools as a manner of reducing the complexity of the annotation process, which is the main functionality offered by annotation tools.

The review of dance annotation tools within this paper was done only on desktop applications. Issues might arise when considering the development of a mobile dance annotation tool. These issues could include the usability aspects that differ in desktop and mobile application, and the implementation of a dance annotation process within a mobile environment, such as uploading a dance

video, segmenting video and annotating it, and the search of annotated dance content.

A number of dance annotation tools have been developed and implemented the use of annotations for the semantics of dance content to make it searchable, which specifically addresses the problem of this research paper. However, more improvements within this area of research needs to be conducted so as to formulate a standard for dance annotation tools within the field for the purpose of improving the efficiency of annotating and searching dance content.

6 Conclusions

This research paper investigates the use of dance representation models to provide a vocabulary for annotations, and how the use of annotations can be used to search dance media content. In addition to this, we review the usability issues and recommendations to consider when developing annotation tools.

From this research, we have identified some uniform approaches taken by dance annotation tools, i.e. the development of a dance representation model. Each dance model differed from tool to tool as there is no standard dance representational model. We, also, identified that annotations can be used for the searching of dance media content, which we can use as an approach to solve the problem of searching dance media objects within an archival system.

Regarding our project of developing a mobile dance application for the purpose of recalling dance moves, annotation tool implementations could be integrated within the application. For a dance representation model that would need to be implemented we could develop our own, which would require a lot of time collaborating and working closely with dance experts and might not be a feasible option. Alternatively, we could use predefined dance ontologies available for use.

Overall, the approaches of the software annotation tools reviewed within this paper provides a good foundation for the development of a dance application, implementing an annotation tool and archival system for the purpose of storing and retrieving dance media objects.

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