Exploring multimedia database solutions for dance applications
Honours Literature Review

Carryn Joseph

Department of Computer Science
University of Cape Town
Cape Town, South Africa
jspcar006@myuct.ac.za

ABSTRACT

Dance is an important part of cultural heritage and is a common activity during social events. Dance movements can be taught at physical classes; however, one does not always remember all those movements when in a social dance setting. This calls for an easily accessible tool that one can use to reflect on dance movements learnt through different multimedia i.e. videos, images and annotations. This paper explores the recent literature on multimedia databases, mobile media access currently available to users and existing dance systems and how they have support multimedia storage and retrieval.

CSS CONCEPTS

● **Databases** → Multimedia Databases, Multimedia database management system**,** queries

KEYWORDS

Dance, Latin Style Dance, Multimedia, Databases, Multimedia database

1   INTRODUCTION

Dance is an age-old form of creative art. It also forms a fundamental part of many cultural heritages and as such needs to be preserved. Latin American dance styles are of the many that hold a lot of cultural value. Latin dance genres include Salsa, Samba, Bachata, Kizomba, Cha-Cha-Cha and many others. Dance styles cannot be learnt overnight but take time to practice. Most dance moves are learnt in a class environment, and one cannot always remember every more learnt from every class. This is when other dance resources come in handy. Some dancers keep record of dance moves and choreographies through hand-written notes and annotations sketches on dance moves while others rely on digital resources such as dance videos and images [1].

Recent research has gone into the integration of modern technology with dance to provide more dance resources. There are studies being done on the use of motion capture, virtual and augmented reality technologies to produce a range of different dance tools [2]. Some of the tools developed are being used for annotating dance movements, capturing and analysing dance movements as well as preserving cultural dance heritage. Of the literature available, most

projects, e.g. WholoDancE [3] and BalOnSe [4], developed tools for popular European dance genres such as Ballet. There is little new research done on tools aimed at Latin American style dance. The research available includes a project by Xu et al. [5] who researched the utilisation of virtual reality in the teaching process of Latin dance and VR Salsa [6] a similar VR interface specifically designed for teaching salsa. There are also mobile applications available aimed at teaching dance, e.g. Learn Salsa and Salsa Anywhere, however, these applications don't have corresponding research from which to gather information. Based on these applications found, there is still lack of research on tools developed for this dance style especially for use in a social setting as well as tools that utilize multimedia databases. This is an opportunity that can be exploited to provide a Latin American style dance tool.

The project is to develop a mobile application that provides Latin American style dance resources. More specifically, an application that can be used in a social setting as a cheat sheet to look up dance movements. The application will need to have access to a database that can store a range of different multimedia dance resources including textual dance movement annotations, videos and images.

This paper explores recent literature to fulfil the following objectives:
- Determine a background on Multimedia Databases and analyse recent studies on query level fusion for accurate video retrieval
- Analyse current mobile multimedia database access i.e. gallery application and YouTube
- Analyse the different ways existing dance systems have implemented their databases to support multimedia data.

2   MULTIMEDIA DATABASE SYSTEMS

 "A multimedia database is a controlled collection of multimedia data items such as text, images, graphic objects, video and audio" [7, 8]. Some multimedia database items have spatial and temporal characteristics which are not supported by traditional text-based relationship database management systems hence the introduction of a multimedia database. Control of the database is done through a database management system (DBMS). The system needs to be able to allow storage, access, and query of data items from the database. According to Kalipsiz [7], multimedia database management systems should meet the following requirements:

- Tradition DMBS capabilities i.e. store, access, query data
- Information retrieval capabilities
- Multimedia query support
- Media integration, composition and presentation
- Multimedia interface and interactivity

2.1 Query-level fusion

In the literature are several studies aiming to improve the performance and accuracy of multimedia retrieval more specifically related to video retrieval. Traditionally, queries performed are single modal relying on textual content to retrieve videos. Sattari et al. [9] study a different approach. They researched the application of multimodal query-level fusion for a more accurate and efficient video retrieval. Similar research was done by Wei et.al [10]. Both articles aim at improving video retrieval through multimodal queries by concept. Multimodal queries are a combination of one or more modal types, i.e. a sample audio or an image of an object for query. A multimodal query by concept is a query that comprises of the concepts extracted from multiple modals.

While Wei's article focuses on the fusion of two modal, textual and visual, the research done by Sattari et al. includes audio modal query as well. They approach the query fusion in a series of steps. First step is to treat the query as a vector and separate the terms of the query into sub vectors by modal type. For each nonzero sub vector an intramodal correlation between the concept terms is calculated using the Pearson correlation coefficient. Once the intramodal correlation is determined, an intermodal correlation is calculated. The strength of the relationships between the pairs of modal vectors are determined though canonical correlation analysis. The final modal query vector for each modal type is then the average of the intramodal relationship between terms and the relation between the modal type vector and every other modal type vector. The final query vector is then the combination of each modal type vector i.e. the fusion step. The result of that experiment showed that query-level fusion improved the accuracy and efficiency of the multimodal queries.

3 MOBILE DEVICE MEDIA ACCESS

Mobile devices are of the most used technologies in the world because of its range of uses including viewing and storing multimedia data. Recently its growing in popularity as a way of providing digital education resources [11], this including dance resources. Mobile media storage and YouTube are two forms of multimedia data access that are currently available for users to view dance videos and images.

3.1 Mobile Gallery Application

Mobile technologies: phones, tablets etc. have a camera function that affords easy video recording and capturing of images [11]. This can be used to record classes, support studying, and store and transfer files. Mobile devices, with an Android operating system, offer a gallery application than can act as an offline media repository dancer can to store video files and images of dance movements they learnt in class as an alternative to paper-based note taking. The gallery application utilizes the Android multimedia framework API and media player class library [12]. The media data

is indexed using SQLite databases. The index information of that data is stored, along with all user data, on the devices on-board NAND flash memory chip [13] or an external SD card.

3.2 YouTube Video Streaming

YouTube, a video-sharing website, is one of the most popular websites used in today's time. It hosts videos on all sorts of topics including a large amount of dance videos and tutorials. On a survey, analysing students perspectives on using YouTube as a learning tool [14], students shared that YouTube helped them learn and understand. 77% of them agreeing that the use YouTube to look for answers to specific questions. YouTube has a search functionality that allows users to search for videos based on information such as the uploaders name, the video name or context. Dancers can use this search function to search a video to see how to do a move in a social dance setting. The video selection process, when a user performs a search, depends on the videos metadata and videos related to those selected videos. The metadata consists on keywords that the uploader used to tag their videos [15] as well as video upload information such as video title and uploader's name. This can make it difficult to find specific videos based on the content of the video or if you don't know the exact title of videos or the precise tags the uploader used.

Another challenge with searching YouTube videos is it depends on one having an internet connection. The YouTube platform uses Adobe Flash Player plug-in to download and playback the selected video on the user's browser. Videos are requested via an HTTP message between the Flash Plugin and a YouTube content Server [16].

4 EXISTING DANCE SYSTEMS

Dance systems provide dance specific resources. These systems have been created for several different reasons ranging from cultural heritage preservation to online learning. Some of them rely on mobile devices media viewer and storage, others source resources from multimedia databases like YouTube or iTunes [11]. This section explores four dance systems, WholoDance movement library (WML), BalOnSe, a classical Balinese dance website, and a motion capture search engine, and how they have managed their multimedia data.

4.1 WholoDancE and BalOnSe

The WholoDancE project [3] and the BalOnSe project [4] are two of web-based interfaces that provide resources for European style dance. The WholoDance project is one of the most recent dance system projects aiming to preserve European dance cultural heritage using modern technology. They created a motion capture database of dance motions. This is stored alongside other multimedia recordings including video and audio in a large repository called the WholoDancE movement library (WML) [17]. The WML is accessible through a web-based application that allows users the view motion capture recordings and videos as well as annotate videos. The BalOnSe application allows for annotation as well. BalOnSe is an ontology-based web interface that provides an archival system for users to keep track of video content. The BalOnSe project researches the terminology most valuable to users within the ballet context to provide an interface usable to both ballet experts and users less acquainted with the ballet vocabulary.

Ballet.owl is an OWL-2 ontology based on classical ballet syllabus terminology. The BalOnSe system utilizes this ontology to create a hierarchical vocabulary that users can use to annotate and search classical ballet videos. The functionality of searching through annotation allows the user to search videos not only by multimedia meta data, e.g. title, dancer etc., but also allows for search by dance terminology e.g. searching by movement concepts.

4.1.1 Query Handling

Both applications use the same selection process when searches are performed. When users search the library, the application finds recordings through the corresponding metadata. For WholoDancE this includes dance genre, time and place of motion capture, the dancers, the dance company, and dance movement principles included in the video. For BalOnSe the metadata is the video title, genre, dancer, dance work and dance company. Both applications also retrieve videos based on associated annotation. Annotations made on WholoDancE do not have a strict vocabulary whereas annotations on the BalOnSe system use an ontology-based vocabulary.

4.1.2 Architecture and Database Design

Both application architectures follow a model view controller (MVC) design pattern and utilize an open-source database engine. The WML motion capture data is stored using a PostgreSQL database engine and is managed using a Comprehensive Knowledge Archive Network (CKAN) system. CKAN is an open source data portal used for storage and distribution of data. BalOnSe stores its data in an H2 database.

4.2 Balinese Dance Preservation System

This project focuses on the development of an information system to digitize classical Balinese dance [18]. This research produced a model of an integrated classical Balinese dance website and mobile application that provides dance information as well as dance studio information. The application grants access to data including dance history, dance descriptions, dance studios, and images and videos of classical Balinese dance, which was obtained through a series of interviews and observations with dance experts, artists and studios.

4.2.1 Query Handling

From the web and mobile application interfaces users can query dance and studio related information as well as videos and images by using keywords. The keywords can consist of any studio or dance related metadata such as: studio name, location, dance genre etc.

4.2.2 Architecture and Database Design

The application utilizes a web server to store and transfer multimedia data to the webpage and the mobile application. XAMPP is an open-source web server solution that connects to a MySQL coded relational database.

4.3 Motion Capture Search Engine

There are several research articles that make mention of motion capture technology and how it can be used to digitize dance both for dance preservation as well as for dance analysis. Aristdou et al. [19] developed a framework to identify qualities of motions and a way of motion indexing based on Laban Movement Analysis. Using this framework, they designed and implemented a prototype motion search engine application that would allow for motion capture data retrieval, from a fold dance database, using motion clip comparison.

4.3.1 Query Handling

The application has query-by-example capability that let users query with motion clips. The application displays clips based on whether they are related. The process of comparison started with the motion slip being into 35-frame windows. For each window, the LMA components, i.e. body, effort, shape and space, are calculated. The data from these windows are then compared with windows of a different motion clip using a correlation matrix to determine the Pearson's linear correlation coefficient for each component. The overall calculation of each of the component coefficients then determines if the two motion clips are related.

4.3.2 Architecture and Database Design

The motion clips used this research was stored using an online Dance Motion Capture Database

5 DANCE SYSTEM COMPARISON

From the systems analysed, there are a few glaring differences as well as a few similarities. WholoDancE [17] and BalOnSe [4] being a tool for European dance genres (specifically Ballet), the Balinese dance system [18] being a Balinese genre tool and the motion capture search engine[19] searching a folk dance database is the most obvious difference. All four also differ in objectives, the WholoDancE projects focus was on storing motion capture recordings and providing annotation functionality, the BalOnSe project's focus was the use of ontology for annotation and searching, the Balinese dance system's focus was an information system to preserve dance history and studio information and the motion capture search engine was focused on motion analysis and motion clip querying.

The four applications have similar basic database functionalities, i.e. querying and retrieval of multimedia data, however, from the literature on the background of multimedia databases, a multimedia database management system should not only afford users to store, access and query multimedia data. It should have multimedia query capabilities and provide a presentation of multimedia data [7]. The motion capture search engine is the only one of the four applications that allows for queries other than textual queries by providing motion query capabilities.

The WholoDance, BalOnSe and Balinese dance systems are all web-based applications the present the multimedia data to the user through a web interface. The Balinese preservation system also designed a mobile application that would access the same database as its web application. The research on the motion capture search engine made no mention of the interface users would interact with.

The motion capture search engine connects to an online Dance Motion Capture Database. The three other applications connect to three different open-source database management systems. WholoDancE used PostgreSQL, BalOnSe used an H2 database and the Balinese dance system used a MySQL database. H2 and MySQL are both relational database management systems while PostgreSQL is an object-relational database management system.

Queries made to the WholoDancE, BalOnSe and Balinese dance system databases were based on textual inputs relating to video metadata and annotations as well as keywords for the Balinese dance system. This is a singular modality type query whereas recent literature on multimedia databases explores the use of multimodal queries and query-level fusion. The motion capture search engine is the only application that queried using a different medium, however, this was also a singular modal query type which is not in line with recent literature.

6 CONCLUSIONS

This paper reviewed three different areas of literature: Multimedia databases and the use of query-level fusion for multimodal queries by concept, the workings of mobile media database access and existing dance systems and their use of multimedia databases. From the recent literature, it was established that there are several different open-source database management systems that can be utilized for multimedia storage. Existing systems also focus predominantly on one modal type queries where multimedia database research is exploring multimodal queries. The future work for this project will be to explore the potential for multimodal querying and investigate the use of SQLite, PostgreSQL or H2 Database to house the dance resources for our mobile application.

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