Salsational Dance Application: Project Proposal

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1 PROJECT DESCRIPTION

The Evolution Dance Theatre (EDT) is Cape Town's first community-based Salsa Dance company. It is an organisation that provides a friendly and professional environment for people to immerse themselves in the enthrallment of dance. It provides a creative outlet for the appreciation of this artform. The primary focus is on the development of dance, with the vision of making Salsa accessible to all the people of Cape Town. Such an establishment gives new impetus to dance. In the interest of fulfilling this vision, the current methods of teaching dance need to be revised.

Dance is a performance art and is considered to be an ancient, cultural tradition. Additionally, dance is not only a form of expression but provides the means to improve one's mental capacity [15]. Consequently, the preservation of dance is of major importance. Oral communication is prone to error [4] and humans are circumscribed by memory, concerning the intricacies of past and present dance art forms. Therefore, it is imperative to archive various performance arts for future generations in order to facilitate the survival of dance. Due to the lack of comprehensive dance documentation [1], dance novices are likely to video a dance lesson with the intention of using this video to practice a dance. This approach often proves to be futile because the video quality may be substandard, there is no formal clarification of moves into clear steps and the overall method is inefficient.

We propose to develop a tool which aids and improves the learning process of dance. The resulting tool must allow experts to define moves clearly, allowing learners to review and explore various sequences of steps. This entails formalising and computerising a specific dance language that may be accompanied by a visualisation of dance figures.

2 RELATED WORK

There are multiple dance notations that have been created to record the movement of dance through symbols. Feuillet's Notation was one of the earliest discovered types of dance notation. This notation is able to document foot positions [10]; however, this notation is limited by its inability to represent movement for the upper part of the body [12]. Labanotation, a dance notation, was invented in 1928 [8]. It has been described as complicated and only easily understood by those who study it [1, 3]. In spite of this, it is still the most popular dance notation used today [1]. This dance notation is used for human movement but has not been optimised for a partnered dance. These notations focus on the more classical dance styles and does not allows users to experiment with different sequences and clearly see the movement of different parts of the body. Previous projects have focused on animating human motion and more classical dance styles such as Ballet and Bharatanatyam. These are however designed to include only one person. Renesse and Ecke [16] created a "Space of Salsa Dance" notation using mathematical equations in the form of a text-based diagram. This method is limited to arm movement and lacks notation for feet movement which is a fundamental part of Salsa Dance. In 2002, the "Salsa Dictionary" was created [13] as a way to learn Salsa turn patterns displayed in a table-based notation. The basic elements of the system are hand holds, feet movement, directions and positions. To the best of our knowledge, this method however is not defined in XML or any other structured serialisation. Due to the format of the Salsa Dictionary, a move is defined for a pair: the leader and follower. In the past 17 years, there has been no uptake to the use of this notation. The aforementioned notations are paper-based notations, which can be easily misinterpreted and difficult to conceptualise [3].

LabanWriter [6], LabanEditor [6] and DanceLaban [6, 17] are extensions of Labanotation. LabanWriter was created as a Labanotation editor. It treats the symbols strictly as 2D objects and it does not perform grammar checks, so one cannot ensure accuracy of the elements. LabanDancer [17] was created to translate LabanWriter scores into 3D animation. LabanDancer [17] does not have a function that prepares Labanotation scores which is useful in enabling dance movements to be accurately interpreted. MovementXML [2] was then created as a tool that extends LabanWriter. MovementXML ensures that the score will always be correct. It has a structured nature making it possible to search for a pattern in the score. MovementXML allows scores to be used outside the editor that created it. Despite this, the efforts were neither aimed at describing gestural interactions nor have they been widely adopted.

In 2018, the WebDANCE project [5, 9] was the first of its kind to be developed as an e-learning dance tool. This attests to the fact that there has been little development in the approach to teaching dance and that there are no established tools to do so. Life Forms [18], a proprietary software platform, addresses the issue of single character animation by allowing multiple figures to be animated using motion capture data, but it cannot produce dance movement for a partnered dance in Salsa. SmartBody [14] is an open source, research-based character animation framework. It can be used to program and manipulate the of characters independently through the use of controller modules.

3 PROBLEM STATEMENT, AIM AND RESEARCH QUESTIONS

There are existing dance tools that implement paper-based dance notations to teach dance, however no tools exist solely for the purpose of teaching Salsa dance style. Existing paper-based notations are complicated for students to record and model the dance choreography. From our external expert's knowledge, Angus Prince from

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EDT, the dance community relies heavily on videos to record dance moves which is problematic because videos lack formal clarification of moves into clear steps and positions which proves this method to be inefficient.

The aim of this project is to develop a user-friendly, software tool, in the form of a desktop application, for teachers to plan lessons that will provide a different approach to the way Salsa dance is taught. This tool will allow novice dancers to develop their skills by enabling them to analyse specific dance moves graphically and learn dance sequences defined by teachers. The research questions are:

(1) How effectively can our software tool computerise the Salsa Dictionary, formalise a sequence of steps for the **upper body** and convert it to graphics?
(2) How effectively can our software tool computerise the Salsa Dictionary, formalise a sequence of steps for the **lower body** and convert it to graphics?
(3) How accurate is the generation of animations from the transcribed notation scores based on our computerisation of the Salsa Dictionary?
(4) How can SmartBody be used to animate a computerised notation for the Salsa On1 dance style?
(5) How can dance animation data be accurately synthesised from the metadata of the Salsa Dictionary?

4 PROCEDURES AND METHODS

In this section we detail the technical components of the DeDance system pipeline and the methods to create the components. The conversion of notation to graphical representation follows a two-stage approach, requiring multi-class processing for each stage. The first segment is notation analysis and conversion, which is then followed by graphical processing. The notation analysis phase requires the system to determine legal movement positions based on immediate predecessor steps written by the user, which should be determined by the system from a pre-existent logical rule set based on the Salsa On1 dance style. The legal notation is then fed into the notation conversion process which produces input into the graphical processing stage after which an animation is generated. We have chosen to develop a desktop application for the project due the processing power required for the system and greater extensibility of the platform for future development.

4.1 Requirements

Considering this is a software engineering project, our first step is to conduct a user experiment in order to meet the requirements of our client, Angus Prince, who will provide us with insight into possible features to implement. We will inquire about the functionality desired by the dance instructors in order to prioritise the implementation of features. From the client's perspective, there are currently no existing tools that describe and animate a sequence of steps for Salsa Dance.

The proposed solution should allow for dance instructors to define moves and for students to experiment with the sequence of moves in order to enhance their learning experience. The solution should include a visual aspect or animation of the dance in the form of graphics or a series of stills. Ongoing prototyping and evaluation is required in order to ensure that we satisfy the needs of the user and produce a solution that meets all the requirements. We also aim for our project to be utilised by other companies in the future. The implementation of the requirements for our project are explored in greater detail in the upcoming sections of this proposal.

4.2 Work allocation

Appendix A defines the separate components that each team member will develop. Each subcomponent is discussed in the following sections. The three components that are pertaining to each person can be identified by a different colour.

This project comprises of two main components. The first component pertains to the formalisation and computerisation of a dance language, with the second component comprising of the visualisation of the dance. The former will be divided into the upper and lower body, with the upper body part being done by Alka Baijnath and the lower being Micara Marajh. A notation system, analysis and conversion will be done for both the upper and lower body and will correspond to each other. The latter will be done by Jordy Chetty.

4.3 Notation pipeline

4.3.1 Notation system. We intend on leveraging existing notation systems to generate a more representative notation for Salsa On1. For this purpose we intend to allow the user to enter notation graphically, similar to [6, 17].

We will computerise a notation based on the Salsa Dictionary [13]. We will also consult with experts to provide us with a syllabus of Salsa dance based on the Salsa Dictionary [13] to depict the moves. We will be implementing a subset of steps to define the different moves associated with the Salsa On1 dance style. There is ambiguity in the representation of the symbols used to describe the actions in the Salsa Dictionary [13]. To compensate for the ambiguous nature of the notation, we will adjust the notation but we will still preserve its fundamental principles.

To ensure that we treat the notation with meticulous attention to detail, we will divide the notation into the upper body and lower body. This division entails that the process of implementing a move is done rigorously to ensure we don't leave room for error. The Salsa dictionary defines footwork and hand holds independent of one another which maps directly to our implementation strategy [13].

The computerisation involves defining attributes for a pair (leader and follower) for each step. These attributes are direction and position corresponding to each part of the body. The lower body will focus on the footwork described in Salsa dance [13]. This consists of the basic steps, footwork required for turns and freestyle footwork. The upper body has additional attributes which define the state of handholds (held, crossed, not held).

4.3.2 Notation analysis. The notation system will be governed by an underlying rule-set which specifies moves that can and cannot be performed in succession. We call this phase notation analysis.

We will be developing our own parser to analyse the notation. Once we define steps, these will be utilised in our parser to determine the legality of a dance sequence. The structure of the style

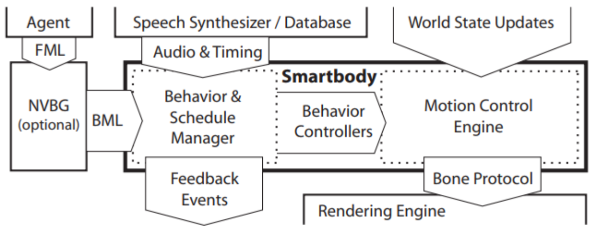

Figure 1: The SmartBody system architecture. [SmartBody: Behavior Realization for Embodied Conversational Agents. 2008.]

imposes constraints on which moves can and cannot be performed in sequence.

The following example reinforces this concept: Let L be the set of symbols which represent dance steps, $L = \{a, b, c\}$ and the dance move representing b cannot be performed after a, then we will define a grammar that enforces these constraints. Examples of possible sequences are:

- *acbc*
- *aaaa*
- *acbb*

4.3.3 Notation conversion. We will transcribe the notation into a format that will make it possible to visualise the notation. From the notation, we will break up each move into the different parts of the body. We will be converting the notation into Behavior Markup Language (BML) [11, 14] which is compatible with SmartBody [14], a character animation library.

4.4 Graphics Pipeline

At a high level overview, the graphics pipeline takes in a BML file which describes different components of the of an entity in a choreography. It allows motion-data information to be directly embedded into the file. SmartBody is then used to process the BML file, after which the resulting animation is displayed. We have decided to use SmartBody because it was built for use within research-based animation. The framework is able to process multiple characters at any given time. It allows ontrollers to be added to the architecture pipeline for custom functionality if need be. Furthermore, the availability of a Python API to interface with the framework makes the outputs of the system easily accessible for use with other scientific packages. This may be useful to further refine the quality of the animated output. The python API currently does not have support for graphics rendering. We will need to create a component to render the animations generated from SmartBody.

4.4.1 Motion analysis. Using data in the BML file, we generate animated choreographies. The data present in the file may either be key poses of each character or direct motion data. From two key poses, interpolation can be performed to generate continuous motion. In the case of interpolation, SmartBody provides a forward and inverse kinematics interface using controllers. From motion-data, we can associate discrete symbols with existing motion-captured segments to produce preliminary animation sequences. Publicly available motion-data databases such as the Carnegie Mellon University Motion Capture Database [7] will be used for this purpose. This data needs to be annotated and segmented before it can be used. Given variations for the same pose which may be described in the score, the motion data is transformed to reflect these augmentations using the SmartBody Motion Editing API. Sequences of movement, either from key poses or motion-data, will then be blended together using the Blending API to produce a fluid choreography before rendering takes place.

4.4.2 Music analysis. BML allows timing metadata to be associated with behaviours and actions that are performed by a character. Using the Aubio sound analysis library, we aim to determine rhythmic information to align a piece of music with an animation sequence. For this we intend to use the Aubio Analysis API. Prior to integrating this piece of functionality into the system, we will have to determine whether the addition of musical timing information to BML impacts the realism of the visualisations produced by the system.

4.4.3 Animation Playback. Using the data generated by SmartBody, the system will display the final animation in a panel on the user interface.

4.5 Development practices and methods

The notation system will be developed using the Waterfall approach. The first step is acquiring the dance syllabus from Angus. This syllabus will be used to develop the notation definition component, which is followed by the notation analysis component. This produces the notation system. The defined notation is then converted into BML. Lastly, this component is integrated with the visualisation aspect. The graphics pipeline will also use the Waterfall development methodology. Angus will be used for requirement gathering.

4.6 Evaluation Methods

4.6.1 Notation component. In order to evaluate our tool we will follow an evaluation criteria to ensure that our developed components are efficient and effective. We have opted to conduct usability tests with the experts for qualitative research. This will ensure that we meet the requirements of our users in order to obtain customer satisfaction. The first step is to interview each dance teacher and acquire feedback on the design of the computerised notation and whether it is explicit. The analysis phase of the notation will be evaluated by quality testing. This will be tested against a criteria, provided by the experts, comprising of legal sequences of moves to see if the system is able to meet this criteria. The experts will interact with a graphical user interface in order to assess the general ease of use of the tool. The interface will provide the functionality for a user to view various dance steps and define a dance sequence using these steps. The experts will determine if our tool is user-friendly and if it is able to successfully represent Salsa dance moves using the computerised notation, hence meeting the requirements. Additionally, user sessions will be held in order to receive feedback on the usability of our user interface.

4.6.2 Graphics component. The components produced in each iteration will be validated with Angus Prince prior to the continuation of the project during its life cycle. Satisfaction metrics will be employed in order to validate the components after each iteration. Input into the graphics pipeline will be standardised throughout each testing phase to improve the accuracy of the feedback. Testing the graphics component will primarily involve subjects assessing the quality of the animations generated from the system. The quality of the animations is dependent on the constituent controllers used to generate the animation. Direct feedback on each component will be obtained. The music analysis testing phase will involve users evaluating the accuracy of the beats-per-minute and tempo estimation of a piece of music. This will be performed qualitatively by informing the subjects of the estimated results generated from the component.

5 ETHIC, PROFESSIONAL AND LEGAL ISSUES

In order to conduct these user sessions discussed in section 4.6, we will need to receive ethical clearance from the Faculty of Science Research Ethics Committee. This requires the submission of an ethical clearance form before conducting these user sessions. We will also comply with the ethical principles from the Belmont Report [6] relating to the participants.

As developers, we hold the intellectual property rights of this project that has been developed in the university environment. We plan to open-source our project in order to promote external improvements and encourage innovative ideas to the problem.

6 ANTICIPATED OUTCOMES

6.1 Software

At the end of the project lifecycle we expect to have created a system that allows users to input a symbolic representation of Salsa which can be rendered into a three-dimensional visualisation. The input will be subject to an underlying constraint system which is then validated using a notation analysis component before being rendered. The visualisation will be able to be viewed from any viewpoint and shows key movements during a choreography.

The front-end of the system will allow users to enter in Salsa Dictionary elements. The collection of these elements describe the choreography for a particular routine.

The backend of the system takes in the input from the user and analyses it using the constraint system described previously. The upper and lower limbs are processed separately before being parsed into BML and sent for processing into the graphics pipeline. The graphics component analyses the BML before producing an animation of the score.

The key features of the system are the notation-writing component that allows users to input a piece of notation, the constraint system which identifies illegal user input, an interactive user interface that allows the user to engage with the platform, and the graphical generation component which visualises the user input.

6.1.1 Major design challenges. The disambiguation of the Salsa Dictionary may add complexity to the system. Compensating for the requirements of the user with respect to the usage of the notation in the system may be challenging. Producing realistic animation sequences given a valid notation score may be problematic, particularly instances where interpolated movement follows motion-captured movement, and vice-versa.

Deliverable Description	Date
Project proposal	23 May 2019
Project plan	23 May 2019
Project proposal presentation	29 May 2019
Initial software feasibility demonstration	19 July 2019
First draft of project paper	12 August 2019
Final complete draft of project paper	16 August 2019
Complete project paper	26 August 2019
Final project code	2 September 2019
Project demonstration	2-16 September 2019
Project poster	23 September 2019
Web page	30 September 2019
Reflection paper	7 October 2019

Table 1: Deliverables throughout the project lifecycle and their associated due dates.

6.2 Expected impact

In the context of the Salsa Dictionary, we would be providing a way to convey more information to the user than that is available by allowing a sequence of notation to be animated. The current version makes use of still images, where each image represents a single move. We propose a more user-friendly alternative to existing dance-transcription and animation systems by allowing users to enter familiar terms (elements of the Salsa Dictionary, which comprise alphabetical symbols predominantly) as opposed to complicated symbols to represent a dance schema. We hope we will assist dance students in enhancing their learning experience through the use of our tool. By making our project open source , we hope that the system can lay the groundwork for the development of future systems to extend upon.

6.3 Key success factors

The success of the system will be based on a) the ability of a user to express a score in the system and generate reasonable graphical output, b) the usability of the interface - both learners and teachers should be able to navigate and use the system intuitively to fulfill their needs, and c) the quality of the generated animations. These factors will be assessed qualitatively using feedback from subjects and EDT.

7 PROJECT PLAN

7.1 Risks and Risk Management Strategies

The risk and risk management strategies can be found in Appendix B.

7.2 Timeline

A Gantt chart depicting the timeline for this project is available in Appendix C. It is constructed for the duration from the 23rd of May to the 7th of October.

7.3 Resources required (equipment, people, special software, etc.

The notation component requires subjects during the testing phase to assess the usability of the component. Dance domain experts from EDT will also be required for consultation.

The graphical component will require experts from EDC for the annotation and segmentation process mentioned previously. They will also be used to evaluate the quality of the visualisations. Graphics experts will need to be consulted for advice on improving the movement synthesis and motion-data visualisation stage. Software to be used for this component will primarily SmartBody and Aubio. MotionMachine running on OpenFramework will be used to annotate and support segmentation of motion data. Other minor open-source components may also be used to support the functionality.

7.4 Deliverables

The deliverable components and due dates can be found in Table 1.

7.5 Milestones

For a list of the milestones, refer to the Gantt Chart in Appendix C.

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A SALSATIONAL SYSTEM ARCHITECTURE

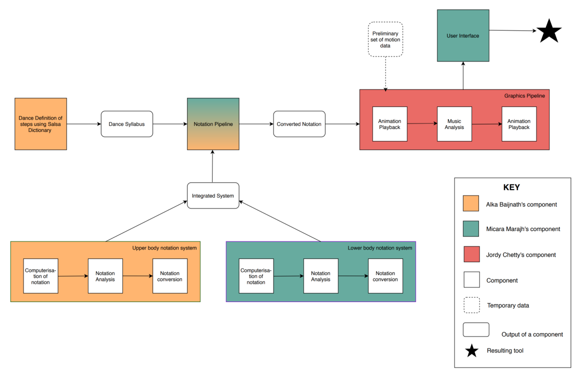

Figure 2: Detailed Salsational system architecture along with work allocation.

B RISK AND RISK MANAGEMENT STRATEGIES

Risk	Probability	Impact	Consequence	Mitigation	Monitoring	Management
Project milestones not delivered on time	High	Medium	Work not being delivered on time and added pressure to complete project.	Use dummy data as input to test functionality.	Monitor each individuals progress, plan regular meetings.	Report the issue to the supervisor in charge.
User interface too complicated for general user.	Low	Medium	Dance desktop application cannot be used by many users.	Remove unnecessary functionality from user interface.	Get feedback from users and supervisor at each stage of the development process.	Consult supervisor immediately.
Unable to meet the project deadline.	Medium	High	Impact on marks and dissatisfaction from client.	Add initial buffer to the completion time estimated.	If delay drastically exceeds proposed plan,then work to make up for delay or remove unnecessary functionality.	Apply for an extension from the supervisor
Scope creep.	High	High	Change in requirements and more pressing time constraints.	Allocate extra time to allow for unexpected changes.	Keep up with the changing needs of the client by having regular meetings.	Stick to to an agile approach to the project.
Scope of the project is too broad.	Medium	Low	The client indicates that solution does not live up to objectives during testing.	In-depth analysis of clients' needs and requirements of the system.	Regular meetings with clients.	Identify and perform additions to solution.
A team member drops out of the course.	Medium	High	Work not being delivered in time and increase in pressure to complete project.	Maintain regular contact with team members, arrange a back-up plan for work completion.	Monitor teammates progress, plan meetings and encourage clear communication and understanding.	Split tasks equally amongst team members, communicate problem to supervisor.
Research project solutions is no longer cost-free.	Low	Medium	Software will be a burden to department and might lead to re designing.	Perform research into all tools regarding future costs.	Monitor the risks of switching to a paid service.	Search for an alternative solution or consult supervisor for financial assistance.
No access to an expert	Low	High	Prevents us from receiving a syllabus for the Salsa On 1 dance style to define and implement correct moves.	Search for "Salsa Dance Syllabus"	Ensure constant communication between ourselves and the expert.	Consult supervisor to secure an additional expert in case of a setback.
Notation choices does not have an adequate amount of moves described	Medium	High	An incomplete and inadequate representation of the Salsa dance genre	Carefully decide between notation options	Do consistent tests with the tool to see if moves can be described	Add on to the notation chosen and implement new moves using their notation methods.
Integration phase may not occur	Medium	Medium	Will not have a resulting tool that can display the desired functionality	Stick to our project plan (Gantt chart) and ensure we meet our deliverables on time.	Monitor when we are meeting our milestones and check if it corresponds with the gantt chart.	Ensure that the formalization of dance exceeds performance of previous work done
No current tools to implement the chosen notation for this project.	High	Medium	Affects the successful computerization of the notation.	Ensure we have in depth understanding of the notation we're using.	Continuous research into how existing tools can be used to computerize Salsa Dance.	Experimenting with various tools to determine which tool can successfully compertize Salsa Dance.

Figure 3: Risk management matrix for the Salsational system development.

C GANTT CHART

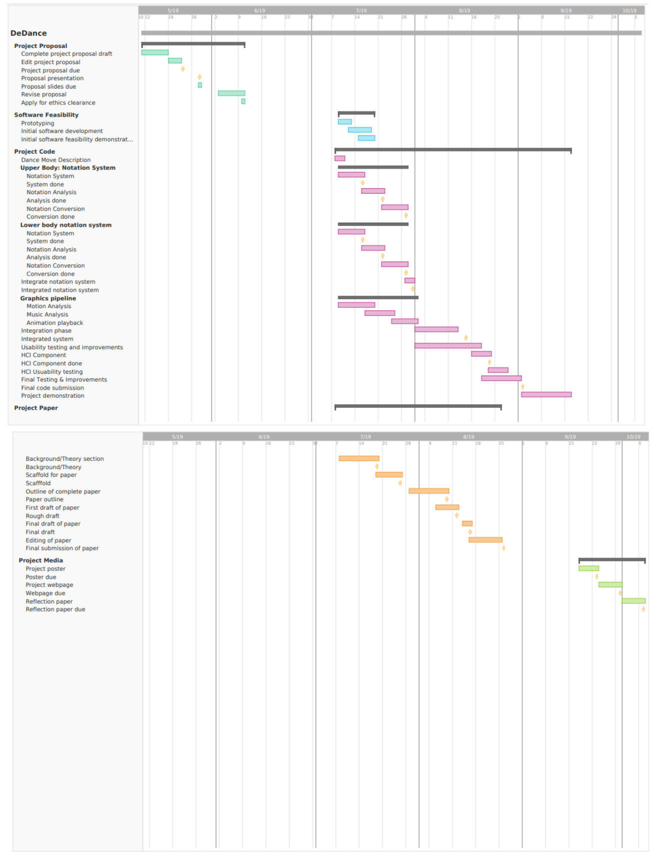

Figure 4: Gantt chart of project milestones and activities.