

Music Driven Walk Cycle For Humanoid Character

Aditi Patil (asp270)
Gunjan Singh (gs896)
Karan Pardasani (kp955)

Research Mentor- Jerry Chang

Problem Statement: What is problem you are trying to solve ?

While animating humanoid character walk cycle, animators have to create keyframes and map them to the beats of background music. This is easy for senior animator but beginners struggle with this. Nevertheless, it requires skills and it is a time consuming process. We propose a system that will map given walk-cycle motion with the given music piece, thereby reducing the work of the animator.

Motivation: Why is the problem interesting to AIVC community ?

Animated walk-cycle is a motion and we are trying to map it to music by synchronizing motion signal to audio signal. Modifying motion signal by audio reference is not been researched/explored thoroughly. Audio and visual effects go hand in hand in animation industry. For instance, to animate a falling object, there has to be sound. Animators have to modify the keyframes manually to adjust this. Though there are a lot of handy tools for doing these alterations, senior animators spend a lot of time doing this. Hence, automating the motion-audio synchronization would benefit to the AIVC community.

Applications: What are some applications to the solution of the problem ?

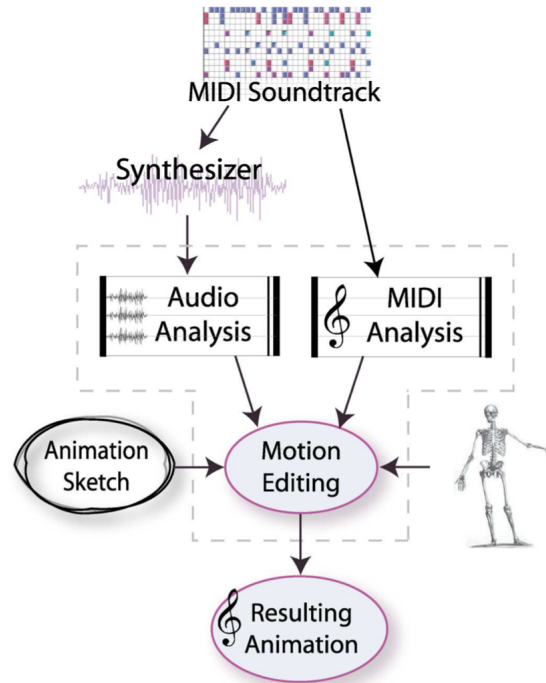
- Animation Industry -
 - Movements of crowds can be manipulated easily by creating an audio reference and modifying the motion signal.
 - Similar logic can be applied to other animations, apart from walkcycle, such as falling objects.
- Dance Academy - Dancer's motion can be captured and motion signal can be generated from it, and the movements can be analysed for how many beats were missed.

Challenges: What are the main research challenges to solving this problem ?

- Modifying motion signal -
we need to create animation of walk cycle, then generate motion signal from it. Every humanoid movement involves a lot of muscles and body parts. When an arm is raised, the shoulder from another side also moves a little. While modifying the motion signal, these subtle movements might get distorted and seem artificial.
- Generating animation from modified motion signal - After the mapping of music to motion, the animation needs to be rendered. The quality of that animation might be low in terms of natural movements.

Prior Work: How have prior researchers tried to solve this problem ? Where have they succeeded ?

Not a lot of research has been done in the field of mapping the beats of the music with the character walk-cycle. We found some similar topics such as, Music driven dance moves, Music and motion mapping, Emotional analysis of music piece. We are following the Music and motion mapping research paper ("Music-driven motion editing: local motion transformations guided by music analysis"). This research paper uses MIDI soundtrack along with audio to generate music signal, and then it is used to modify motion signal.



Limitations: Where have they failed ?

In Music and motion mapping research paper, the resultant modified motion signal was not converted to the animation, it was mentioned in the future scope. In research on music driven dance moves, the dance moves were predicted by model trained on neural networks. As a result, the generated dance moves seemed unnatural as the system did not take account of the subtle movements of other muscles that were not actively used. While predicting the major move (like jump), the NN did not predict the small subtle movements that are part of jump.

Proposed Approach: How do you propose to address these limitations and solve the problem ?

We are using techniques applied in several research papers.

- Retrieve MIDI soundtrack from given audio
using online tools, we would retrieve MIDI signal
- Generate audio signal to analyse beats from the music
- Create motion signal for 2D animation keyframes
We would use walkcycle of 4-8 keyframes, generate it's motion signal by using approach provided in "Motion signal processing" research paper (cited below)
- Map the motion signal to music signal
This approach is described in "Music-driven motion editing: local motion transformations guided by

P1: Project Proposal

music analysis.”. When the character takes a step, there is a moment before taking the next step when the character is at steady state. We want to map this steady state with the beat.

- Render the modified signal
This can be achieved by following ”Motion signal processing” paper.

Contributions: What are the main scientific contributions of your work ?

Motion signal processing based on audio signal, is an unexplored field. This project can be scaled to cover musical emotions as part of the motion. The music signal can be analysed to get emotional properties and then using those properties a walkcycle can be generated that reflects the emotions, by modifying the posture of the character.

Evaluation: How will you evaluate your proposed approach ?

The motion signal and audio signal should be synchronised. We can evaluate this by comparing the graphs of both the signals.

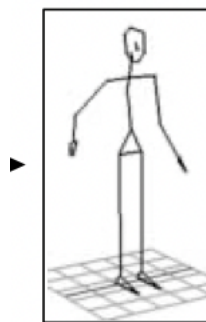
Finally, the 2D animation of walkcycle should be synchronised with the provided music. The foot steps of the character would be according to the beats of the music.

Benefits: What are the benefits of your approach ?

We are not using neural networks for modifying the motion signal. Hence, the subtle movements would remain unaltered. We would be changing the pace of the motion signal, by stretching it or shrinking it. We would not change the amplitude or other properties of the signal.

Expected Deliverable: What is the main expected outcome of this project ?

Given the music piece, the walkcycle of 2D character (similar to following sketch) would be in sync with the beats of music. We would generate a video of GIF that will combine the modified motion signal and music piece.



Feedback from previous project proposal and from mentor (Jerry Chang)

Initially, we were planning to analyse emotions in the music piece and create a walkcycle that reflects the emotions. As none of us has experience in signal processing, the project seemed ambitious. We also planned to use 3D animation for this, and resultant motion would also be a 3D animation, which is difficult to incorporate given the resources we have. Jerry suggested us to use walkcycle of 4-8 keyframes, which would be easier to map to the music beats.

Hence, we reduced the scope of the project. We are now focusing on just one walk-cycle motion and mapping it to the music piece. The walkcycle motion would be in 2D. We are also restricting our scope in music pieces, we would be using music pieces with steady beats and tempo, without gaps or irregular beats.

Relevant Research papers

- M. Cardle, L. Barthe, S. Brooks and P. Robinson, "Music-driven motion editing: local motion transformations guided by music analysis," Proceedings 20th Eurographics UK Conference, 2002, pp. 38-44, doi: 10.1109/EGUK.2002.1011270.
- Bruderlin, A. and Williams, L., 1995, September. Motion signal processing. In Proceedings of the 22nd annual conference on Computer graphics and interactive techniques (pp. 97-104).
- Y. Qi, Y. Liu and Q. Sun, "Music-Driven Dance Generation," in IEEE Access, vol. 7, pp. 166540-166550, 2019, doi: 10.1109/ACCESS.2019.2953698.
- Anders Friberg, Johan Sundberg Lars Frydén (2000) Music from Motion: Sound Level Envelopes of Tones Expressing Human Locomotion, Journal of New Music Research, 29:3, 199-210, DOI: 10.1076/jnmr.29.3.199.3093
- Tae-hoon Kim, Sang Il Park, and Sung Yong Shin. 2003. Rhythmic-motion synthesis based on motion-beat analysis. ACM Trans. Graph. 22, 3 (July 2003), 392–401. DOI:https://doi.org/10.1145/882262.882283