# THE DETERMINATION OF BALLROOM DANCE MUSICAL RHYTHM AND CATEGORIES FOR BEGINNERS

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## *Abstract*

*Ballroom Dance is one of the international sport dances. It has five categories namely Waltz, Tango, Slow Foxtrot, Quickstep, and Viennese Waltz. The basic of these categories is the music rhythm, consisting of the tempo and music bar. Nowadays, music rhythm calculation is usually calculated based on the feeling of the listeners. Therefore, some different perceptions in the calculation of the music rhythm sometimes might be found between the teacher and the dancer while learning the dance. This research was made to solve the problem, as well as to provide some knowledge about the names of the dance variations. The result of the research was an application that detects the peaks of audio wave inputted by the user in order to determine the tempo which is the basis of bar specification. Once the tempo and the bar were determined, the music would be classified based on the ballroom dance categories. Through this research, the beginner dancers are expected to easily determine the music rhythm and to acknowledge the types of ballroom dance in accordance with the desired song.*

Keywords: *audio processing, music rythm, ballroom dance.*

## Introduction

The basic to learn ballroom dance is music rhythm. It is the most important thing to choose the types and dance moves. The music rhythm to be applied in ballroom dance is the tempo and the music bar. In the science of music, tempo and beat are connected to each other. These two things are able to arise the feelings and emotion of the listeners. Just like in ballroom dance, each category has different tempo and beat because each category of ballroom dance has different characteristics. For instance, Tango has distinct character with the tempo 128 taps per minute and with the beat 4/4. The importance of these things make the dancers indirectly learn to count the tap and the beat, so that it will be connected with the dance moves.

These days, to count the rhythm in ballroom dance is still done verbally and by using the feelings between the choreographer and the dancers. This makes the beginner ballroom dancers undergo difficulties in counting the tap and the beat, also some dancers have different calculation with their choreographer. These kinds of difficulties usually happen to the beginners because some of them do not now about music.

That is why this research was made to overcome those problems. The result of this research is an application to calculate the rhythm in ballroom dance for beginners. This application is able to determine the tempo and the beat of music used by the user. The outcome of this application is the tempo and the beat of ballroom music and the category of the dance followed by the music. Besides, this application gives additional information, such as, playlist, dance variations, and dance videos according to the determination of the rhythm used by the user as the reference and knowledge for the user.

This kind of research was done in advance entitled, Signal Processing for Music Analysis by using the pitch method calculation and harmony. The determination of the tempo in this research was done by finding out the sound intensity produced by the analyzed music (Gao, Zhanchun, Y. Liu, Y. Jiang., 2015). However, the determination of the beat was done by analyzing the left and right audio to find out the beat pattern which was more accurate to the science of music by dolmetsch (Blood, B., 2017). After getting the information of the tempo and beat, the next step done was to classify the music to be the music category of ballroom dance according to the tempo and the beat of ballroom dance music which was used in ballroom competition for beginners (Irvine, B., 1994).

This application is expected to help everybody who wants to learn ballroom dance starting from beginner level which is to learn counting the tempo of the song and understand which song is suitable for certain ballroom dance.

## Research methods

I . Developing System Method
The developing system method applied in this application used prototype method. For the details, it can be seen in picture 1 below :
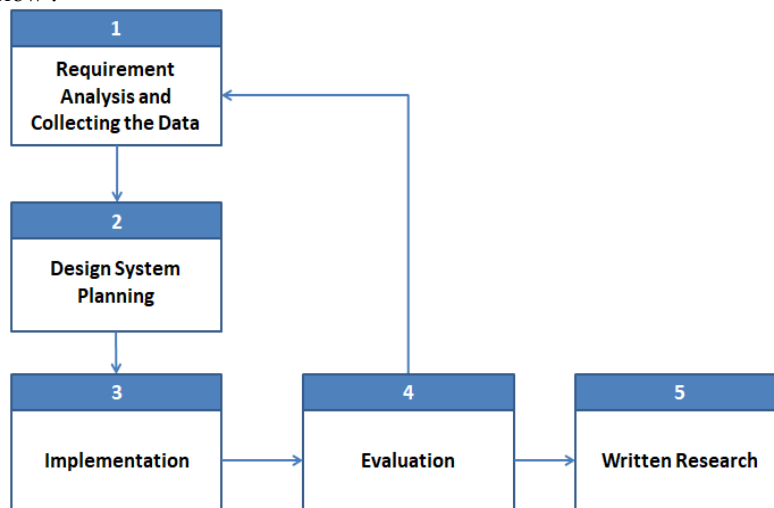


**Figure 1.** Developing System Method

1. Requirement Analysis and Collecting the Data
   The first step was collecting the data related to the research and analyze the data according to the needs of the user. Those data were ballroom music science which is about the categories of ballroom dances to the tempo and the beat of ballroom music, collected 50 ballroom songs that are used to be using, beat pattern, and other supported data, such as, ballroom dance variations, ballroom dance music titles, and ballroom dance videos.
2. Design System Planning
   In this step, design system planning was applied in the application.
3. Implementation
   The next step which was the third step, the desktop application was made according to the needs.
4. Evaluation
   The fourth step, evaluation was done in order to determine and evaluate whether or not the application suits the user. If the application suits the user, the next step would be done. However, if the application does not work well, the first step will be done over again starting from collecting the data.
5 . The last step was making a written research about it.

II . Flowchart

This flowchart portrays the coherence of the research and the relation of the each process in the application. When the application is run, the first menu displayed will be home that contains of 3 main menus, which are analysis menu, references menu, and help menu. Analysis menu is the menu used to analyze the music chosen by the user to be determined the tempo and the beat. Also, in this menu, the ballroom category will be determined. References menu has song playlists of ballroom dance that contains the titles of ballroom songs. The last menu in this application is help menu that contains of guide to run the application. The flowchart of this application can be seen in Figure 2.
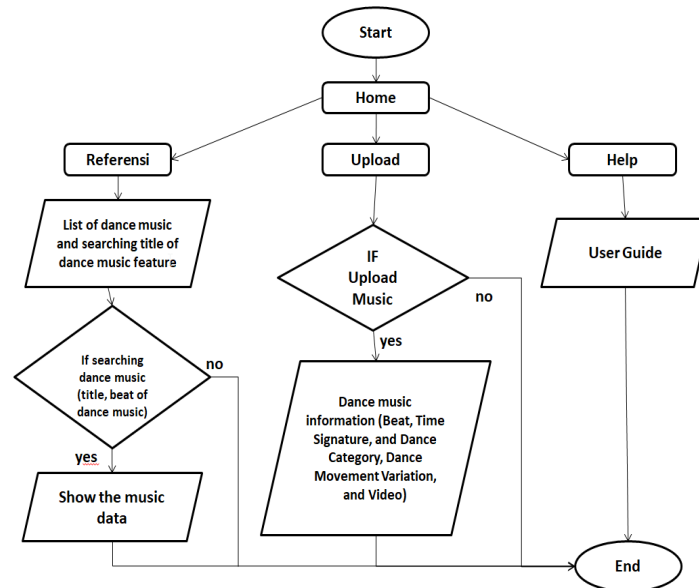


**Figure 2.** Flowchart

III. Workflow

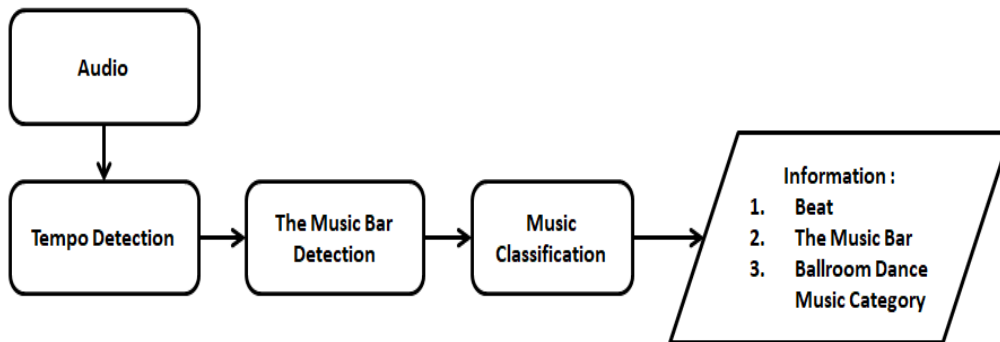The workflow can be in Figure 3.



**Figure 3.** Workflow

Below is the explanation of the workflow:

a . Tempo Detection

Tempo is the beat total in one minute. The tempo denomination is beat per minute. However, beat is the tap of music. The beat in music usually has low pitch like bass. To find the beat in a music, computation and audio processing are applied. By applying audio processing, we may be able to hush up the high pitch and focus on the lower pitch. The lower pitch or bass in signal and audio processing is placed at the lowest frequency of a soundwave. Here are the steps to get the beat:

1. Changing the audio analog signal into digital in order to get the information of amplitude, frequency in minute denomination. Then, quantifying the audio for 44.100 samples per second.
2. By using low pass filter, we can cut the upper frequency off and get the lower frequency in a signal to quantify the audio sampling and detect the peak of its amplitude. After that, determine the limit of peak sampling. If the peak is over the border determined, that is what is called as beat. Then, write down the time that has been detected by the beat.

3. Those 2 steps above can be done by an application called aubio.exe. By using aubio, we can detect the beat time from the start the audio is turned on until it stops. However, aubio cannot detect the amount of the tempo in 1 minute. That is why this research will be continued to the next step which was measuring the tempo by noting the first time the beat appeared until the interval reached for one minute.
4. Then, it could be found the amount of the beat in 1 minute and the result was the tempo. After that, it could be continued to the next step which is the music bar detection.

b . The Music Bar Detection

After getting the tempo/beat in the music, it continued to the detection of time signature. The noted timeframe of where the beat was, could be used to find out the time signature pattern according to its relation with amplitude. Here are the steps to find time signature:

1. Since quantifying the audio was done by using aubio application, the system would be broke down from the beginning for 44.100 samples per second. These samples would be used to get the volume in the beat pitch that had been noted.

2. In the noted beat timeframe, 500 samples were taken before the timeframe samples hand not been found and 500 samples were taken after the timeframe samples were found.

3. After that the amplitude of those sample were taken to find out the biggest energy or the biggest volume in the music bar pattern. To find out the beat volume feature volume formula was applied:
   - Finding out the specific timeframe of each beat in 1 minute. For example, the noted timeframe is 1,875 seconds in the first beat. So, to find out the sampling in that pitch is 1,874 x 44.100 becomes 82.687,5. Since it is quite impossible that has coma, the result can be integrated into 82.688.
   - After that it would be processed by using volume formula (1) (Liu, Zhu & Chen, Y. W. T.):
   Formula (1) :

$$v(n) = \sqrt{\frac{1}{n}\sum_{i=0}^{N-1}\left(Sn(i)\right)^2} \qquad (1)$$

   - After getting the volume of each beat in 1 minute, the volume was noted and saved to get the music bar pattern.
   - This step in order to get the volume, was done twice which was for the left and right audio considering music is stereo.

4. In ballroom dance, the first thing to count is the beat in bar without seeing the rhythm. That is why to detect the music bar in ballroom music can only be seen by finding out the amount of the beat in bar. Through ballroom dance music theory, it can be seen that the 3rd and 6th the music bar have the same patterns if they are taken from the last beat and the third beat as the beginning of detecting the first beat. The pattern is the last beat from the music bar 3 or the last one from the 6th the music bar is smaller than afterward. However, the music bar 4 according to general music theory is the first beat is always bigger than the next beat in a bar. This pattern counts from the 4th seconds of the music which is intro where the beat does not occur.

By using that the music bar pattern, each volume counts the probability of the appearance of the music bar 3, 4, and 6. At first, the the music bar probability on the left audio must be counted, then it goes to the right one. After that, make a note of which the biggest the music bar is, the left audio or the right audio. If the biggest the music bar probability is 4, the detected the music bar is 4. If the biggest the music bar probability is 3, the detected the music bar is 3, so is the the music bar 6.

c . Classification

The classification of ballroom music uses decision tree to determine the ballroom dance music according to the measurement of the tempo and the music bar that have been found (The National Dance Council of America, Inc., 2017). This classification works by seeing the tempo first, and if the tempo is classified as ballroom dance music, it will be continued to the the music bar. The the music bar will be seen from the left and right audio. If the tempo and the music bar from one of the left or the right audio is the characteristic of ballroom dance music, there will be some information that the music is not a ballroom dance music. The visualization of decision tree can be seen in Figure 4.

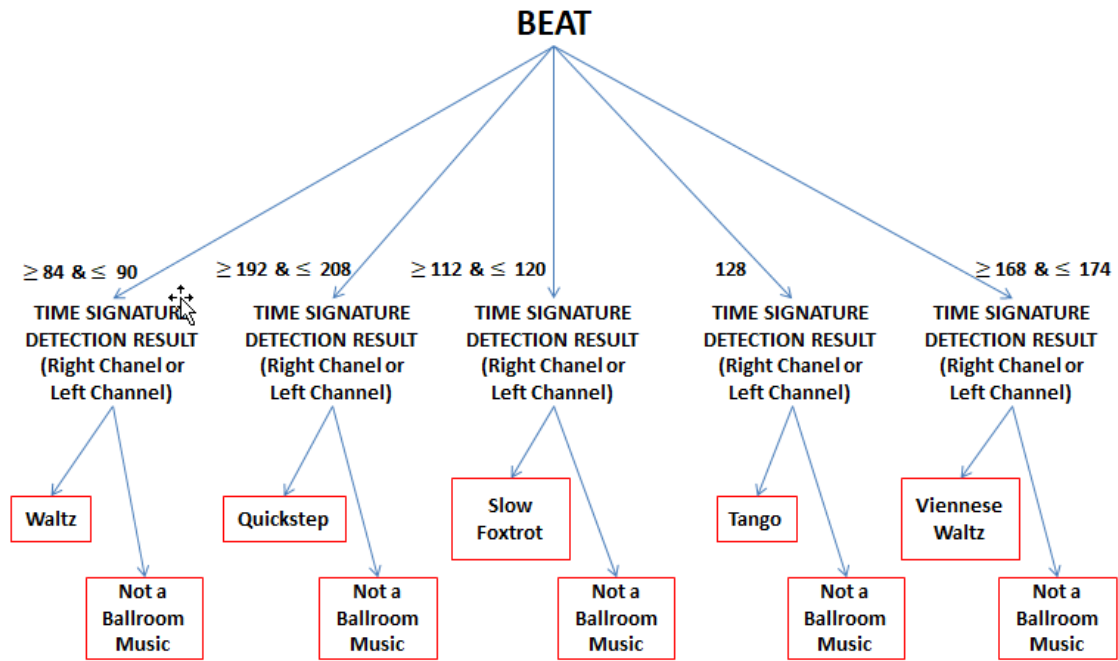**Figure 4.** Decision Tree

## Research Results and Discussion

This application was examined by applying 50 ballroom dance songs. The test was done by comparing the result of the detected tempo in the application examined by metronome, and the result of the detected rhythm using the references of ballroom dance music according to its category. Below is the result which can be seen in Table 1:

**Table 1.** Research Result

| No | Name | Beat Detection Result | | Beat Detection Accuracy | Time Signature Detection | Reference | Time Signature Detection Validity |
|----|------|------|------|------|------|------|------|
| | | Apps | Metronome | | | | |
| 1 | Valzer Lento - If you dont know me by now | 90 | 90 | 100 | 3 | 3 | RIGHT |
| 2 | Valzer Lento - Più che puoi | 88 | 88 | 100 | 3 | 3 | RIGHT |
| 3 | Dj Ice ft. Jonna - When We Were Young | 91 | 87 | 95.402299 | 4 | 3 | FALSE |
| 4 | Slow Waltz - Unchained melody | 94 | 87 | 91.954023 | 3 | 3 | RIGHT |
| 5 | Slow Waltz - Remember When | 87 | 87 | 100 | 3 | 3 | RIGHT |
| 6 | Slow Waltz - Try | 97 | 87 | 88.505747 | 3 | 3 | RIGHT |
| 7 | Slow Waltz - I Went To Your Wedding | 89 | 87 | 97.701149 | 3 | 3 | RIGHT |
| 8 | Slow Waltz - Let Me Love You | 88 | 88 | 100 | 3 | 3 | RIGHT |
| 9 | Slow Waltz - Mr Lonely | 92 | 87 | 94.252874 | 3 | 3 | RIGHT |
| 10 | Slow Waltz - Under The Tongue | 92 | 87 | 94.252874 | 4 | 3 | FALSE |
| 11 | Dj - Set Fire To The Rain | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 12 | Dj Ice - Glad You Came | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 13 | Dj Ice - How Deep is Your Love | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 14 | Dj Hero - Unbreak My Heart | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 15 | Dj Ice - Clocks | 127 | 128 | 99.21875 | 4 | 4 | RIGHT |
| 16 | Dj Ice - Say It Right | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 17 | Una Lacrima Sul Viso | 128 | 128 | 100 | 4 | 4 | RIGHT |
| 18 | Dj Ice - Dynamite | 127 | 128 | 99.21875 | 4 | 4 | RIGHT |
| 19 | Dj Ice - Radioactive | 127 | 128 | 99.21875 | 4 | 4 | RIGHT |
| 20 | Dj Ice - Paparazzi | 129 | 128 | 99.21875 | 3 | 4 | FALSE |
| 21 | Chill | 113 | 113 | 100 | 4 | 4 | RIGHT |
| 22 | Lena Horne - I Got Rhythm | 121 | 119 | 98.319328 | 4 | 4 | RIGHT |
| 23 | Dj Ice - Fly me to the moon Slow Fox | 112 | 112 | 100 | 4 | 4 | RIGHT |
| 24 | Dj Ice - Bad Romance | 116 | 112 | 96.428571 | 4 | 4 | RIGHT |
| 25 | Dj Ice - Miss Sha La La La | 116 | 116 | 100 | 3 | 4 | FALSE |
| 26 | Dj Ice - Cant Take My Eyes Off you | 118 | 116 | 98.275862 | 4 | 4 | RIGHT |
| 27 | Dj Ice - All About The Bass | 117 | 117 | 100 | 4 | 4 | RIGHT |
| 28 | My My Time Flies Slow Fox | 112 | 112 | 100 | 4 | 4 | RIGHT |
| 29 | New York New York Slow Fox | 112 | 112 | 100 | 4 | 4 | RIGHT |
| 30 | Angel Eyes Slow Fox | 112 | 112 | 100 | 4 | 4 | RIGHT |
| 31 | Quickstep - Happy Days | 101 | 196 | 51.530612 | 4 | 4 | RIGHT |
| 32 | Quickstep- Pencil Full Of Lead | 108 | 201 | 53.731343 | 4 | 4 | RIGHT |
| 33 | Quickstep - Rhythm | 100 | 200 | 50 | 4 | 4 | RIGHT |
| 34 | Dj Ice - Lets Get Loud | 104 | 201 | 51.741294 | 6 | 4 | FALSE |
| 35 | Quickstep - Im So Excited | 100 | 204 | 49.019608 | 4 | 4 | RIGHT |
| 36 | Dj Hero - Zombie | 103 | 200 | 51.5 | 4 | 4 | RIGHT |
| 37 | Quickstep - Midnight in Moscow | 106 | 202 | 52.475248 | 6 | 4 | FALSE |
| 38 | Quickstep Jambalaya | 109 | 208 | 52.403846 | 4 | 4 | RIGHT |
| 39 | Bei Mir Bist Du Schon ~ Lawrence and Gorme | 110 | 200 | 55 | 4 | 4 | RIGHT |
| 40 | Quickstep - Cheri Cheri Lady | 101 | 202 | 50 | 4 | 4 | RIGHT |
| 41 | Mecano - Hijo De La Luna | 174 | 174 | 100 | 6 | 6 | RIGHT |
| 42 | Dj Masky - Earned It | 169 | 174 | 97.126437 | 6 | 6 | RIGHT |
| 43 | Viennese - This Is One For All Children | 171 | 174 | 98.275862 | 6 | 6 | RIGHT |
| 44 | Shostakovich - Jazz Suite No. 1 Waltz | 172 | 175 | 98.285714 | 6 | 6 | RIGHT |
| 45 | Valzer Viennese - Annies Song | 172 | 175 | 98.285714 | 4 | 6 | FALSE |
| 46 | Valzer Viennese - Thats Amore | 170 | 174 | 97.701149 | 6 | 6 | RIGHT |
| 47 | Valzer Viennese - Non Credere | 172 | 172 | 100 | 4 | 6 | FALSE |
| 48 | Wiener Waltz - Kufsteiner lied (Viennese) | 177 | 177 | 100 | 4 | 6 | FALSE |
| 49 | Hollywood Movie Strings - Valse De Amelie | 171 | 176 | 97.159091 | 4 | 6 | FALSE |
| 50 | Viennese Waltz - You Lost Me | 169 | 174 | 97.126437 | 6 | 6 | RIGHT |
| | | | Beat Accuracy Total | 89.066602 | | Time Signature Validity Result | 40 |

The evaluation result of this application can be seen in table 1. The result is the comparison of the tempo that was calculated by using metronome. In this tempo, the accurate tempo is 89% which can be seen by using this formula (2):

$$\frac{Beat\ on\ App\ and\ Metronome\ Difference}{Beat\ Calculation\ by\ Metronome}\ x\ 100\% \quad (2)$$

However, the music bar was compared to the result of the application calculation which was gotten from the ballroom dance music. In the music bar calculation, there were 50 songs, and 40 out of 50 were correct and 10 songs were wrong. For example, the valzer viennese - annies song should be detected for viennese waltz ballroom

dance music. But the results of the detection of the time signature on the channel there are 4, whereas it should be 6 or 3 then it is detected not a dance song. Examples of other songs from dj ice - paparazzi song that should have been detected by Tango songs with 128 BPM, detected 129 BPM on the application so that the song was detected incorrectly or not a dance song. That incorrect detected is because there has a variations in tone where that is on the low pitch level or bass.

## Conclusions and recommendations

From the result, it can be concluded that :

1 . The exact result of the tempo is 89%. This can be seen from the comparison of the result of the application calculation using metronome.

2 . In the music bar calculation, from 50 songs that were examined, 40 songs were correctly detected and the other 10 were wrong. The result of the detection was done by using the ballroom dance music and the detection used the theory of dolmetsch.

The main mistake that this application produces is the pitch and the upper pitch are not its concern, and the pitch can only be counted using feelings considering that a composer uses his feelings and emotions to make pitch.

### Acknowledgment

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