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Spectrum analysis for assessment and evaluation of vocal music based on intonation

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APPROVAL FORM

The undersigned certify that they have supervised the student HWATA KUDZASHE MARRION (B1645428) dissertation entitled, “Spectrum analysis for assessment and evaluation of vocal music based on intonation in relation to the major scale”. Submitted in Partial fulfilment of the requirements for the Bachelor of Computer Science Honors Degree of Bindura University of Science Education.

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DEDICATION

This effort is dedicated to God Almighty, my creator, who has provided me with inspiration, wisdom, knowledge, and insight. Throughout this project, he has been a significant source of strength for me. I also dedicate this project to my family and friends, who have supported me throughout the process and ensured that I give it everything I have to finish what I have started.

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I'd like to express my gratitude to the Almighty for providing me with this opportunity and for being there for me in my darkest hours; may all praise be given to you, Lord. It would be possible to do everything. If it weren't for Him, I wouldn't be here.

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ABSTRACT

Vocal music performance occupies a dominant position in the musical landscape of Kenya yet scholars have had numerous debates as to how music should be assessed and evaluated. Instructional refinement and related matters of liability have provided a domain for the widespread need for diverse assessment and evaluation grading systems(G/Tsadik *et al.*, 2020). The research being done was on ““Spectrum analysis for assessment and evaluation of vocal music based on intonation in relation to the major scale”. The purpose of this research was to come up with a system that is able to measure pitch accuracy of a singer based on the rules of music in this case thus the major scale. A model was developed using spectrum analysis

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CHAPTER 1: PROJECT PROPOSAL

1.0 Introduction

Within the instrument's complete frequency range, a spectrum analyzer evaluates the magnitude of an input signal vs frequency. The most common application is to determine the strength of a spectrum of known and unknown signals. Vocal music is an essential component in human lives, existing in many forms such as classical music and folk music are purposefully used at many levels of complexity(G/Tsadik *et al.*, 2020). Music will continue to grow in the future with singing competitions being held locally, nationally and globally to test on the ability of the singer to sing in tune which is the intonation. Some of these competitions include, World Championship of Performing Arts which is a global competition, American idol, Karaoke world championship, hal Leonard vocal competitions, International Hans Gabor Belvedere Singing Competition and many more. With these competitions being done there's need for a good evaluation technique. They are different ways to evaluate the vocal singing which has been used in the past like the music experts assessing singing on the basis of musical knowledge and perceptual relevance which is known as the subjective judgmental method. Personal biases and inclinations, on the other hand, are unavoidable in human judgment. As a result, a spectrum analyzer might be useful in this situation, with applications such as karaoke singing scoring and as a practice tool for singers. According to Porter (2016), vocal music is the oldest form of music, since it does not require any instrument besides the human voice. In this study, the voice is presumed to be the original musical instrument(G/Tsadik *et al.*, 2020). The voice is considered to be the first musical instrument in this research. The human voice as observed by Andang'o (2000) supersedes any other existing instrument because of its uniqueness and potentiality(G/Tsadik *et al.*, 2020). The principles of singing or musical notions drawn from music theory are used to evaluate how well a singer sings. Human listeners should enjoy the vocal quality as well. Assessing and evaluating vocal music as Freer (2011) postulates, has existed for hundreds of years(G/Tsadik *et al.*, 2020).

1.2 BACKGROUND OF THE STUDY

A music festival is a public event that seeks to recognize and reward exceptional musical ensembles, soloists, composers, conductors, and musicologists, however this thesis will focus on the human voice. Pop music competitions are music competitions held to discover new pop stars. Music competitions are held not only globally, but also locally, regionally, nationally, and internationally. Local competitions are primarily held at Zimbabwean schools, which include elementary, secondary, and higher levels. The

major goal of these competitions is to determine the greatest singers in terms of intonation accuracy, rhythm consistency, proper vibrato, timbre brightness, dynamic range, and vocal clarity, which are all aspects of singing in tune. Using human judgment in the form of Judges has always been a biased evaluation strategy because it allows for a lot of unfairness in rigging the competitors. In this research a spectrum analyzer will be used to evaluate vocal music, in order to eliminate all of the unfairness in these musical competitions.

1.3 STATEMENT OF THE PROBLEM.

Giving an eye to the global world music it's a renowned art thing it is done in every country and in every corner of the world. Music competitions are held everywhere from primary schools to secondary schools. Music competitions does not only end in schools but it's a global thing as well. Using human judgement in the form of Judges has always been a biased evaluation technique because they are open chances to rigging the competitors with a lot of unfairness. This thesis seeks to get rid of all the unfairness in these musical competitions by using spectrum analyzer for evaluating soloists referred to as human vocals and testing on its level of impact.

1.4 AIM OF THE PROJECT

To come up with a system for evaluating the vocal music to see whether a singer is singing in-tune or singing off-tune, as well as testing the effectiveness of the system.

1.5 RESEARCH OBJECTIVES

- To analyze the effectiveness of the spectrum analyzer in determining the singing ability of a singer in vocal music.
- To design and implement a system using a spectrum analyzer to determine the intonation of a singer.
- To analyze different audio processing techniques.

1.6 RESEARCH QUESTIONS

- How will the system analyze singers?
- What are the benefits of having the spectrum system?
- What are the types of audio processing techniques?

1.7 RESEARCH PROPOSITIONS OR HYPOTHESIS

The research proposes that evaluating of human vocal melody using a spectrum analyzer is the best approach and effective way rather than the manual way where there is human judgement.

A Hypothesis:
H0: The use of a spectrum analyzer is not an effective way to assess and evaluate vocal music.
H1: The use of a spectrum analyzer is an effective way to assess and evaluate vocal music.

1.8 JUSTIFICATION OR SIGNIFICANCE OF THE STUDY

Many adjustments are being made in numerous industries as they shift from manual to computer-assisted methods. Low costs and time efficient solutions are being promoted by these new automatic systems(Pandey & Rajeswari 2013). There are numerous issues with the manual approach, such as human judgment in the appraisal of vocal music in musical competitions. Favoritism by judges and racial segregation are two of the most serious issues. A spectrum analyzer would see justice in the outcome if an automated computer-based system was included. When compared to human judgment, the system offers an unbiased outcome, which eliminates human effort and saves time and resources. The proposed instrument would be used as an evaluation learning tool in Zimbabwe's primary, secondary, and higher education institutions, as well as an international evaluation learning tool in vocal musical competitions.

1.9 RESEARCH ASSUMPTIONS

The researcher assumes that:
1) The judges much well understand the system and how it works.
2) Both the competitors and the Judges will embrace and appreciate the system.

1.10 LIMITATIONS OR CHALLENGES

The first limitation we have is rejection of the system with Judges in fear of losing jobs with machines replacing humans. Another limitation is that it might take time to learn the new computer system as the competitors, audience and the judges will be used to the old manual system.

1.11 SCOPE OR DELIMITATION OF THE RESEARCH

The research will be carried out at Bindura University of Science Education (BUSE), Faculty of Science and Department of Computer Science using courses: (Artificial Intelligence), digital signal processing(DSP) as a sample.

1.12 DEFINITION OF TERMS

DSP – Digital Signal processing

BUSE—Bindura University Of Science Education

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

The study affirmed the chapter's goals and gives a critical overview of published research literature related to the research endeavor in question. The study's goal is to see the impact of computer systems for evaluating vocal music based on intonation, therefore the chapter examines relevant literature. This study delves into prior systems that have been developed and how they have impacted their field of study, what benefit they have provided to the community as a whole, and whether they were able to achieve their individual set goals as well as the general I.T goals that they were designed for. The reason for this is that following the analysis, the automated judgment of vocal music based on intonation takes place. If the previous systems have any flaws, a spectrum analyzer can correct these flaws, making it a better method for evaluating vocal music.

2.1 Previous Systems Used For Evaluation Of Vocal Music.

The evaluation with expert Judges is one of the earliest ways in which music has been evaluated. These Judges differ in categories and categorized as novice, intermediate to expert.

2.2 Assessment and Evaluation Concept in Music

Assessment and evaluation are key components in instructional and learning environments. Both of these ideas are important in the training process and design. In the context of music education, several academics have defined assessment and evaluation, and the terms have been used interchangeably.

Asmus (1999) defines assessment in the context of teaching as "that which objectively measures an acquired mastery of expertise over a period of time in order to assign a just score and identifies appropriate future teaching experiences that an instructor may provide to strengthen students' training(G/Tsadik *et al.*, 2020)." In order to improve a student's musical development, a trainer uses a number of teaching tactics as part of a class evaluation. Vocal warm-ups, scale singing, breath control exercises, and other techniques could be employed as pedagogical tools. Stegman (2003) mentions the necessity for instructors to implement reachable vocal techniques as part of evaluation strategies that would help students grow their musical experiences and abilities in a timely manner(G/Tsadik *et al.*, 2020). Warm-ups are a great example of how to dramatically boost a student's incredible enthusiasm during singing. A performance practice regimen is necessary for vocal music growth and learning. Studies by Demorest (1998), Wang (2001) and Kurkul (2007) allude to the urgency of objective studies towards training on the voice instrument(G/Tsadik *et al.*, 2020). Singing scales, for example, are used to strengthen the vocal chord muscles, improve memory, and improve pitching ability. The most effective educational tasks for assessing and evaluating the vocal instrument are singing scales. Stegman (ibid) eminently recommends instructors to constitute varied and significant instructional techniques that are balanced with continued methodologies that are necessary to students' vocal growth(G/Tsadik *et al.*, 2020). As a result, assessment is concerned with the educational process, whereas evaluation is concerned with the final result or output. Evaluation is the last step in the process of determining the quality of the procedure, which is also evaluated by scores.

2.3 Voice Music Examination Concerns and Patterns

Rating pupils' musical ability has included a variety of activities, all of which have become increasingly relevant globally. The utilization of these various assessment activities has the potential to influence and modify how people perceive musical experiences. Earlier research has also found that the format in which

a music performance is presented has a substantial impact on the instructor's performance ratings, but the findings are mixed. As a result, the goal of this research was to look into the evaluation procedures in vocal music performance. The method in which a music performance is presented has a significant impact on the instructor's performance assessments, according to previous study, however the results are mixed. As a result, the purpose of this study was to investigate vocal music performance evaluation methodologies. Segmented evaluations, on the other hand, require the use of precisely defined criteria that often constitute a criterion-referenced measuring scale with predetermined qualities. Universal assessment refers to having a consistent grading system throughout their course rather than a disconnected grading system. While some examiners believe that employing the criteria allows them to focus on significant assessment difficulties, others believe that segmented evaluation allows them to confine their perspective on musical performance. Many descriptions of the notion have been found in a growing corpus of literature, with up to five variables forming vocal music performance. Here are several examples: intonation, dynamics, phrasing, expression and stylistic. Many intriguing questions about vocal music assessment and evaluation criteria have arisen, necessitating the invention and dissemination of enhanced and objective new vocal music assessment methodologies and measurements. This study looked into the missing key linkages between vocal music performance assessment, evaluation, and feedback.

2.4 Assessment and evaluation of logical and emotional domains.

Students' first learning experiences, mastery, and ability to monitor their progress, collect data, and provide feedback on their achievement are all assessed. Students are also given feedback on what they have learned and what needs to be done in order to maintain instructional continuity. Vocal music instruction is linked to music training as a topic of study. Singing accurately with considerations of techniques such as breath control, which implies understanding of correct processes, is the major goal here and what is examined. Students are expected to apply what they have learned in class in the Logical domain. Instructors are expected to evaluate how well students apply their understanding of musical aspects such as trills, dynamics analysis, and piece interpretation, all of which are logical processes in a vocal music performance.

On the other hand, the emotional domain conceptualizes, internalizes, and describes values of emotions or attitudes that are crucial in vocal music. When attempting to examine the affective domain in vocal music, a teacher is expected to consider not just the performance's facial emotions but also how they

affect the evaluation of the speed, intonation, and even ferocity. The emotional domain offers a framework for instruction, practice, and evaluation, and it is strongly characterized by emphasizing vocal music interpretation through emotional feelings.

2.5 standardization of grading manuals for vocal music assessment and evaluation

Assessment and evaluation of students are essential components of developing academic programs. Teachers must construct assessments based on what students have been taught since learners must be tested and evaluated. Trainers know that students are fascinated with what is portrayed in assessment in their specialised area; as a result, trainers must realize that assessment drives learners' knowledge. These are the viewpoints that make it necessary for tutors to choose the most important areas that are suitable for participants' learning and assessment. This study examined the methods trainers employ to identify and develop pupils who are verbally and technically remarkable. Is my program meeting its goals and objectives? is the concern that an accurate estimate aims to answer. As a result, its main applications are to present music performance and value outcomes; to compare the aims of the voice performance with its realized outcomes; and to provide formative feedback information for the change and improvement in performance.

This calls for allocating enough time and resources to translate a plan's goals and objectives into educational endeavors that satisfy the needs, stimuli, and skills of the students. The main goal of instructional assessment is to promote education while also delivering significant findings to students and teachers on the advancement of educational objectives. Because of the benefits they provide for learning, trainers are urged to incorporate evaluation and instructional strategies into their lessons. In order to produce judgment that includes rating, grading, or descriptions of quality, a person or collection of persons will attempt to balance and synthesize various criteria of personal skill in music. However, there is a noticeable lack of music performance evaluation among trainers, and results are frequently biased. Assessment of vocal music is a very difficult task. According to studies on music assessment, formal evaluation of musical number can be viewed as a structural system made up of a number of interconnected variables. It is difficult to evaluate since aesthetic value judgments have an impact on it, making it subjective in form. Studies show the importance of educators developing another uniform language for assessing and evaluating vocal music performance. Therefore, the goal of this work

was to create a vocal music assessment and evaluation system that accurately estimates musical performance.

2.6 Used algorithm for system development.

The OMP algorithm is initialized with an iteration step I, the following computational steps are performed:

- **Select the column X which is maximally related to the respective error vector.**
- **Update the support and the corresponding set of active columns.**
- **Update the estimate of the parameter vector**
- **Update the error vector**
- **The algorithm terminates if the norm of the error becomes less than a preselected user-defined constant**

2.7 SUMMARY

This chapter gave a summary of what other researchers discovered about assessment and evaluation of vocal music, looking at the early systems and the later systems that has been used. In view of the literature obtained from the various researchers, the general view that was discovered by the researchers is that assessment and evaluation of vocal music is a critical subject and it takes effort to be able to develop such systems. The developed computer system is a way to improve the education sector especially in universities. The main question that comes with the research is that, “will the spectrum analyzer assess and evaluate vocal music?” “Is the spectrum analyzer capable of saving costs, time and space and at the same time maintaining accuracy of the evaluation results?” If it can bring change, “then to what extend?” The next chapter highlights the research methodology.

CHAPTER THREE: METHODOLOGY

3.0 INTRODUCTION

The systematic solution of research problems is known as research methodology. It is a branch of science that studies how scientific research is carried out. Under it, the researcher learns about the numerous procedures that are commonly used to explore a research problem, as well as how to write a research proposal. The logic that underpins them (Beckerian et al. 2010). For example, if you want to draw attention to something, an element of a sociological theory or a test of an algorithm for a particular component of data you must demonstrate that you comprehend the retrieval, or test the validity of a certain system. The methodology's underlying concepts.

The researcher will explain how he addressed the research questions and/or hypotheses by describing the methods she used. The procedures are detailed in sufficient detail for the study to be duplicated, or at the very least conducted in a comparable manner, in a different setting. Every stage is described and defended, with detailed justifications for the procedures and materials used.

3.1 Requirements definition

While defining requirements, it is vital to have information required by certain software or system. It describes the capabilities, features, and attributes of the project. For instance, the program should have a capability that allows singers to assess and evaluate their vocal musical ability.

- The software must be able to assess and evaluate vocal music based on intonation in relation to the sung melody or song.
- The software must be able to give agreeable results after evaluation.

3.1.1 Requirements specification

This idea includes a description of the system's ideal design as well as a list of both functional and non-functional requirements. The main objective of the system is to produce results that satisfy these demands and objectives. It also emphasizes those users whose access to the system is restricted. For instance, the system should enable users to assess themselves using the major scale as the main metric. An illustration of a requirements specification that will be used are as follows:

- The singer should sing a song and assess the results

- The singer should be able to deduce the results from the sung melody.

3.1.2 Functional requirements

It outlines the capability or system services required to complete a specific task. In other words, "functional" refers to how the system responds to a set of inputs, as well as its behavior and output. These clear assertions should describe how the system reacts to specific inputs and how it should behave in specific situations. The following are some of them:

- The user will sing a song in any pitch as a reference point
- The system shall be able to assess and evaluate the input from the user to give agreeable output result.

3.1.3 Non-functional requirements

These are the attributes and restrictions of the system. They define criteria that can be used to assess the system's operation rather than specific actions. The following are the non-functional requirements:

- The system will be 99% available during scheduled uptime
- The system shall be accurate in the assessment and evaluation of vocal music.
- Methodology
- Tools used
  - C# Programming Language as a backend programming language.
  - Digital Signal Processing concepts.
  - Windows form for the user Interface (GUI)

3.2 THE SYSTEM DEVELOPMENT MODEL

A framework for organizing the steps of the development process in the overall effort to build a system is known as a system development methodology. As a consequence of several studies, a variety of models have been developed that can be used to the system-building process. The waterfall model was the first, and subsequent models were created as technology improved. Regardless of the model employed, it is not appropriate for one methodology to be applied in all projects. The projects that each technique is best suited for depend on its intricacy, organizational structure, project kind, and project team. The author decided on the RAD model.

3.2.1 RAD model

Rapid Application Development (RAD) is a software development process that focuses on a short development cycle. Rapid development is performed utilizing a component-based construction approach in RAD, which is a high-speed adaption of the waterfall model. The researcher chose this model because it aids in the rapid delivery of the system in such a way that any tweaks or additions can be made there.

The RAD uses an iterative and progressive approach, with small teams working on individual modules to create a complete system. Because the system is modular, it is much more appropriate to use the RAD because it allows you to work on each module in parallel, allowing for integration. Requirements Planning, User Design, Rapid Construction, and Transition are the five steps of the RAD methodology.

3.2.2 Requirements planning

The researcher's initial step is to collect requirements for the problem he or she has uncovered.

The essential goal is to fully comprehend that particular problem so that knowledge on how to address it is readily available. The researcher carried out a random sampling data from different vocal performers ranging from young age, to middle age up to old age groups.

3.2.3 User design

The goal was to thoroughly examine the operations related with the system under construction, as well as to design the system's structure in terms of the automated and manual functions that will be included. This stage results in a detailed area model, a system outline, and a plan for implementation. The researcher completed the design for an automated machine learning system for assessing and evaluating voice music at this level.

3.2.4 Rapid Construction

The researcher next finalized the system's thorough design and performed several tests to test the system, which is known as black box testing. Documentation was prepared that was required to run the spectrum analyzer vocal music evaluation system. The test data was gathered from different singers

and it was utilized to check the system's operational capability, as well as in the integration and acceptance testing.

3.2.5 Transition

This was the final stage, which involved putting the system into action. The system then achieved the following goals:

- To analyze the effectiveness of the spectrum in determining singing ability of a singer in vocal music.
- To design and implement a system using a spectrum analyzer to determine the intonation of a singer.
- To analyze different audio processing techniques.

3.3 Research design

For a system to be effectively deployed or "go live," the researcher must first create a good system design. To do this, distinct system modules and their intended functions must be developed. The system must be simple to use and generate the desired outcomes. A system's user interface must find a balance between usability and functionality. These two characteristics work together to develop high-quality software. In addition, the researcher will describe how the system will be tested after it is completed.

3.4 Design Methods

For a learner to be able to assess and evaluate himself or herself from the sung melody then the production of a software to enable the process should be facilitated. The spectrum analyzer system was implemented using the following:

- ✓ C#
- ✓ Spectograms
- ✓ C# windows form for data entry
- ✓ C# Libraries

3.4.1 System architecture.

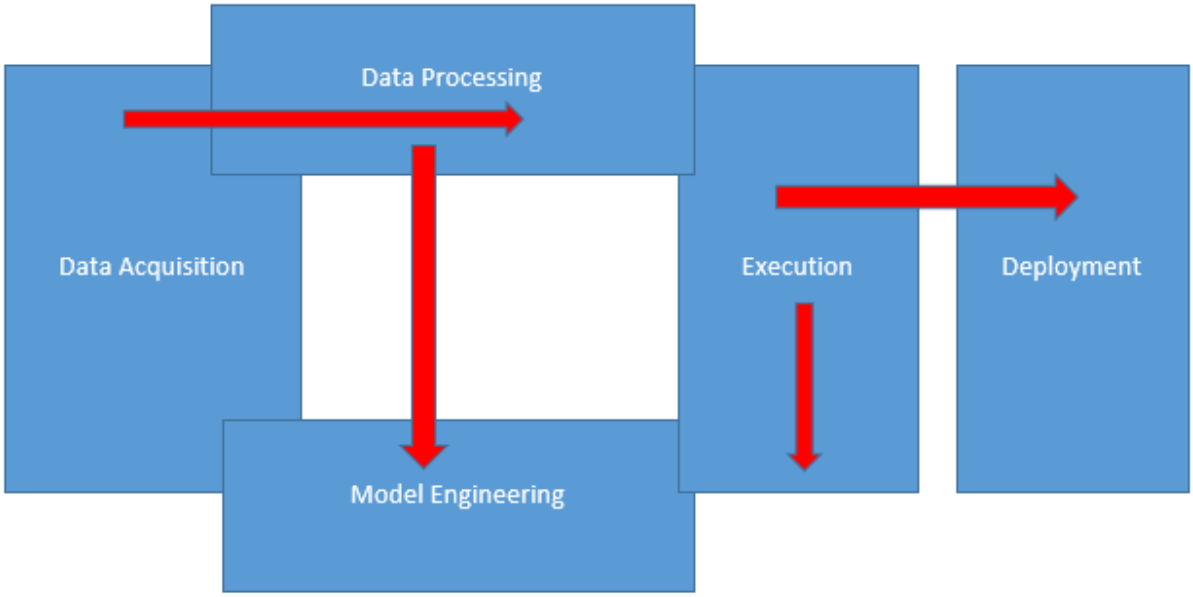


Fig 1.0 System Architecture

3.4.2 Data acquisition

Since machine learning relies on readily available data for the system to make a decision, data collection is the first phase stated in the architecture. In order to do this, information must be gathered, put together and categorized based on specific elements of the decision-making process, and then sent to the processing unit for further categorization. This level is also known as the data preparation step. Human vocalizations were used as the source of the data, which were then measured based on the value of their frequency ranges and classified as musical cents.

3.4.3 Data Processing

Data normalization, data cleaning, data transformation, and data encoding are just a few of the additional processing steps that the data processing layer performs on the data obtained by the data acquisition layer. The type of learning that is used affects how the data is processed.Data processing also depends on the kind of processing required and can range from actions on continuous data, which call for the usage of a particular function-based architecture, such as lambda architecture, to actions on discrete data, which call for memory-bound processing. Whether data is processed in memory whether it is in transit or at rest is decided by the data processing layer.

3.4.4 Model Engineering

The selection of multiple algorithms is required for this layer of the architecture in order to tailor the system to the issue being solved by the learning process. These algorithms either developed independently or were passed down from a number of libraries. In order to properly represent the data and set up the system for execution, algorithms are needed.

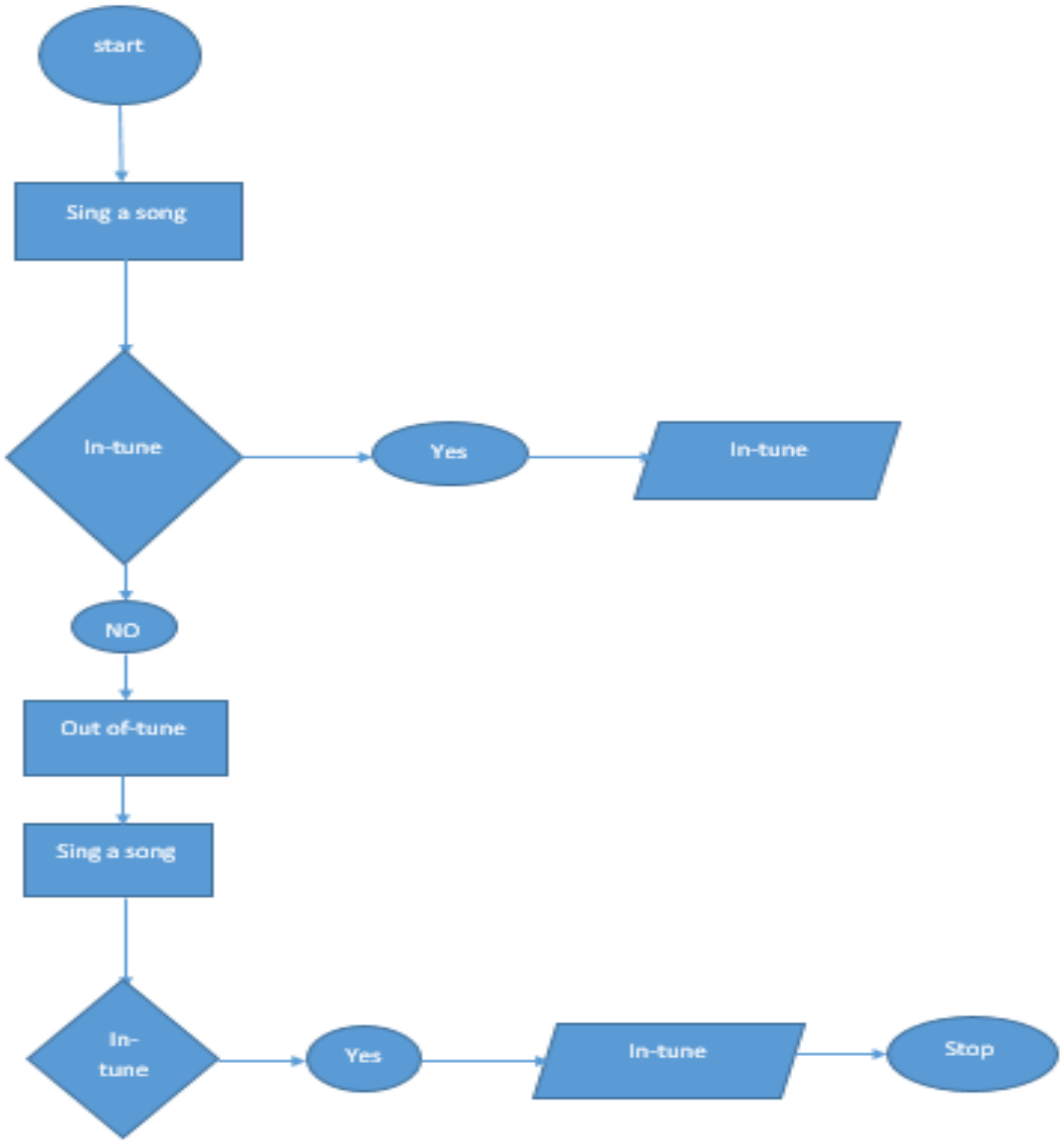
3.4.5 Execution

At this level, research, testing, and adjusting are all conducted. The overarching goal is to optimize system performance by optimizing the algorithm to extract the required machine output. The step's result is a refined solution that can provide the information the machine needs to make decisions.

3.4.6 Deployment

Like any other program output, results output needs to be operationalized or submitted for additional research. The outcome could be viewed as a non-deterministic investigation that must be included to the decision-making process. The ML output should be smoothly transitioned to production, enabling the machine to make decisions right away depending on the outcome and minimizing the need for further experimental operations.

Fig 2.0 : Flowchart for singers.


start
Sing a song
In-tune
Yes
In-tune
NO
Out of-tune
Sing a song
In-
tune
Yes
In-tune
Stop

4.0 CHAPTE FOUR: RESULTS AND ANALYSIS

4.1 INTRODUCTION

This section of the research is to help present the results of the spectrum system. This chapter examines results obtained from research and try to present them in a more meaningful way.

The **objectives** of the project where:

- To analyze the effectiveness of the spectrum in determining the singing ability of a singer in vocal music.
- To design and implement a system using a spectrum analyzer to determine the intonation of a singer.
- To analyze different audio processing techniques.

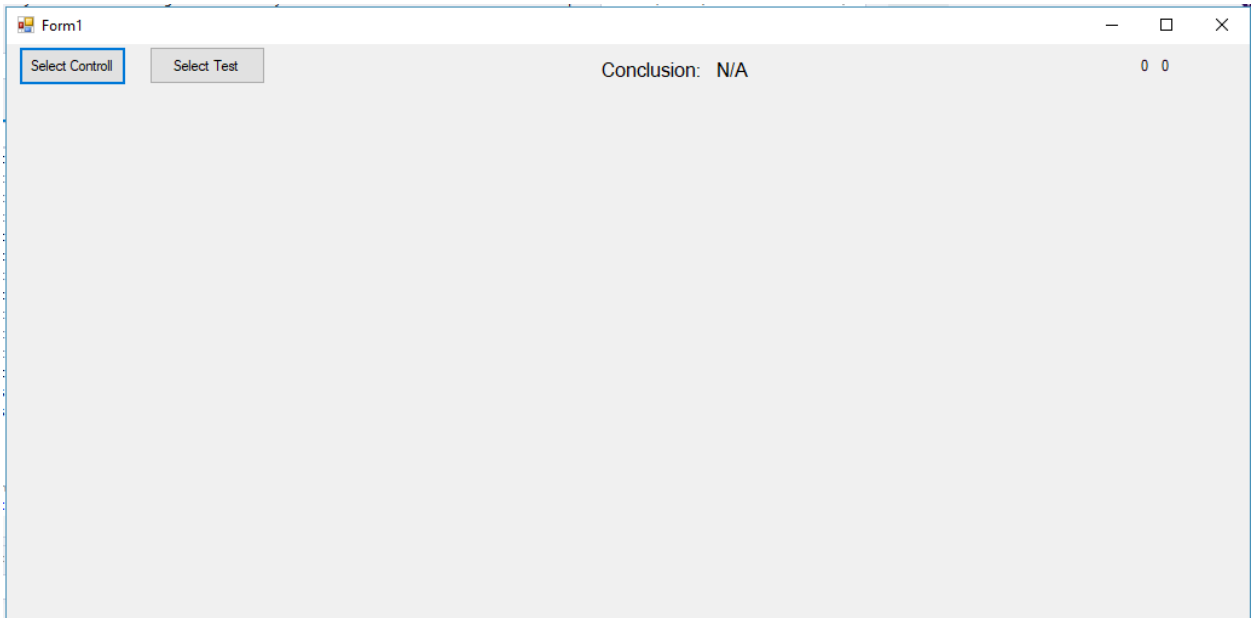
4.2 ANALYSIS AND PRESENTATION OF RESULTS:

To test whether the singer is in tune or out of tune there was a control which was used as a reference point and following up there was a test which was done to see whether you are in tune or you are out of tune.

The diagram below clearly illustrates this where there was a select control and a select test.

The select control was used as a standard and the select test was used as a test.

Input : Add songs



Screenshot for adding song tracks. **Fig 3.0**

The input the select control in this case it was used as a standard to see whether one is singing in tune or one is singing out of tune. If the frequencies of the select test match with the frequencies of the select control then this means that one is singing in tune other he or she is out of tune.

Executable program generate result.

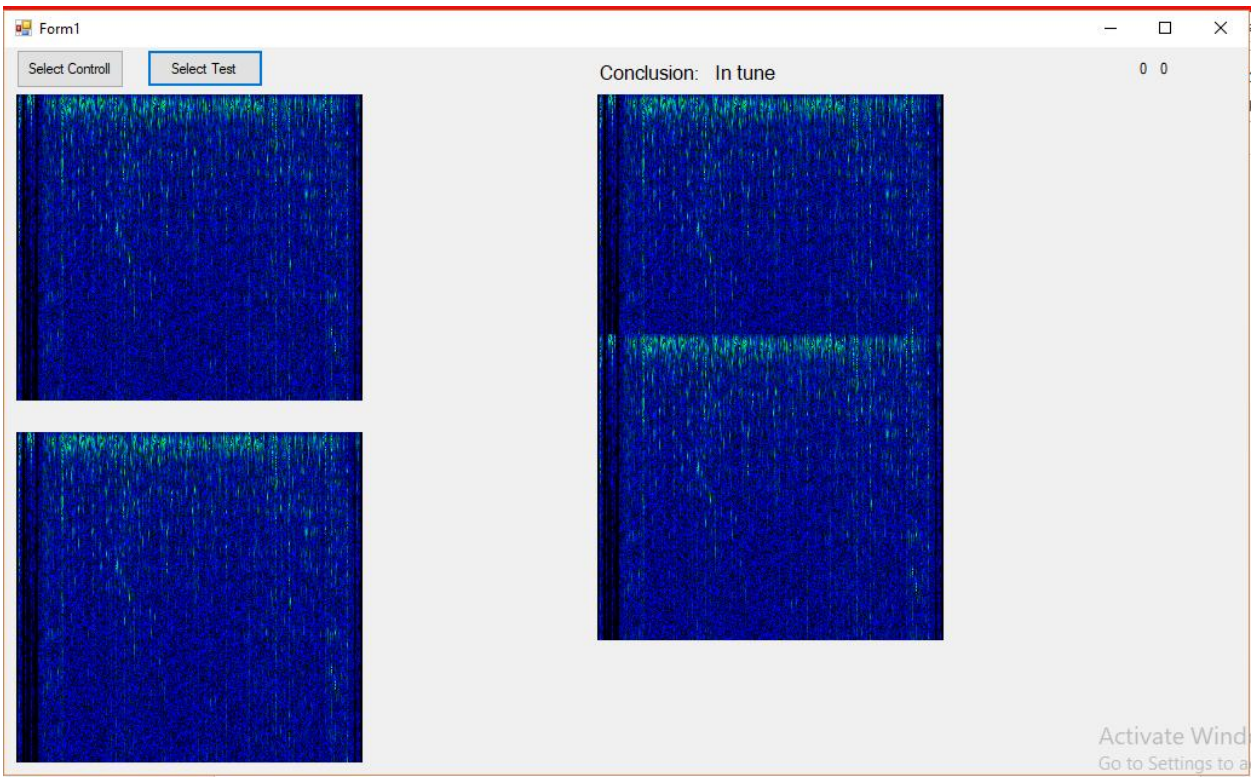


Fig 4.0

The diagram above shows that one is singing in tune because spectrum one matches with spectrum two, this means that the singer is singing in tune.

Result two

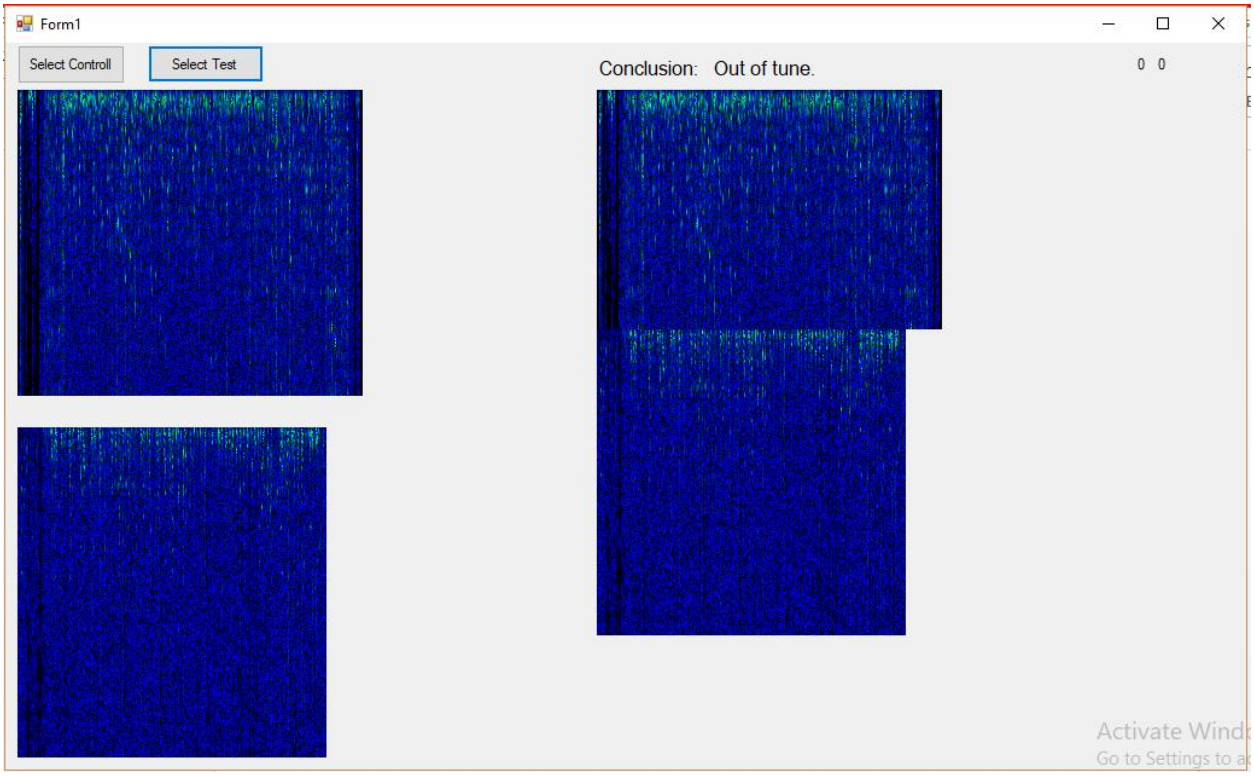


Fig 5.0

The figure above shows that the singer was out of tune because select test did not match with the select control therefore this shows us that the singer was out of tune.

Results Output:

4.3 ANALYSIS OF RESULTS:

Analysis of results was done using the confusion matrix:

Table 1.0

Test case	In tune	Number of tests	Correct	False	Classification
1	Yes	10	10	0	True Positive
2	No	10	8	2	True Negative

Accuracy = 10 + 8 /20 = 90%

4.4 A SUMMARY OF RESEARCH FINDINGS.

The system developed managed to produce results with the control test as a standard which is used to see whether a singer is in tune or out of tune using the control test. The research findings shows that the select control is always in tune and the select test is determined by the select control or the control experiment. Ten singers sang their melodies and the results were tabulated in the table above. The following chapter considers the summary of the research findings and helps to give some feedback upon the obtained results.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS.

5.1 INTRODUCTION

This part of the research clearly outlines to give a summary of the research findings. The research then goes on to conclude the findings seen from the research. Table shows that though it's a hard thing to sing in tune but it's a possibility as well to sing in tune. Recommendations drawn from the research conclusion where then clearly outlined.

5.2 Aims of the research.

The aim of the research was to see whether a singer is singing in tune or out of tune which is termed intonation or pitch accuracy.

Objectives of the research:

- To analyze the effectiveness of the spectrum analyzer in determining the singing ability of a singer in vocal music.
- To design and implement a system using a spectrum analyzer to determine the intonation of a singer.
- To analyze different audio processing techniques.

Research Questions:

- How will the system analyze singers?
- What are the benefits of having the spectrum system?
- What are the types of audio processing techniques?

5.3 DISCUSSION FOR RESULTS:

From the results obtained from the research, there is clarity such that the spectrum analyzer can be a useful tool in the assessment and evaluation of vocal music. Conclusions can then be made such that it can be a useful tool to both musical instructors and learners. Evaluation in musical performance has been done manually with judges deciding upon the outcome of the performance. This system will then replace the manual activity by the judges which have been a subject to biased and unfair results. The system will then evaluate to accurate estimate of the performance.

5.4 CONCLUSION:

As the author of the research I therefore conclude that the system is very useful because it helps to reduce the time spent to evaluate results. The system is also very easy to use hence it can meet requirements with less complexity. The system also helps to eliminate impersonations in which a singer tries to impersonate the work of others.

5.5 RECOMMENDATION FOR FUTURE WORK:

The author recommends that the system should be used in musical competitions which measure according to some standard or reference in this case thus the test control. The system is also helpful in reducing bias from the expert judges who sometimes judge according to favor but not the real outcome. The researcher has appreciated the course named digital signal processing because it has made vast enormous contributions in this research hence it is of great importance as well as C# programming language which has been used in making spectrograms, windows form for data entry and other functionalities hence it is also of great importance as well.

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