DESIGN OF SYNCHRONOUS SERIAL COMMUNICATION TO CONTROL PITCHES OF ANGKLUNG

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ABSTRACT

This thesis describes the control device angklung (traditional musical instrument) with a 3 octave by using microcontroller. Each angklung pitch should be shaken to produce intonation. The electric motor is used as a vibrator mechanism and installed on every pitch angklung. Parameters such as the time duration and the motor speed to needs to be controlled and this require a Motor Drivers. Angklung pitch usually arranged in a Diatonic Scale. In a frame of angklung, there is 7 pitch intonation compiled in one octave, then there are 21 motors needs to be controlled by a microcontroller to control the angklung that has 3 different octaves. If each motor requires 12 volt and 100 mA to move, then 2.1 A is required for all motor to operate simultaneously without problems. This requires Power Supply which provide 12 volt and 3 A. By using the Serial Parallel Interface (SPI), 21 connections from microcontroller to control each motor can be reduced. Because all motor drivers connected in serial connection, then the latency in motor drivers should be measure. Latency is the amount of time it takes for a system after the system receives the signal till the system is producing other signal out. If the motor drivers produce high latency, the delay produced by the angklung can be heard. The normal human ear can notice latency more than 3 ms.

ABSTRAK

Tesis ini menerangkan alat pengawalan angklung (alat muzik tradisional) yang mempunyai 3 oktaf dengan menggunakan microcontroller. Setiap pitch angklung perlu digoncang untuk menghasilkan intonasi. Motor elektrik digunakan sebagai mekanisme penggetar dan dipasang pada setiap pitch angklung. Parameter seperti tempoh masa dan halaju motor perlu dikawal dan ini memerlukan Motor Driver. Pitch angklung kebiasaannya disusun mengikut sekala diatonic. Dalam satu bingkai angklung tersusunnya 7 pitch intonasi dalam satu oktaf, maka terdapat 21 biji motor perlu dikawal oleh microcontroller untuk mengawal angklung yang mempunyai 3 oktaf yang berbeza. Jika setiap motor memerlukan 12 volt dan 100 mA untuk bergerak, maka 2.1 A diperlukan untuk kesemua motor beroperasi serentak tanpa masalah. Ini memerlukan Power Supply yang mampu mengeluar 12 volt dan 3 A. Dengan menggunakan Serial Parallel Interface bus (SPI), 21 sambungan kawalan dari microcontroller kepada setiap motor dapat dikurangkan. Oleh kerana kesemua motor driver disambung secara serial communication, maka Latency di dalam motor driver perlu diambil kira. Latency adalah jumlah masa yang diambil bagi sesebuah sistem selepas sistem itu menerima isyarat hinga sistem itu mengeluarkan isyarat keluar. Jika motor driver menghasilkan latency yang tinggi, maka delay intonasi yang dihasilkan oleh angklung dapat didengar. Latency yang dapat didengar oleh telinga manusia biasa adalah melebihi 3 ms.

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LIST OF ABBREVIATIONS

DC	Direct Current
MOSFETs	Metal-Oxide Semiconductor Field-Effect Transistors
BJT	Bipolar Junction Transistors
CMOS	complementary MOS
MOS	Metal-Oxide Semiconductor
TTL	Transistor-Transistor Logic
IC	Integrated Circuit
SPI	Serial Peripheral Interface Bus

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will describe background of proposed study, problem statement, objectives, scope of research and significant of research. Those information are important as we will further discuss it in the analysis and study case later.

1.2 Project Background

Many traditional musical instruments have been modified according to the latest trends form an instrument which automatically controlled. For this project, Angklung will be implemented to play by device that being control by microcontroller.

Angklung is music instrument that have being made by joining pieces of bamboo. It consists of two to four bamboo tubes suspended within a bamboo frame and produce certain notes when the bamboo frame is shaken or tapped. Each angklung produces a single note or chord, so several players must collaborate in order to play melodies.

This project is to develop device that can control Angklung with 3 octaves at minimum. In one octave of Angklung, there have about 12 of frame angklung. That frame will be taped by DC motor to produce a sound. Duration and velocity of the DC motor need to be control. Because we have about 3 octave of angklung, 36 DC motor needs to control by microcontroller. In this project, serial communication technology being applied to control all of that DC motor.

1.3 Project Problem Statement

The idea of electrically playing a angklung is not new. Many student from Indonesia have already produced a angklung-playing system under the names "Klungbot" and "Klungto Mobi". The usual angklung-playing system is just being preinstalled to the angklung and the system being control using parallel communication. This system is not easy to be maintained or troubleshoot by a normal guy. The new system could be installed into any existing angklung and allowing it to play music stored on computers that can send out MIDI signal. The device connected to the angklung by serial communication, capable to operate to add expression to the music by varying the voltages applied to the motors and can play angklung that have many octave.

1.4 Project Objective

The objectives of this study are:

(i) Develop the mechanical system that can be used to play an angklung.

(ii) Develop the electronic circuit to control all mechanical system.

(iii) Develop the electronic circuit using Synchronous Serial Communication concept.

1.5 Project Scope

The scope of the project is limited to the below parameter:

(i) Using Synchronous Serial Communication concept to control the angklung.

(ii) Controlling minimum 3 octave of the angklung.

1.6 Thesis Outline

This thesis contains 5 chapter which is every chapter have its own purpose. After viewing the entire chapter in this thesis hopefully viewer can understand the whole system design for this project.

Chapter 1 describe background of proposed study, problem statement, objectives, scope of research and significant of research. Those information are important as we will further discuss it in the analysis and study case later.

Chapter 2 describes about relation of Angklung Control and Serial Communications. The sources are taking from the journals, and articles and books. Literature review is helping in order to provide important information regarding previous research which related to this project. Those information are important to know before can proceed further to analysis and study later.

Chapter 3 describes about the procedures analysis on the serial data that being sending to motor driver to control the motor. Research methodology is a set of procedures or methods used to conduct research. Methodology is needed for a guideline in order to ensure the result is accurate based on objective. There are several steps need to be followed to ensure the objective of the research can be achieve starting from finding literatures until submitting the final report.

Chapter 4 will discuss every experiment on the methodology or the flow of work is come out with the result and analysis. The result of this project will include the signals that have being handled by motor drive to drive the motor. This chapter will discuss mainly about the problems encountered during the whole project was been carried out.

Chapter 5 represents about conclusion and recommendation for the project. In this chapter will discuss mainly about the conclusion of the project, concluding all the process that involved. Besides that this chapter also contains recommendation about

the project. So for this recommendation it can make further improvement for future reference.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will explain about relation of Angklung Control and Serial Communications. The sources are taking from the journals, and articles and books. Literature review is helping in order to provide important information regarding previous research which related to this project. Those information are important to know before can proceed further to analysis and study later.

2.2 Principle of Angklung

Angklung is a music instrument made from joint pieces of bamboo. It consists of two to four bamboo tubes mounted together within a bamboo frame, bound with rattan cords. The angklung produce certain notes when the bamboo frame is shaken or tapped. Each angklung produces a single note or chord, so several players must collaborate in order to play melodies. The instrument has been known since ancient times in some parts of Indonesia, especially in West Java, Central Java, East Java, and Bali. Figure 2.1 shows example single pitch of the Angklung. (Professor Kuo-Huang Han)

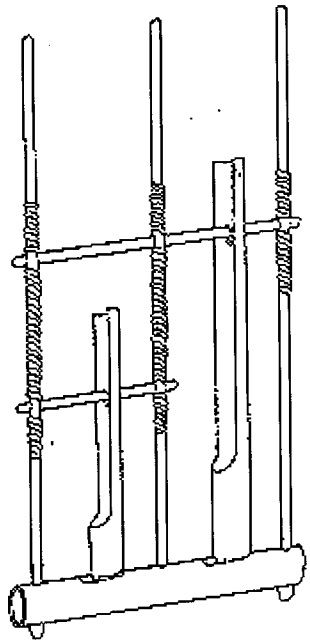

Figure 2.1: Example single pitch of the Angklung

The interval between the differently-sized bamboo tubes on each Angklung is one octave. Most Angklung sets today are tuned to the western chromatic and diatonic scales. (Professor Kuo-Huang Han)

2.3 Basic of the Angklung Scale

In music, an octave or perfect octave is the interval between one musical pitch and another with half or double its frequency. The octave relationship is a natural phenomenon that has been referred to as the "basic miracle of music", the use of which is "common in most musical systems". It may be derived from the harmonic series as the interval between the first and second harmonics.

2.3.1 The Diatonic Scale

In music theory, a diatonic scale is commonly defined as a seven-note, octave-repeating musical scale comprising five whole steps and two half steps for each octave, in which the two half steps are separated from each other by either two or three whole

steps. This pattern ensures that, in a diatonic scale spanning more than one octave, all the half steps are maximally separated from each other. (Adam Koss)

Any sequence of seven successive natural notes, such as C-D-E-F-G-A-B, and any transposition thereof, is a diatonic scale. Table 2.1 shows diatonic scale in degrees in solfege. Piano keyboards are designed to play natural notes, and hence diatonic scales, with their white keys. It is made up of seven distinct notes, plus an eighth which duplicates the first an octave higher Insolfege, the syllables used to name each degree of the scale are "Do–Re–Mi–Fa–Sol–La–Ti–Do". Figure 2.2 below shows example diatonic scale on the angklung. (Adam Koss)

Table 2.1: Example Diatonic Scale

Notes in C major	C	D	E	F	G	A	B	C
Degrees in solfege	Do	Re	Mi	Fa	Sol	La	Ti	Do

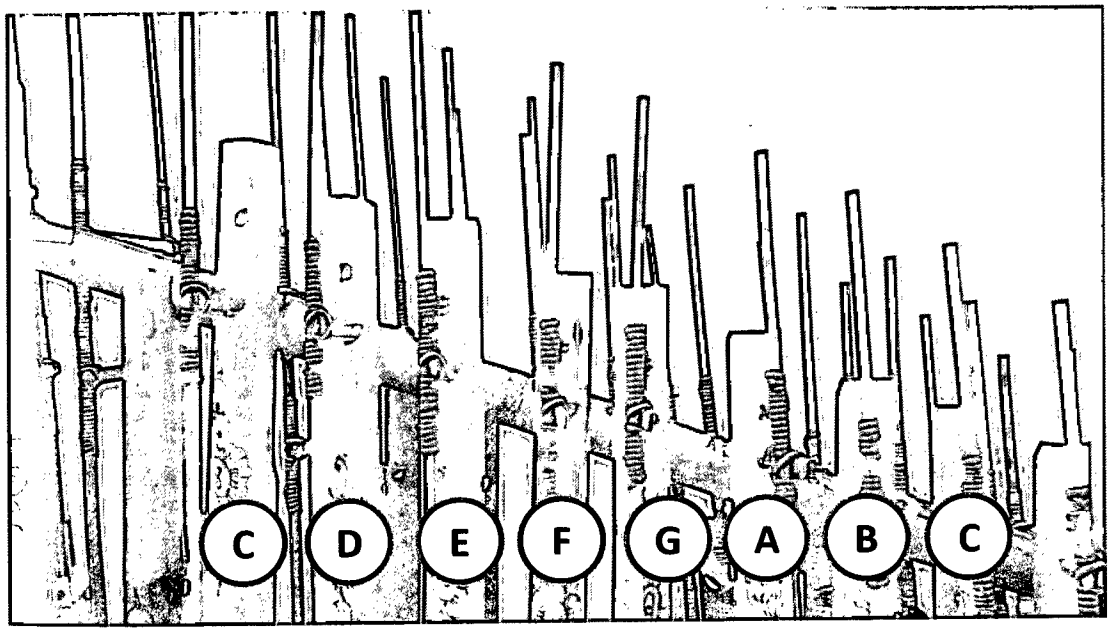

Figure 2.2: One Octave of the Angklung

2.3.2 The Chromatic Scale

The word "chromatic" comes from the Greek word chroma meaning "color." The chromatic scale consists of 12 notes each a half step apart. It is from the chromatic scale that every other scale or chord in most Western music is derived. On the piano/keyboard when you play all the black and white keys of an octave in an ascending or descending order you are playing a chromatic scale. We will take the C chromatic scale as an example on Table 2.2.

Table 2.2: Example Chromatic Scale

Notes in C major	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C

2.4 Type of Data Communications

There have a few standards to choose from when considering a communications protocol that can be implement in this project. Those are:

(i) Parallel Communication

(ii) Synchronous Serial Communication

(iii) Asynchronous Serial Communication

2.4.1 Parallel Communication

Parallel communication implies sending a whole byte (or more) of data over multiple parallel wires. Figure 2.3 shows example parallel communication. (Silicon Laboratories)

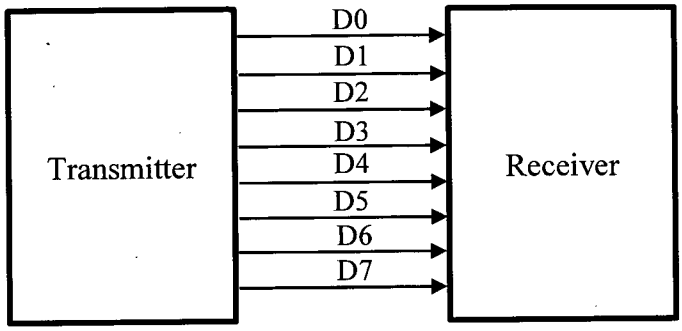

Figure 2.3: Example Parallel Communication

2.4.2 Synchronous Serial Communication

Serial communication implies sending data bit by bit over a single wire. Synchronous serial requires the clock signal to be transmitted from the source along with the data. Figure 2.4 shows example synchronous serial communication. Data rate for the link must be the same for the transmitter and the receiver. (Silicon Laboratories)

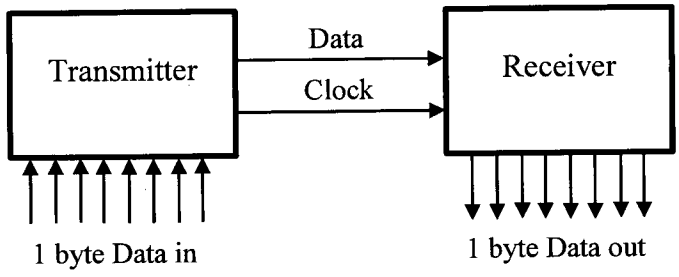

Figure 2.4: Example Synchronous Serial Communication

In the synchronous mode, the transmitter and receiver share a common clock signal. Figure 2.5 shows example signal out from transmitter to receiver. The transmitter typically provides the clock as a separate signal in addition to the serial data. (Silicon Laboratories)

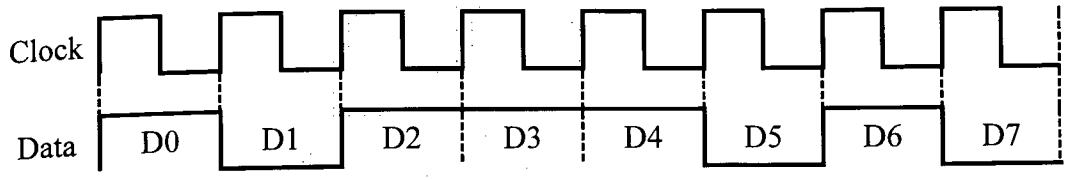

Figure 2.5: Example signal out from transmitter to receiver

2.4.3 Asynchronous Serial Communication

Serial communication implies sending data bit by bit over a single wire as shown in figure 2.6. Asynchronous transmission is easy to implement but less efficient as it requires an extra 2-3 control bits for every 8 data bits. Figure 2.7 shows example signal out from transmitter to receiver that contains extra bit. This method is usually used for low volume transmission. (Silicon Laboratories)

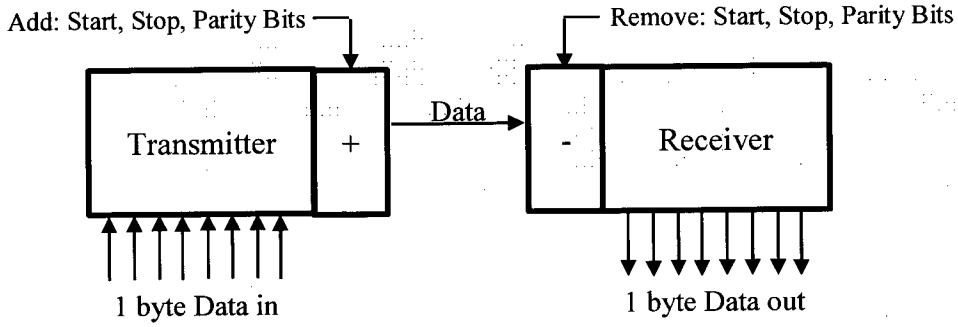

Figure 2.6: Example Asynchronous Serial Communication

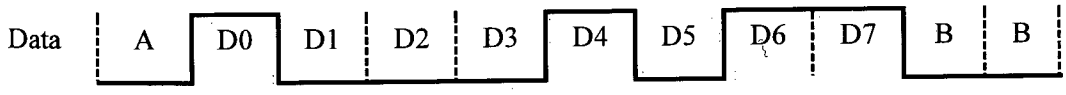

Figure 2.7: Example signal out from transmitter to receiver

A - Start bit, indicates the beginning of the data word.

B - Stop bit, indicates the end of the data word

D0-7 – 8 Data bit, indicates the actual data to be transmitted

2.5 Shift Register for Data Communications

2.5.1 Shift Register Serial In/Parallel Out

Shift register serial in/parallel out can be used as serial-to-parallel data converter. Serial data transmission from one digital system to another is commonly used to reduce the number of wires in the transmission line. For example, eight bits can be sent serially over one wire, but it takes eight wires to send the same data in parallel. Serial data transmission is widely used by peripherals to pass data back and forth to a computer. (Floyd)

2.5.2 Parallel-Access Shift Register

For shift register with parallel data inputs, the bits are entered simultaneously into their respective stages on parallel lines rather than on a bit by bit basis on one line as with serial data inputs. Once the data are stored, each bit appears on its respective output line, and all bits are available simultaneously. (Floyd)

2.6 Rotary to Linear Motion Conversion Concept

2.6.1 Crank Mechanism

Slider-crank mechanism (or a simple crank), shown in Figure 2.8, converts rotary to linear motion and vice versa, depending on its application.

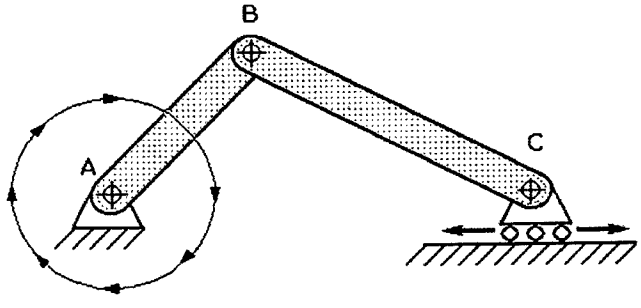

Figure 2.8: Slider-crank mechanism

Link AB is free to rotate 360° around the hinge while link BC oscillates back and forth because point C is hinged to a roller which restricts it to linear motion. Either the slider or the rotating link AB can be the driver. (Neil Sclater)

2.6.2 Scotch-Yoke Mechanism

Scotch-yoke mechanism, pictured in Figure 2.9, functions in a manner similar to that of the simple crank mechanism except that its linear output motion is sinusoidal.

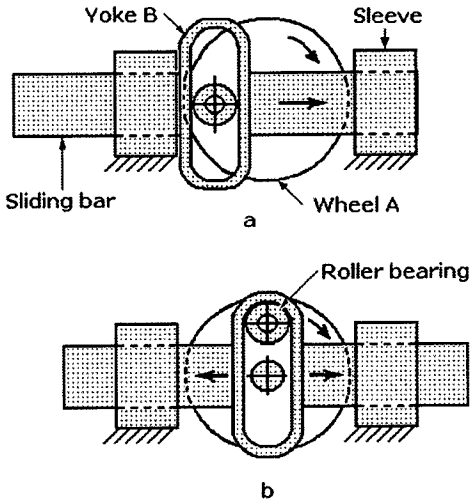

Figure 2.9: Scotch-yoke mechanism

As wheel A, the driver, rotates, the pin or roller bearing at its periphery exerts torque within the closed yoke B; this causes the attached sliding bar to reciprocate, tracing a sinusoidal waveform. Part A shows the sliding bar when the roller is at 270°, and Part B shows the sliding bar when the roller is at 0°. (Neil Sclater)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will described about the procedures analysis on the serial data that being sending to motor driver to control the motor. Research methodology is a set of procedures or methods used to conduct research. Methodology is needed for a guideline in order to ensure the result is accurate based on objective. There are several steps need to be followed to ensure the objective of the research can be achieve starting from finding literatures until submitting the final report.

3.2 Flow Chart of Methodology

Flowchart is represents a process by showing the steps as box of various kinds, and their order by connecting with arrows. Flowchart is important in doing research by helping viewer to understand a process flow and help to visualize what is going on. Flow chart methodologies were constructed related to the scope of product as a guided principal to formulate this research successfully, in order to achieve the objectives of the project research. This is important to ensure the research experiment is on the right track. The terminology of work and planning for this research was shown in the flow chart in Figure 3.1.

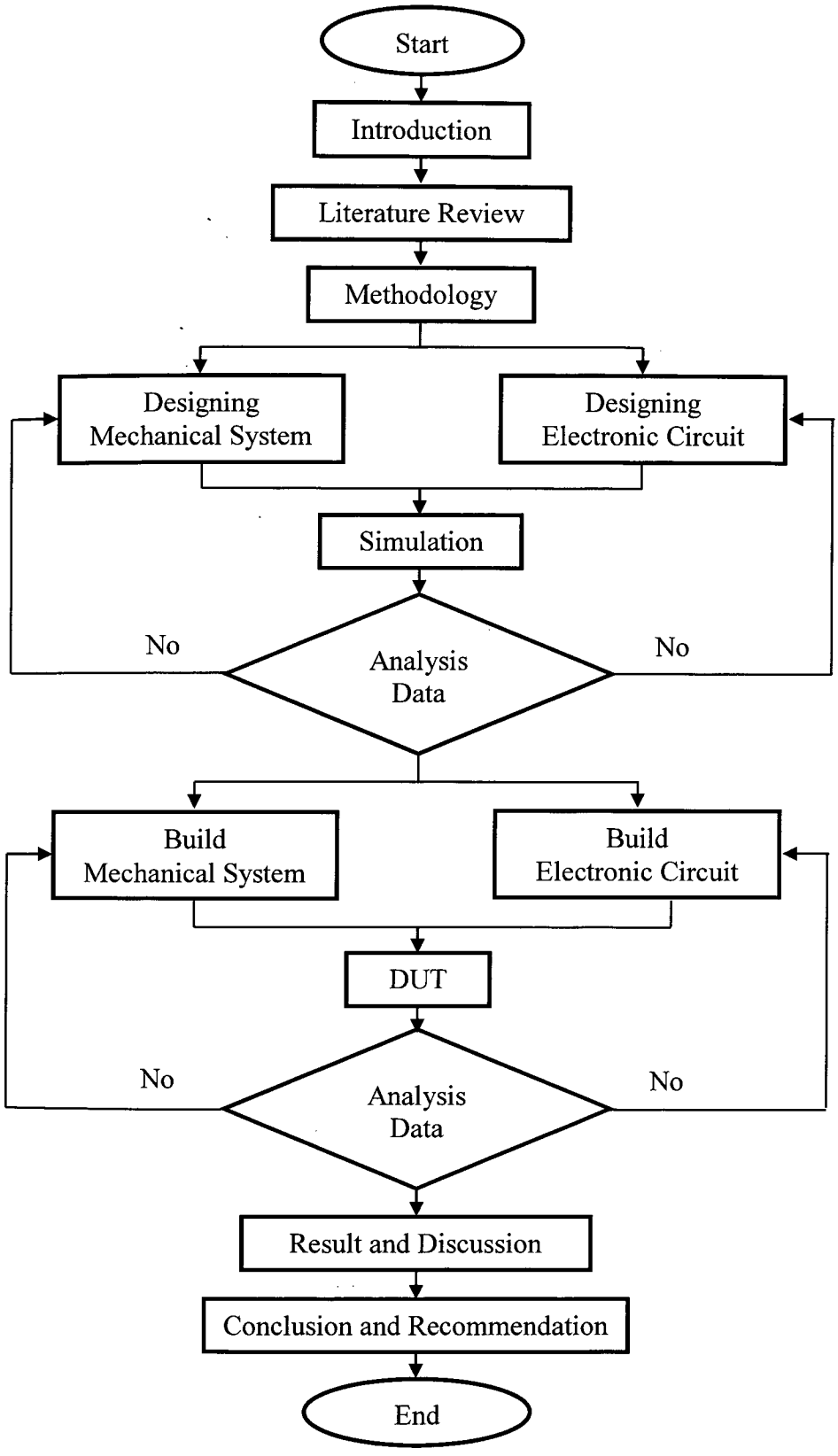

Figure 3.1: Project Flow Chart