COMPUTER CONTROL BASED "ANGKLUNG" TRADITIONAL MUSICAL INSTRUMENT

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ABSTRACT

The use of technology is widely applied to lot of work in our present life. Nowadays, we can see many things in aspect of technology. Present technology has made us possible to do many kinds of jobs in easier way. This includes the traditional music tools where it can be modernized by applying the technology. We can learn and explore about these tools by integrating them with technologies. But, nowadays we can see that many young generations are not very interested with traditional music tool due to the increasing of modern music players' development. They are keen to use modern tools because the traditional music tools are harder to play and more difficult to be understand. A new design in traditional music tools must be developed in order to attract our young generations to love our traditional tools. This can be applied by using a microcontroller to control the tool so that it can play the melody automatically and easily to handle. Basically, the traditional music tools need several human to play it. But, all these needs can be replaced by a gadget that can control the movement of the tools. For an example, a dc motor can be implemented to control a shaking tool. This motor can be control by using a microcontroller which can control all the process in the system. This thesis explained an innovation in traditional musical instrument where an 'angklung' will be integrated with an electronic circuit.

ABSTRAK

Kegunaan teknologi telah banyak digunakan dalam banyak kerja dalam kehidupan masa kini. Pada hari ini, kita boleh melihat banyak perkara berlandaskan teknologi. Teknologi zaman sekarang telah membolehkan kita melakukan banyak kerja dengan lebih mudah. Ini termasuk alat muzik tradisional dimana ia boleh dimodenkan dengan mengaplikasikan teknologi. Kita boleh belajar dan mengkaji mengenai alat ini dengan menggabungkannya dengan teknologi. Tetapi, pada hari ini kita boleh melihat ramai generasi muda tidak begitu berminat dengan alat muzik tradisional disebabkan peningkatan penghasilan alat muzik moden. Mereka lebih berminat menggunkaan alat muzik moden kerana alat muzik tradisional lebih susah untuk digunakan dan juga susah untuk difahami. Satu rekabentuk alat muzik tradisional baru perlu dihasilkan untuk menarik perhatian golongan muda untuk menyayangi alat muzik tradisional kita. Ini boleh diaplikasikan dengan menggunakan mikropengawal untuk mengawal alat supaya ia boleh menghasilkan melodi secara automatic dan juga senang untuk dikawal. Pada asanya, alat muzik tradisional memerlukan beberapa tangan manusia untuk mengawalnya. Tetapi, semua keperluan ini boleh diganti dengan satu alat yang boleh mengawal pergerakan alat tersebut. Sebagai contoh, satu motor dc boleh digunakan untuk mengawal satu alat yang bergetar. Motor ini boleh dikawal dengan mikropengawal yang mana ia boleh mengawal semua proses dalam system tersebut. Tesis ini menerangkan satu inovasi dalam alat muzik traditional di mana 'angklung' akan digabungkan dengan satu litar elektronik.

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LIST OF SYMBOLS

λ	-	wavelength
C	-	speed of light in the air = 3×10^8 m/s
F	-	frequency

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, we all knew that by using technologies all the works can bedone easily and more accurate. By applying technologies to all kind of works, we can increase the production of a product and can multiple the works in one time without using many human workers. In this project, the application of technologies will be applied into a traditional instrument called an "angklung".

An "angklung" is an instrument that made from bamboo. It is made of two bamboo tubes attached to a bamboo frame. The tubes are carved so that they have a resonant pitch when struck. The base of the frame is held with one hand while the other hand shakes the instrument rapidly from side to side. This causes a rapidly repeating note to sound. To play a melody, more than one performer is needed. In this case, the use of human hands will be replaced by a gadget. The gadget will be stick to this musical instrument in order to shake and made it functional. The gadget will be connected to a motor (DC motor) and will be control by using a microcontroller (MC68HC11).

In this project, the application of the MC68HC11 will be used in order to control the motor that will shake the "angklung". MC68HC11 is a type of microcontroller that can control the movement of the motor systematically. In a nutshell, MC68HC11 will be used as the main controller for this project. This project will become a most interesting project because the use of technologies is applied into a musical instrument. Normally, people being entertained by a musical instrument that is quiet complicated to handle traditionally. But, after the technologies being applied to this instrument, the people can be entertained in more easy way.

1.2 Project Objective

The main objective of this project is to design and build a system that can investigate and implement how we could use computer to control and play "angklung" without using hands. In order to achieve the objective, the project is divided into two parts:

- Hardware design that consist of microcontroller, dc motor, and serial interface module.
- Software development by using Assembly Language MC68HC11.

1.3 Project Scope

There are 2 scopes of this project. They are:

(1). The "angklung" can produce a specific music node when a specific key being pushed. This can be implemented by using a single motor to each "angklung" node and the motor will be activated when a key is pushed.

(ii) The angklung can play a simple melody automatically after a specific key being pushed. This will be programmed in the microcontroller where the "angklung" will move automatically to play a simple melody itself.

1.4 Organization of the Thesis

The thesis is orderly into 5 chapters. The content of each chapter explained briefly below.

Chapter 1 presents the background, objective and the scope of the project. The chapter also summarizes the content of the thesis.

Chapter 2 discusses about the theory of the project along with the literature review.

Chapter 3 gives a detail discussion on the design of the project and the methodology used to construct the project.

Chapter 4 presents various testing and result that are conducted to each module.

Chapter 5 discusses about the conclusion and the discussion. Some future recommendation also discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The system is designed using modular technique to simplify the process of testing and troubleshooting. As the system requires the use of microcontroller, the design consists of two parts, hardware and software. The hardware part is a part to actuate the processes. In the other hand, the software part used to program all the processes and will be implemented into the hardware part. All these parts are constructed based on theory found.

2.2 Theory

Figure 2.1 is shows the main block diagram of automatic "angklung" control system. It can be divided into 2 main modules. They are:

- Microcontroller Module
- DC motor module

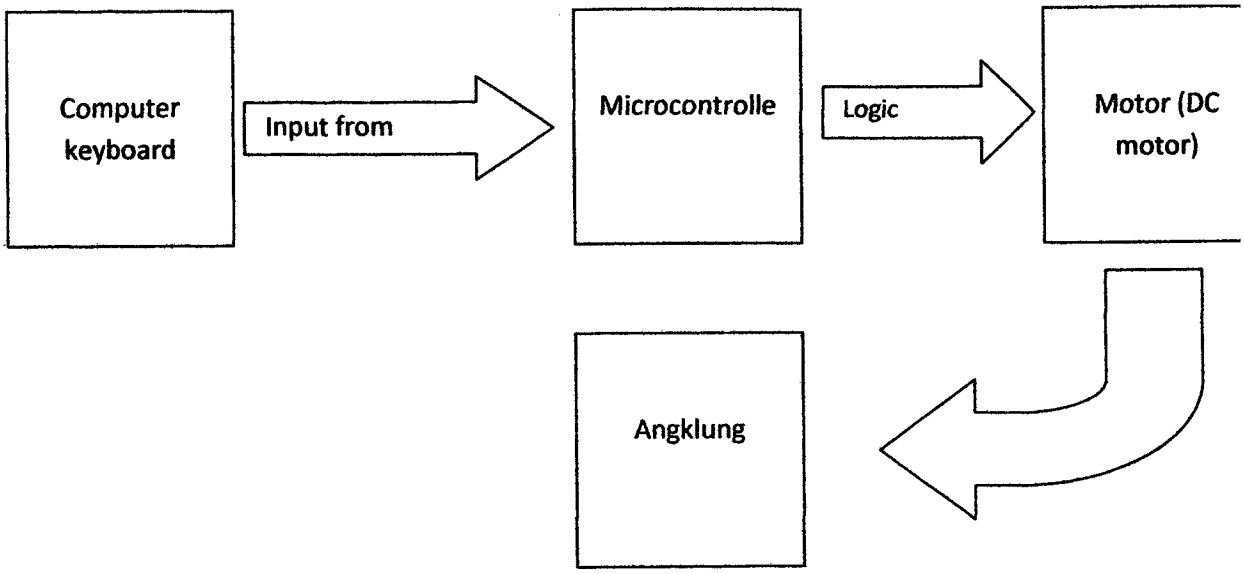

Figure 2.1: Block Diagram for computer control based "angklung"

2.2.1 Microcontroller Module

A microcontroller is a small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, watchdog timer, serial and analog I/O. CPU consists of three important components with different function. It is register, arithmetic logic units (ALU) and control unit. Register is memory that store temporary data during CPU operation. Arithmetic/Logic Unit (ALU) performs the various arithmetic and Boolean operations. Control Unit control the flow of information in CPU, memory and I/O device.

Motorola introduced 6800 as its first microprocessor, and then followed by 6808, 6802 and 6803 with added features. In 1985, Motorola developed the high

performance 8-bit microcontroller that is 68HC11 with added features such as ADC and output compare [1].

Some microcontrollers may operate at clock rate frequencies as low as 4 kHz, as this is adequate for many typical applications, enabling low power consumption (milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt. In addition, the power consumption while sleeping is low. This making many of them well suited for long lasting battery application. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

The microcontroller implemented in this project is an 8-bit family from Motorola that is 68HC11. There are various versions of 68HC11 with different memory sizes and features. In this case, the MC68HC11A1 is chosen since it offers various functions and is applicable for the project. Figure 2.2 shows the example of a MC68HC11A1.

Figure 2.2: MC68HC11A1

This type of microcontroller consists of several block diagrams inside. Figure 2.3 shows the block diagram of MC68HC11A1.

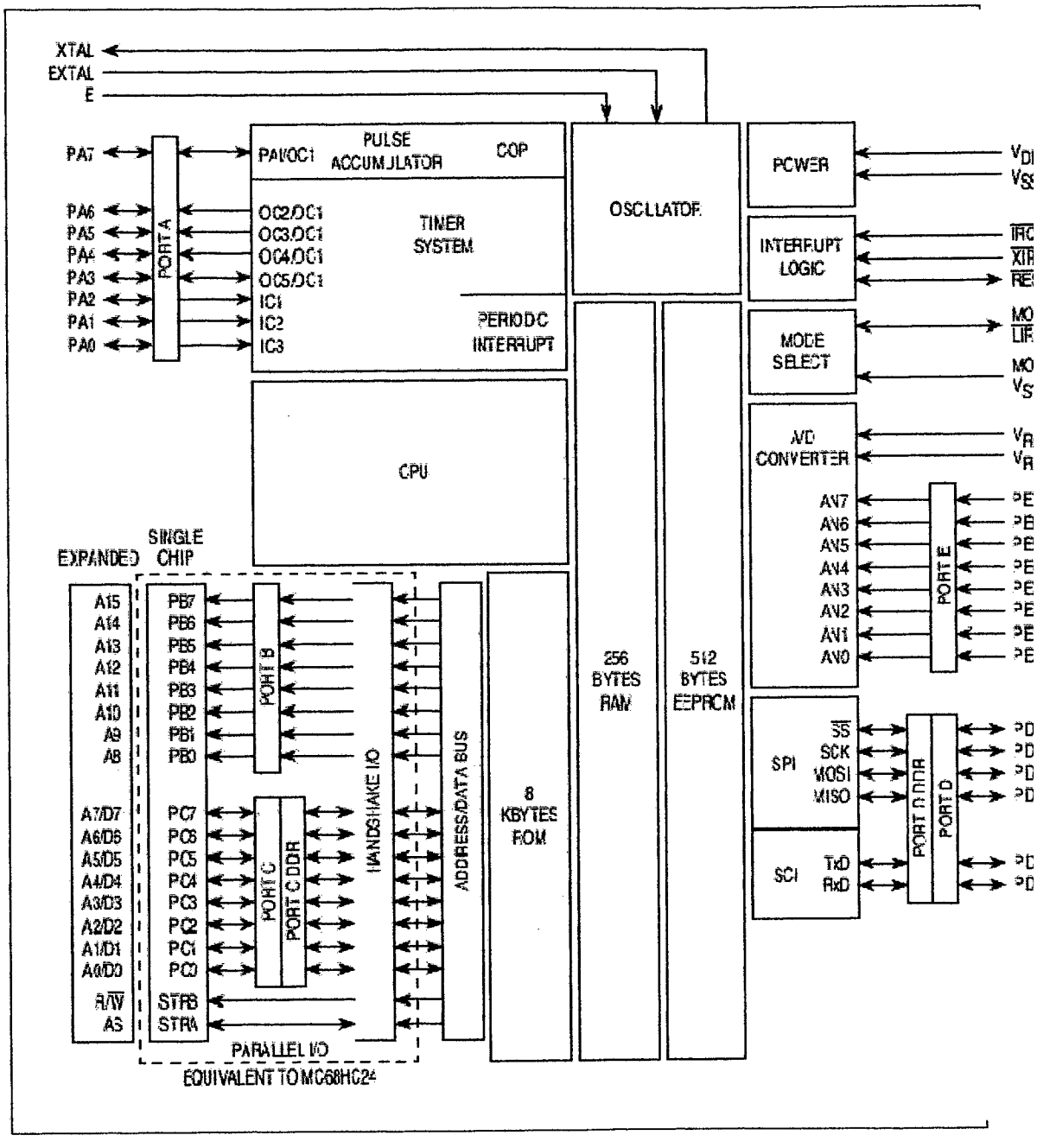

Figure 2.3: MC68HC11A1 block diagram

MC68HC11A1 can operate with four modes. They are Bootstrap mode, Special Test Mode, Single-chip mode, and Expanded mode. This project uses Bootstrap mode due to the project capability and reliability because it does not require extra I/O ports. This microcontroller module consists of power circuit, clock circuit, and EIA232 module as shown in Figure 2.4.

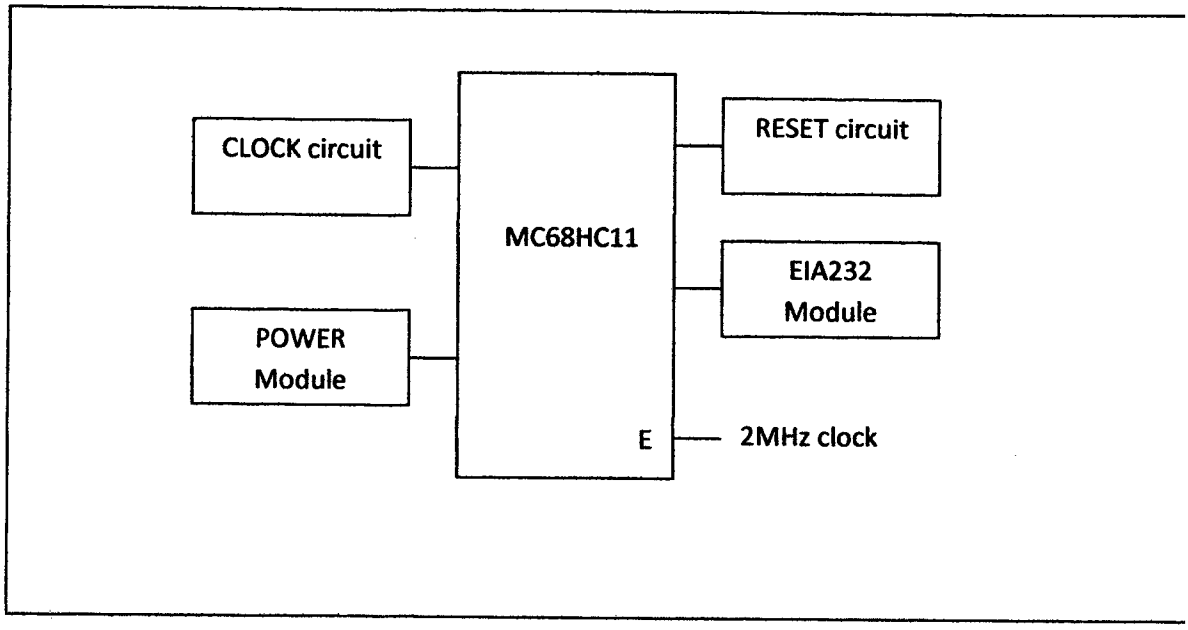

Figure 2.4: Microcontroller Board Module

2.2.2 DC motor module

DC motor is many applied as actuator in so many equipments, either big and also small, slow and also quickly. For this module, the DC motors are used to shake the "angklung". There are many types of dc motor in this era. In this project, a 5V dc motor is chose due to its cost and capability in moving the "angklung". A DC motor is an electric motor that runs on direct current (DC) electricity. A DC motor works by converting electric power into mechanical work. This is accomplished by forcing current through a coil and producing a magnetic field that spins the motor. The voltage source forces voltage through the coil through sliding contacts or brushes that are connected to the DC source. These brushes are found on the end of the coil wires and make a temporary electrical connection with the voltage source. In this motor, the brushes will make a connection every 180 degrees

and current will then flow through the coil wires. At 0 degrees, the brushes are in contact with the voltage source and current is flowing. The current that flows through wire segment C-D interacts with the magnetic field that is present and the result is an upward force on the segment. The current that flows through segment A-B has the same interaction, but the force is in the downward direction. Both forces are of equal magnitude, but in opposing directions since the direction of current flow in the segments are reversed with respect to the magnetic field. At 180 degrees, the same phenomenon occurs, but segment A-B is forced up and C-D is forced down. At 90 and 270-degrees, the brushes are not in contact with the voltage source and no force is produced. In these two positions, the rotational kinetic energy of the motor keeps it spinning until the brushes regain contact [2].

The brushed DC motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary permanent magnets, and rotating electrical magnets. Figure 2.4 shows the basic diagram of a DC motor. On the other hand, Figure 2.5 shows an example of a dc motor. This motor uses a 5V supply. Note that this is an example of a DC motor with an encoder and gearbox attached to it.

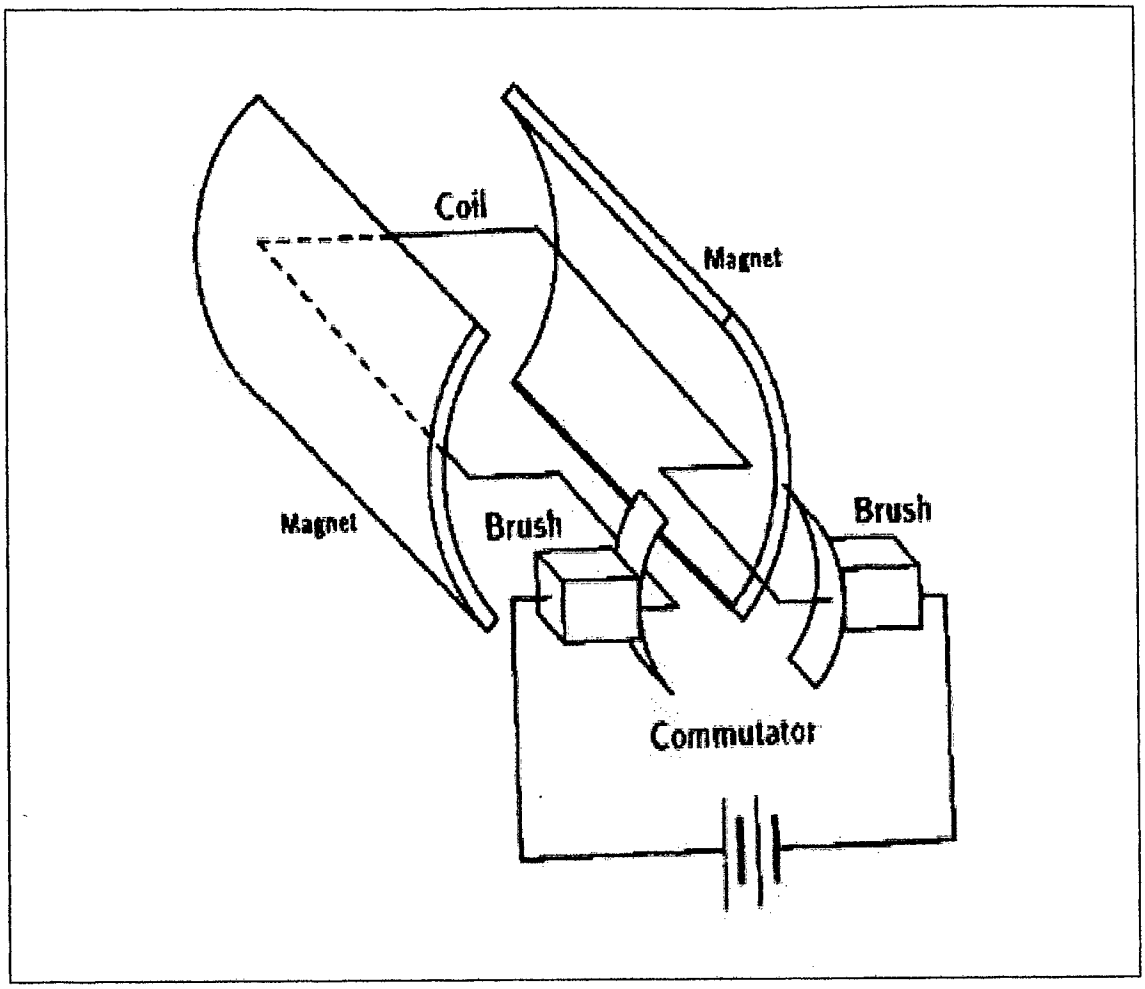

Figure 2.5: A DC Motor Diagram

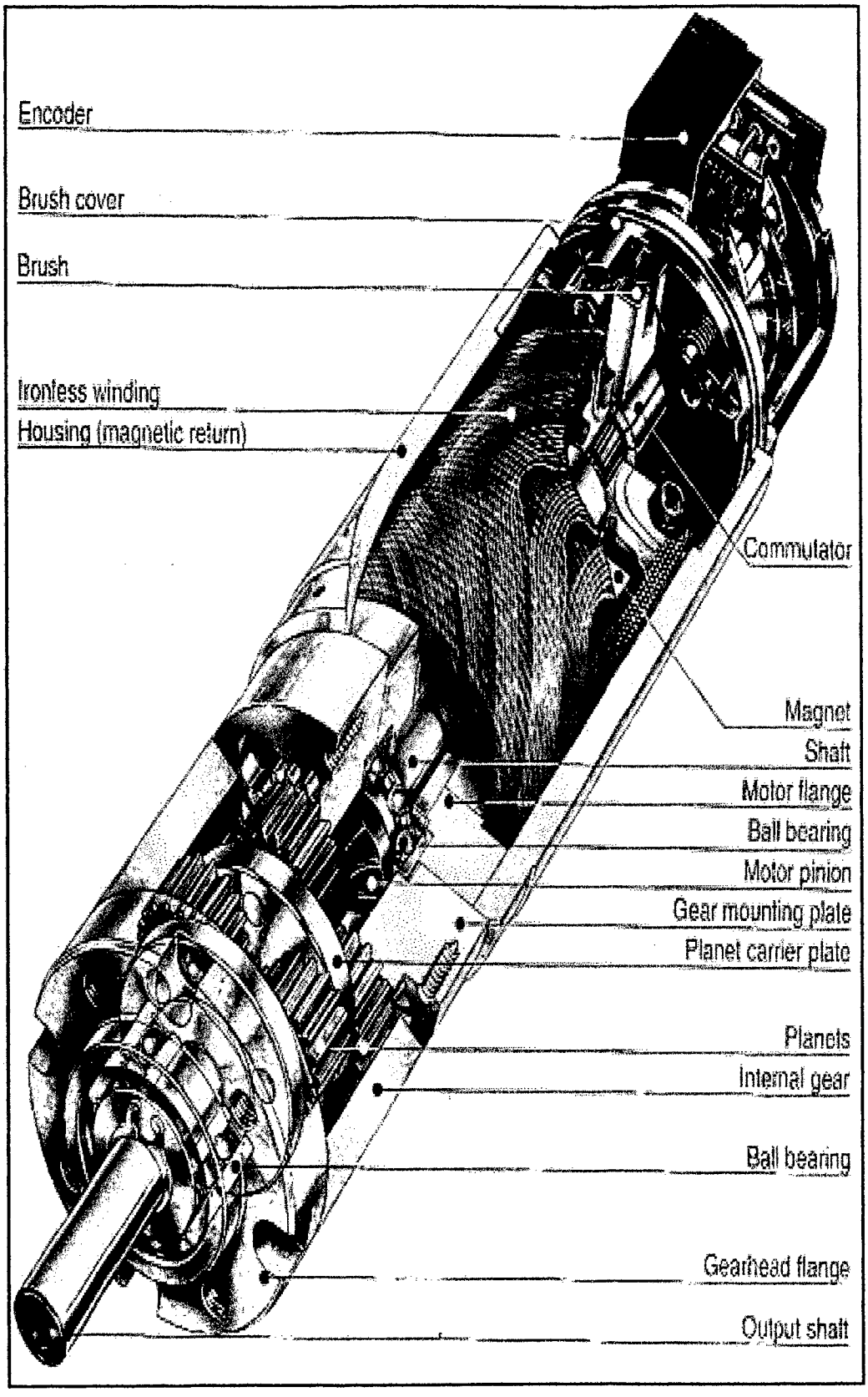

Figure 2.6: A DC motor

2.2.3 Combination of microcontroller module and DC motor module

A microcontroller can be used to control many things including a DC motor. The microcontroller module will be integrated with DC motor module to control the movement of the "angklung". The DC motor module will become an output from microcontroller and the input of the microcontroller come from the computer keyboard. After being generated, the DC motor will running and at the same time will shake the "angklung" based on the connection between the DC motor and the "angklung". The connection between them will be discussed in the next chapter. The output signal from the microcontroller is applicable to run a 5V DC motor. Figure 2.6 shows the combination of these two modules.

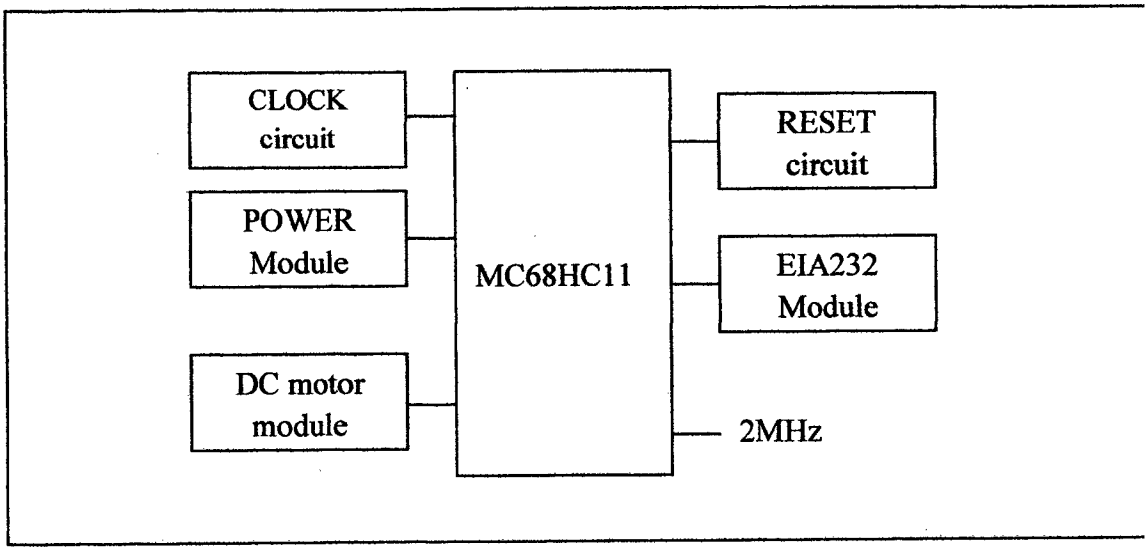

Figure 2.7: Combination Of Microcontroller Module And DC Motor Module

2.3 "Angklung"

The most important component in this project is the "angklung". "Angklung" is known as a traditional musical instrument originated from Indonesia. The "angklung" consists of 2 or 3 bamboo tubes of specify pitch set in a bamboo frame. It is used in sets to play music for entertainment [3].

Formally, each of three or more angklung performers in an ensemble will play just one note and together complete melodies is produced [4].

Thus, it is well known that it is quiet difficult to play an "angklung" based on the skill and the requirement of people to play it. A set of "angklung" can play a very beautiful melody but it requires more than one man to play. Basically, a set of "angklung" consists of eight single "angklung" with different type notes. Each "angklung" represents their own notes.

In music, the term note has two primary meanings. The first meaning is a sign used in musical notation to represent the relative duration of a sound. The second meaning is a pitched sound itself. In traditional music theory pitch classes are represented by the first seven letters of the Latin alphabet (A, B, C, D, E, F, G). The eighth note or octave is given the same name as the first, but has double its frequency. The name octave is also used to indicate the span of notes having a frequency ratio or two [5]. Table 2.1 shows the complete chart of a chromatic scale built on the note C4, or "middle C".

Table 2.1: Complete Chart of A Chromatic Scale

Style	Type	prime		second		third	fourth		fifth		sixth		se
English name	Natural	C		D		E	F		G		A		
	Sharp		C sharp		D sharp			F sharp		G sharp		A sharp	
	Flat		D flat		E flat			G flat		A flat		B flat	

The "angklung" can be categorized in idiophone category. An idiophone is any musical instrument which creates sound primarily by way of the instrument vibrating itself, without the use of strings or membranes. Idiophones are probably the oldest type of musical instrument. Most percussion instruments which are not drums are idiophones. Idiophones are made out of materials that give off unique sounds. The majority of idiophones are made out of glass, metal, ceramics, and wood [6].

For the conclusion, it is well known that the skill to play the "angklung" is by shaking it to produce a sound define by its own note. Hence, a vibrator gadget is constructed to replace the used of hands. Figure 2.7 shows an example of a single "angklung".

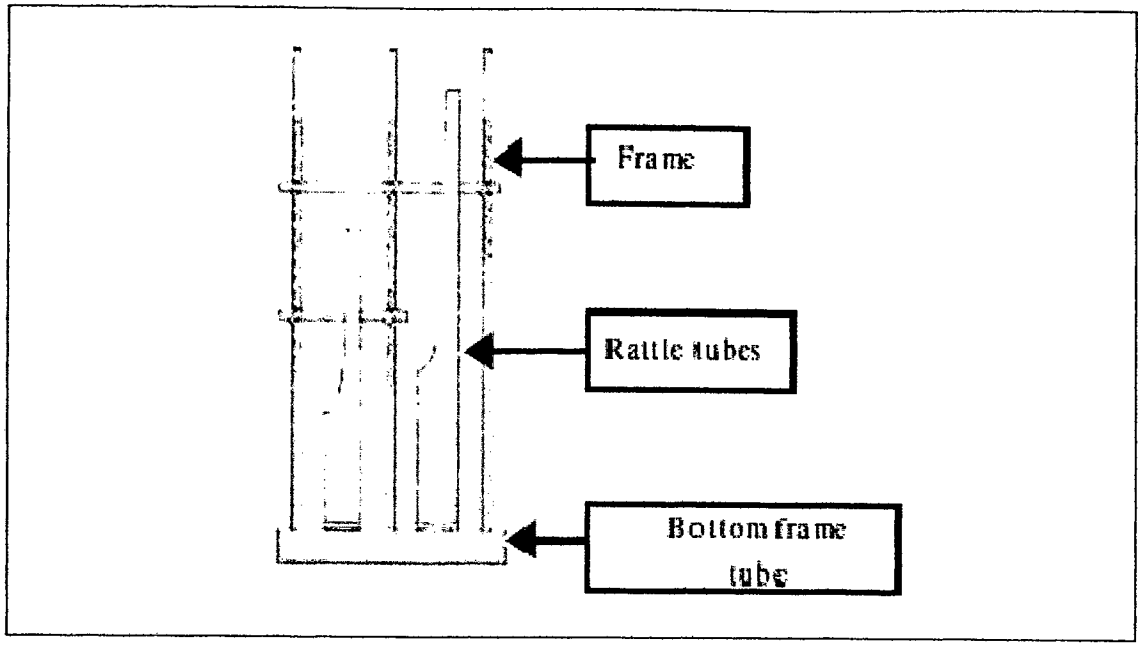

Figure 2.8: A Single "Angklung"

The "angklung" can be played in a set. Figure 2.8 shows a set of "angklung" consists of 8 single "angklung" with different notes.

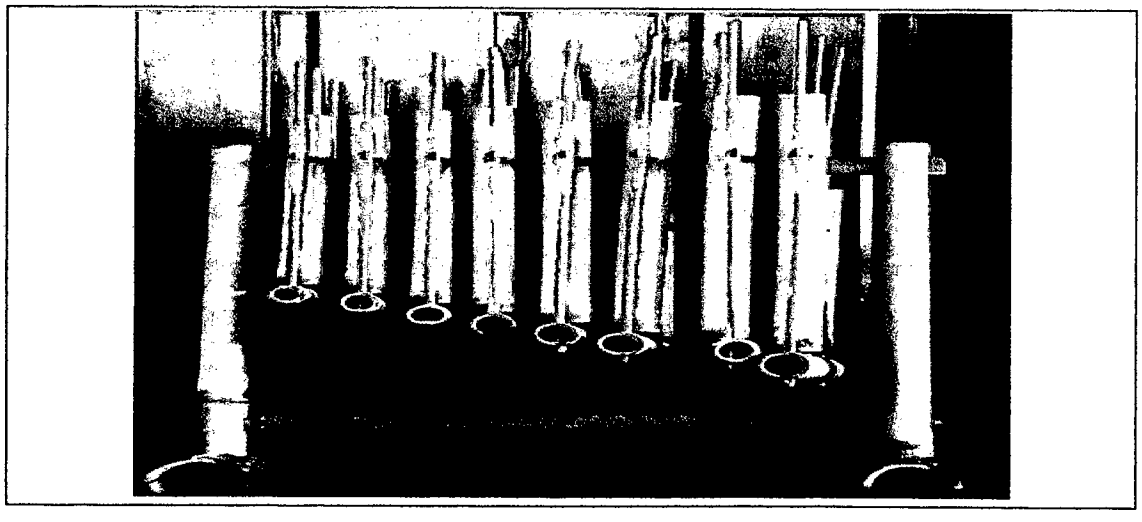

Figure 2.9: A set of "Angklung"

2.3.2 MC68HC11A1

As been told before, MC68HC11 is a part of Motorola microcontroller with several of function and features. It is a high speed with low power consumption chip having multiplexed buses and a fully static design. It can operate at frequencies from 3MHz to dc. This version of 68HC11 has similar characteristic with MC68HC11A8 and MC68HC11A0 where they were created from the same mask. The only differences are the value stored in the CONFIG register, and whether or not the ROM or EEPROM is tested and guaranteed.

As been told before, this version of microcontroller operates with four modes. The first mode is single-chip mode. In this mode, the MC68HC11A1 is a monolithic microcontroller without external address or data buses. In other word, it operates by using internal memories and I/O lines. The second mode is expanded mode. This mode used to expand the memory and I/O lines by using the port B and port C as an address and data buses. The third mode is special test mode where this mode used by manufacturer to test the chip in factory. The final mode is bootstrap mode. This mode allows special purpose programs to be entered into internal RAM. The boot-loader program uses the SCI to read a 256-byte program into on-chip RAM [8]. The mode used for this project is bootstrap mode.

Memory locations are the same for expanded multiplexed and single-chip modes. Figure 2.9 shows the memory map for the microcontroller [7].