Palestine Polytechnic University

College of Engineering & Technology

Introduction Graduation Project

Deceleration Energy Recovery System (DERS)

Project Team

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Palestine Polytechnic University
Hebron –Palestine

College of Engineering and Technology
Mechanical Engineering Department

Project Name

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According to the project supervisor and according to the agreement of the Testing Committee Members, this project is submitted to the Department of Mechanical Engineering at College of Engineering and Technology in partial fulfillments of the requirements of (B.SC) degree.

Supervisor Signature

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Examine Community Signature

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Department Head Signature

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may, 2014

Dedication

To Our Beloved Palestine

To our parents and families.

To all our teachers.

To all our friends.
To all our brothers and sisters.

To Palestine Polytechnic University.
May ALLAH bless you.

And for you we dedicate this project
The Work Group

Acknowledgments

We could not forget our families, who stood by us, with their support, love and care for our whole lives, they were with us with their bodies and souls, believed in us and helped us to accomplish this project.

We would like to thank our amazing teachers at Palestine Polytechnic University, to whom we would carry our gratitude our whole life. Special thanks to our **Supervisor Dr. Imad Al Khteeb**

Abstract:

This project represent the education model for using the lost energy from the braking procedures inside the cars and convert it to useful electrical energy with special processes and procedure through the main subsystems that used in the system, however the system use the output energy from the braking procedure and convert it to electrical energy that is stored in the battery for later use.

The component that used in the system is works with corporation procedures in order to provide a powerful and useful energy, which provide a high performance output electric energy , which represented by input breaking system and shaft and relay system ,electric motor, generator, battery and other devises .

This project provide the availability to convert the kinetic energy from the usual conventional braking system into an electric energy through conversions processes that is applied on the system ,the project success is 95% since all of the system components are works probably unless some wrong result comes from failure with the main measurement instrument that is used by the team.

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CHAPTER ONE

Introduction

1.1 Project Overview

The burning of fossil fuels in transportation has a significantly adverse effect on the environment and contributes to global warming. Additionally, world oil supply is limited and is expected to run out . In order to free the world from its dependence on fossil fuels and to allow mankind to live in a sustainable manner, alternative transportation technologies need to be developed. One of the problems with electric vehicles is that they have a lower range per charge than conventional Internal Combustion Engine (ICE) vehicles have per tank. To increase the range, electric vehicles are able to take advantage of regenerative braking, whereby the motor is run as generator during braking to convert kinetic energy into electrical energy to charge the battery.

The effectiveness of a regenerative braking system depends on the driving conditions as well as the way the vehicle is driven. Conveniently, regenerative braking is most effective in the stop-and-go conditions of urban driving, which most cars are subjected to on a daily basis. Thus, regenerative braking can significantly improve the fuel economy of electric vehicles and can help make electric vehicles a viable replacement for ICE vehicles.

The regenerative braking system (BERS) delivers a number of significant advantages over a car that only has friction brakes. In low-speed, stop- and-go traffic where little deceleration is required; the regenerative braking system can provide the majority of the total braking force. This vastly improves fuel economy with a vehicle, and further enhances the attractiveness of vehicles using regenerative braking for city driving.

The project design the BERS system to be as an educational experimental system in order to improve on all of the previous researches about the lost kinetic energy and transformed it to electrical energy through using different electric and mechanical components ,the output result from the system is compared with the previous result and tried to be improved and enhanced .

1.2 Project description

This project is an educational model using an electric motor to rotate a car wheel , which is attached to a brake system provider when you press on brake pedal or in case of deceleration , the lost energy will be converted into electrical energy and stored in the secondary batteries through a generator and some of the parts are connected to the wheel. there is also an indicator with a lamp to show the level of electrical energy in the secondary batteries before and after pressing the brake pedal

1.3 Project Goal and Objectives

- **Project Goal**

The objective of this project is to design and implement the most effective regenerative brake system to be as an effective educational system about the gained energy .This implementation will have to take into account the budget of project, and the time frame of the project .

- Objectives of the project

Brake Energy Regeneration System is supposed to achieve the following objectives:

1- Convert the wasted kinetic energy to useful electrical energy that can be used for further staff .
2- Improves fuel economy .
3- Educational model available for study purposes in university.
4- This model should be available to be used in automotive after modifications.

1.4 Project Motivation and Importance

This section discus the project motivations , and the project importance .

Project Motivation

As the global economy strives towards clean energy in the face of climate change, the automotive industry is researching into improving the efficiency of automobiles. Electric vehicles (EV) are an answer to the crisis the world is about to face in the near future. But the question that is being constantly asked is, How can the driving range of electric vehicles be increased?

The answer to this question lies in the success of the research for an efficient and power packed energy source like a magic battery or success with fuel cells, efficient regenerative braking systems etc. In conventional braking system, kinetic and potential energy of a vehicle is converted into thermal energy (heat) through the action of friction. Studies show that in urban driving about one-third to one-half of the energy required for operation of a vehicle is consumed in braking. With regenerative braking, this kinetic energy can be converted back into electrical energy that can be stored in batteries for reuse to propel the vehicle during the driving cycle which returned with advantages on these operation, however the team is suggest to design the system for educational and experimental purposes in order to be ready for implemented in the real vehicles.

- **Project Importance**

Regenerative braking has the potential to conserve energy which will improve fuel economy while reducing emissions that contribute to air pollution , the project provide the availability to conserve the lost energy from the usual conventional breaking system and reuse this kind of energy to be transformed to other type of energy like electric energy that is used as source for different applications on cars .

1.5 Work Methodology

Several steps and processes were done to complete the project successful, these steps were as following:

1. Find the idea of the project .
2. Collect the information about the project idea .
3. Budget Estimation about the project
4. Design the component.
5. Assemble the system.
6. Implement the system.
7. Test the project.
8. Collect the result and information.

1.6 Requirements

The system may required individual type of requirement , or types integrated with each other to produce the system goal .

For this system the requirements that will be used is divided into two types as :

1. Human resource requirement .
2. Component requirements.

Human Resource Requirements

This part list all of the humans that will be deal with the system in each stage of the system lifecycle as the following :

Project Team :

The project team consist of two of mechanical engineering students and their specialization automotive Engineering.

Project users: the category of vehicles that will used a system .

- Automotive in general

Component Requirements

components that's used in the system are electrical and mechanical components. All of the requirements needed during this project are listed as the following :

1. Energy Storage Unit (ESU)
2. AC motor
3. DC Generator .
4. Relay system.
5. Controller for charge batteries.
6. Electrical Clutch.
7. Wheel.
8. Hydraulic Break System.

1.7 Project Risks

Every Project has a risk , the risk in projects is defined as any undesirable event associated with the work [2]

That mean any event occur in the future and affect impact on the project plane , and always involves two characteristic:

- Uncertainty- the risk may or may not happen ,there are no 100% probable risk.
- Loss-if the risk become reality unwanted consequence or losses will occur

The types of risks faces the project is:

1- People Risk .

2- Components Risk .

3- Budget Risk .

- **People Risk**

This type of risk related to the kinds of people that deals with project at any time , as the following kinds :

Team

The team may cause a risks as :

1. Some members of the team ill.
2. Faces new information the team does not have experience on it.

Avoidance :

1. Make a correct plane , dividing the work between the group equally.
2. Learning and training about the new information during the project time.

- **Components Risk**

The components may be cause a risks as :

1. Some of the components not founded in the local markets .
2. Some of the components not valid ,and cost more than its importance.
3. Some of the components failure during the work .

Avoidance :

1. If the component not founded in the local markets , the team search and demand it from the global markets .

2. If some of the components not valid or expensive , search for the alternatives or build it.
3. The team must dealing cautiously with the components , and making a save points at every time.

- **Budget Risk**

This type of risk related to the project budget , the possible risk may happened in this side :

1. The project requirement cost more than expected .
2. The project don't meet financially support .

Avoidance :

1. search well about the cheapest components that's specify what project need .
2. search for supporting and marketing the project .

1.8 Project Tasks And Plane [3]

For any system design will the team must follow a list of tasks step by step, and estimating the time required for each task .This section showing the tasks should be followed to develop the project , and the Gantt chart for it .

1.7.1 Tasks

specific steps should be followed in the project life time ,to develop the project some of them may be depends on each other , which is typed as the following tasks :

Task[A] : Select the Idea .

Collect different type of information's about the idea ,and discus them between the project members ,then choose the idea to be applied as a graduation project.

Task [B] : Project Preparation .

search about related projects , or about subsystem will be used in this project to make a clear imagine about the project in order to implement it .

Task [C] : General Project Analysis .

Drawing a general Block Diagram that describes and determine the project requirements .

Task [D] : Determined the Requirements .

Determining all the requirements of the project ,and search for the alternatives .

Task [E] : Requirements Analysis .

Analyzing all the requirements of the project ,and collecting all information needed about usage and implementations .

Task [F] : Defining a project risk and Avoidance.

List all of the possible risks that may occur during the project life time , and prepare a correct plan for avoidance .

Task [G] : System Analysis and Design .

Analyze and design the system by drawing the block diagram and flow charts to clarify the system and its processes .

Task [H] : Writing a documentation .

Writing a documentation for each task in the project.

1.7.2 Project Plan

Project plane estimate that the time consumed for each task represented by weeks , and it summarized in the Table 1.1 as a chart called Gantt Chart .

Table 1.1 : Gantt Chart for the project plan

First Semester for academic year 2013/2014																
W T	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A																
B																
C																
D																
E																
F																
G																
H																

1.8.3 Tasks and plan(tentative Plan)

In the second semester, the project will go through the following tasks:

Task [I]: Project implementation

implementation of the project.

Task [J]: Project testing and maintaining

Test the project working and maintain the problem that appears in the system.

Task [K]: Project documentation

Continue through documentation.

Table 1.2 : Gantt Chart for project implementation and testing

Second semester for 2013/2014 academic year																
W T	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
I																
J																
K																

1.9 Cost Estimation

This section summarize the costs of the component requirements for the two suggested options :

Component requirements costs

The components that will be used in this project and its costs are shown in the Table1.3 .

Table 1.3 : Component Cost

Component Name	Price ($)	Quantity	Total cost($)
Electrical motor	300	1	300
Relay System	20	1	20
Clutch	120	1	120
Tire	20	1	20
Brake system	150	1	150
Battery	120	1	120
belt	10	1	10
Electrical generator	120	1	120
pulley	15	1	15
Speed Sensor	20	1	20
voltage regulator	50	1	50
Lamp	2	1	2
Total Cost			947 **$**

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CHAPTER TWO
Requirement Analysis

2.1 : Introduction

2.2 : Component and Equipment requirement

2.2.1 : Input requirements
2.2.2 : Process requirements

2.2.3 : Output requirements

2.3 : schematic diagram of the system

2.1 Introduction

A brake is a device for applying a force against the friction of the road, slowing or stopping the motion of a machine or vehicle, or alternatively a device to restrain it from starting to move again. The kinetic energy lost by the moving part is usually translated to heat by friction. Alternatively, in regenerative braking, much of the energy is recovered and stored for later use.

A regenerative brake is a mechanism that reduces vehicle speed by converting some of its kinetic energy into a store able form of energy instead of dissipating it as heat as with a conventional brake. The captured energy is stored for future use or fed back into a power system for use by other vehicles.

Electrical regenerative brakes in electric railway vehicles feed the generated electricity back into the supply system. In battery electric and hybrid electric vehicles the energy is stored in a battery or bank of capacitors for later use

This chapter presents the basic system requirement theoretically, by focusing on the technologies and the components that the system need, and some devices that are used in the system, which makes it easy for users to understand and to interact with the system.

System component requirements are divided into three parts :

System Inputs: the input parts of the system is divided to two parts ,the first part is the electric motor and the second part is a brake pedal pressure.

Processing: this part consists of the main process of the system which all devices of the system are connected to it , represented by the wheel of the car and the generator that is connected with it and the break system and the relay system that is used to charge or discharge the DC battery, Microcontroller used to display the speed of the wheel, the main process of the system happened in this part.

System outputs: the main output devices and the data that comes from the process unit that is represented by battery for storing the dc electricity and voltmeter for measure the output voltage in the battery and the ammeter for measure the output Dc current and the speed sensor for the wheel speed in the process part which is displayed on the LCD screen .

2.2 Component requirements

This part discuss the component requirement of the system in three main sections which are input ,process and output. section 2.2.1 Input Requirement specify theoretically all the requirement that will be used as inputs in this system , section 2.2.2 specify Process Requirement and section 2.2.3specify Outputs requirements.

2.2.1 Input Requirements

The input components that will be used in the system to provide motion to the wheel and to apply break on this wheel.

The input components for this system are:

- Electrical motor to provide a motion energy to the wheel in the process part of the system.
- Voltage regulator applied to the electric motor for different speed motion.
- Brake pedal pressure applied to the break system that connect with wheel in the process part.

Electric motor : is an electric device that provide a different motion speed ,after the electric signal is applied to it by a voltage regulator device, it comes with a different kind and a different output power, the electric motor that is choose to be applied to the system depending in some calculations for the output horsepower and the appropriate efficacy for the motor in order to provide high speed .

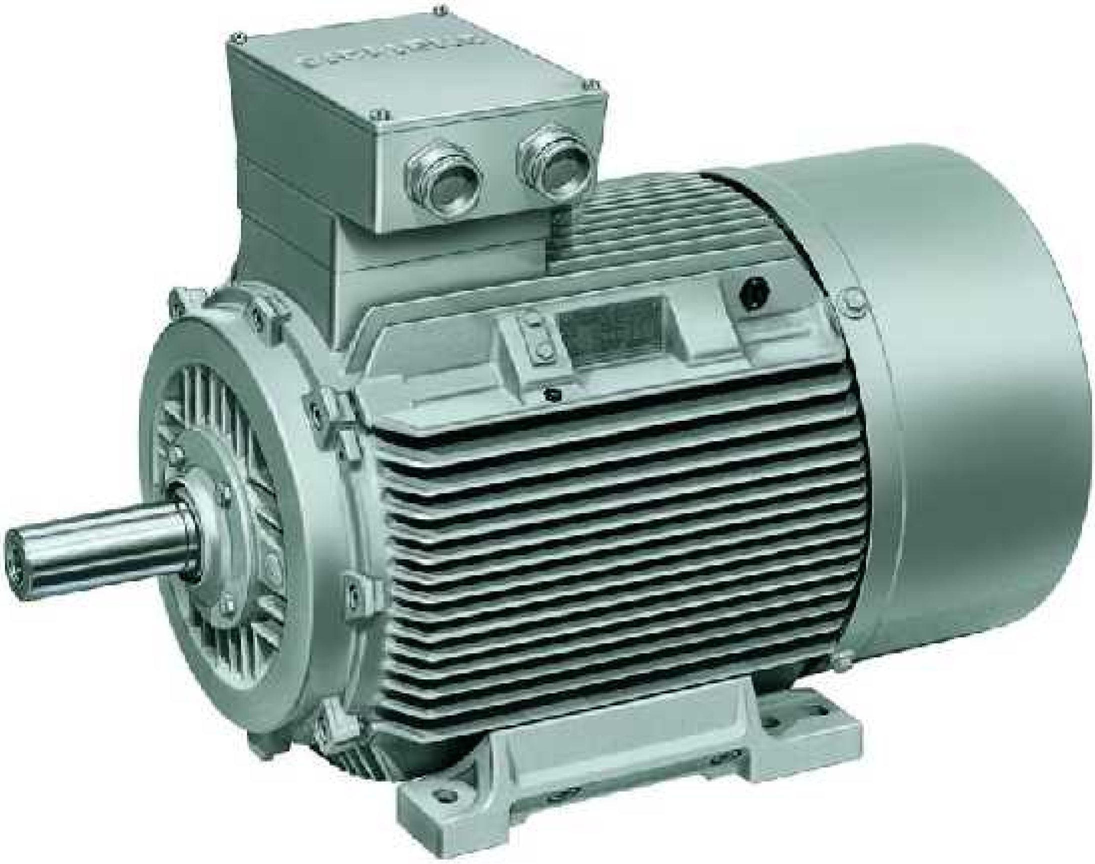

Figure 2.1 AC electric motor with different speed motion [4]

Voltage regulator: is an AC motor control speed which provide different voltage (variable voltage)to the electric motor in order to control the speed that comes from the output of the AC electric motor, there are different kind of it but most of it is working on 220v and a Max current 15A.

Figure 2.2 AC Control Speed (Voltage Regulator).[4]

Break pedal pressure:

We all know that pushing down on the brake pedal slows a car to a stop.

But how does this happen? How does your car transmit the force from your leg to its wheels? How does it multiply the force so that it is enough to stop something as big as a car.

When brake pedal is depressed, the car transmits the force from the foot to its brakes through a fluid. Since the actual brakes require a much greater force than you could apply with your leg, your car must also multiply the force of your foot. It does this in two ways:

- Mechanical advantage.
- Hydraulic force multiplication.

The brakes transmit the force to the tires using friction, and the tires transmit that force to the road using friction also.

The user of the system is applied an input pressure to the pedal which applied to the breaking system as it well described in next sections.

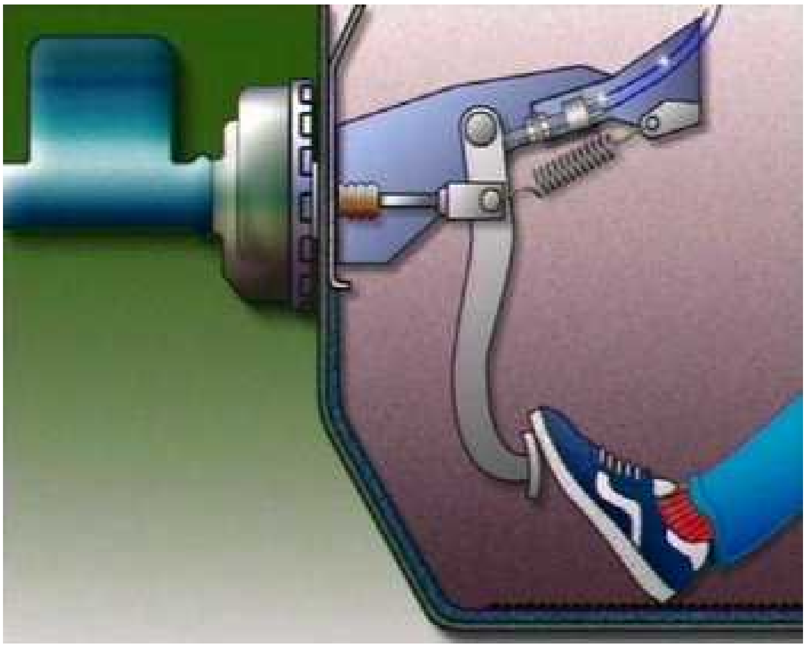

Figure 2.3 Brake Pedal pressure.[5]

2.2.2 Process Requirement

The process unit of any system is the brain and the controller unit that organize and synchronize transferring signals between other part of the system in order to make response for actions , or request actions . This section discuss the process unit used in the system , and the main subsystems inside the process part and how it combined with each other to produce the output to the output part.

Wheel:

General description of wheel used in the system

The wheel represents the main part of the process part, it connected with other subsystems as break system and the electric generator to produce an output electricity, the wheel size is approximately 14-15 inch and it contain the dram disk that connected with electrical motor through shaft to produce a motion that is used in the generator to produce an electricity after the declaration or breaking is applied to the wheel through breaking system.

Breaking system:

The break system is connected with the wheel, the main part of the process unit to decelerate the wheel speed in order to convert the kinetic energy into electric energy through the generator that is connected with the wheel through system called relay system .

A hydraulic brake circuit has fluid-filled master and slave cylinders connected by pipes, When you push the brake pedal it depresses a piston in the master cylinder, forcing fluid along the pipe. the fluid travels to slave cylinders at the wheel and fills it forcing pistons out to apply the brakes, fluid pressure distributes itself evenly around the system.

The combined surface 'pushing area of all the slave pistons is much greater than that of the piston in the master cylinder.

Consequently, the master piston has to travel several inches to move the slave pistons the fraction of an inch it takes to apply the brakes.

Disc brakes:

A disc brake has a disc that turns with the wheel. The disc is straddled by a caliper, in which there are small hydraulic pistons worked by pressure from the master cylinder, the pistons press on friction pads that clamp against the disc from each side to slow or stop it, the pads are shaped to cover a broad sector of the disc. there may be more than a single pair of pistons, especially in dual-circuit brakes.

The pistons move only a tiny distance to apply the brakes, and the pads barely clear the disc when the brakes are release, they have no return springs.

Rubber sealing rings round the pistons are designed to let the pistons slip forward gradually as the pads wear down, so that the tiny gap remains constant and the brakes do not need adjustment.

Figure 2.4 disc brake with caliper .

Relay System :

Relay circuit is used to open or close the roller clutch in the system according to the break pedal pressure , which opposite the roller direction in order to convert the charge state to the system battery, this section describe the relay used in the system which it need 12v power supply to work.

Relay controlled by the electric signal that comes from the system break pedal and it used in the system to change the direction of the moved roller in order to move the electric generator for the battery charging which will be described in more details in next chapters.

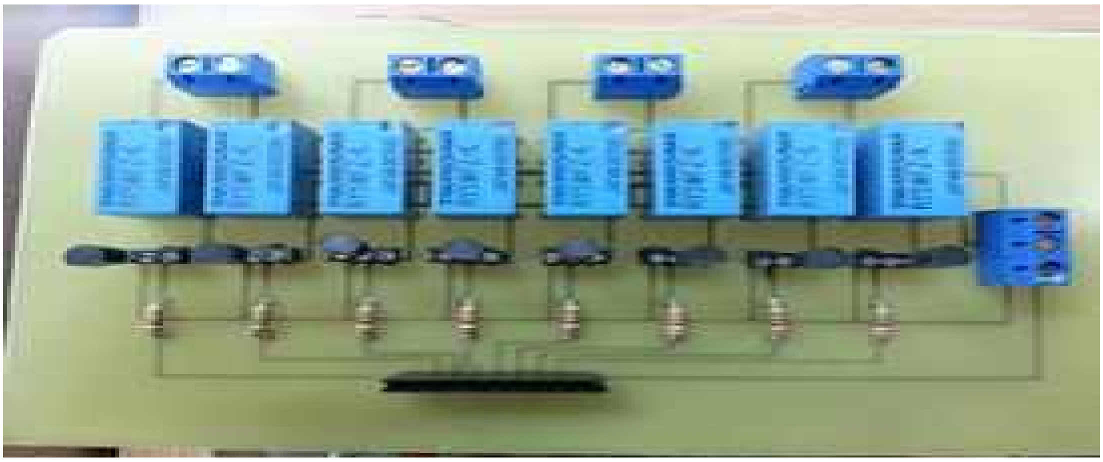

Figure 2.5 Relay System

Electric generator:

The electric generator generates the electric energy depending on the motion that is applied to the planetary gear, the electric energy is varied according to the speed of the motion from the planetary gear the output electric DC energy that is used in the output part to be stored for further uses.

Figure 2.6 Electric generator

Pulley with clutch:

It is a pulley with clutch mounted on the shaft that connected with the electric motor, when the motor rotates the clutch is engaged in order to transmit motion to the wheel and gaining speed through the belt.

The clutch will disengage from the pulley when the user presses on the brake pedal to become the electrical motor rotate without connection with the wheel, and the generator will becoming rotate to convert the kinetic energy gained into electrical energy that will storage in the battery.

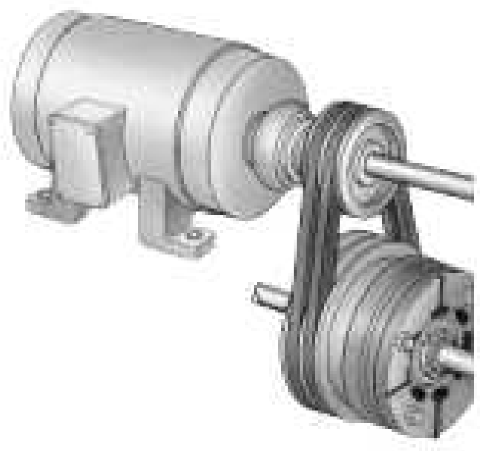

Figure 2.7 Pulley with clutch[5]

Microcontroller (Arduino Mega 2560)

The Microcontrollers are different from their types and properties, its instruction is changed from one type to another, it depends on the company that manufactured the microcontroller, but all of microcontrollers used approximately the same language C,C++ for programming. however the microcontroller used in the system to display the wheel speed sensor reading through the LCD screen through serial reading.

The microcontroller features are described in the next table.

Table 2.1 Arduino microcontroller properties

Name	Properties	Cost	Memory
Arduino (MC) AVR microcontroller type Arduino Mega 2560	õ DAC õ ADC õ Support external interrupts õ 16MHZ clock speed õ two pin o/p voltage for external devices support õ 54 pin for PWM that is used as digital i\p and o\p. õ Serial port communication	35$	32KB of 2KB SRAM And 1 KB of EEPROM 256 KB of which 8 KB used by boot loader

Arduino Mega 2560 Specification and features [7] :

The Arduino Microcontrollers are a series of AVR Microcontroller development boards designed for rapid prototyping.

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack and a reset button for stuck states . It contains everything needed to support the microcontroller; simply it connect to a computer with a USB cable or it power with a AC-to-DC adapter or battery to get started.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

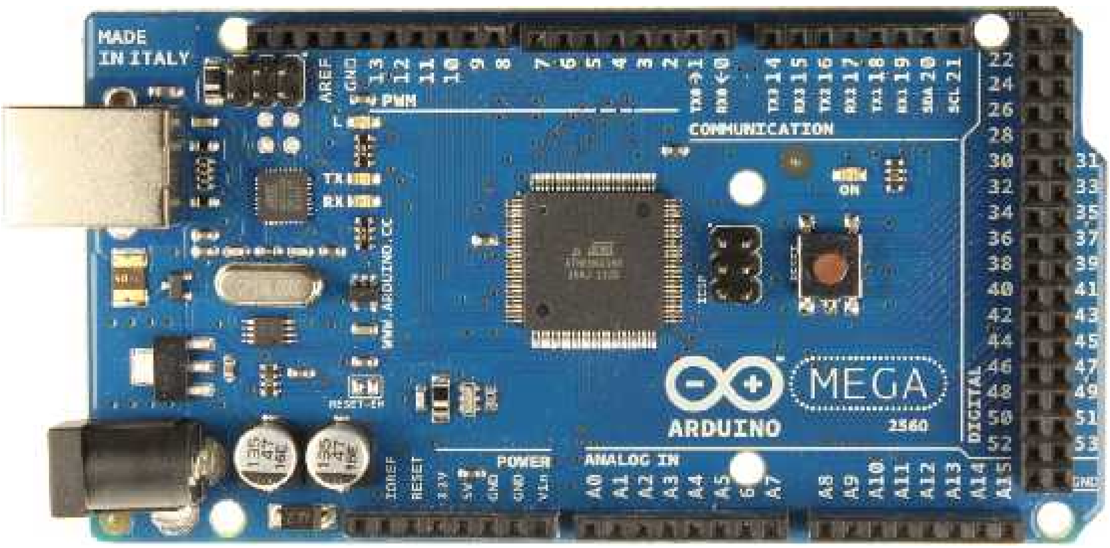

Figure 2.8 Arduino Mega 2560 Microcontroller

2.2.3 Output requirements

The output port of the system is connected directly with the main unit of the system, and the electric energy is applied directly to the output devices. The system consists of these output devices battery, Voltmeter, Ammeter and speed sensor of the wheel .

All of these devices are described in the following subsections.

- **Battery:**

The battery of the system is a type of rechargeable battery that supplies electric energy that used for storing the dc voltage that come from the process part of the system, the one that is required to be used in the system is 12v and 55 ah approximately .

Figure 2.9 Rechargeable battery.

- **Voltmeter:**

Is a device used to measure the output voltage of the battery that it stored from the process part , which measure the voltage in DC that is represent the result of the output part of the system Volt.

Figure 2.10 Dc voltmeter

- **Ammeter:**

Is a device used to measure the output current on the battery that it comes from the process part , which is measure it in the DC current that is represent the result of the output part of the system in Am.

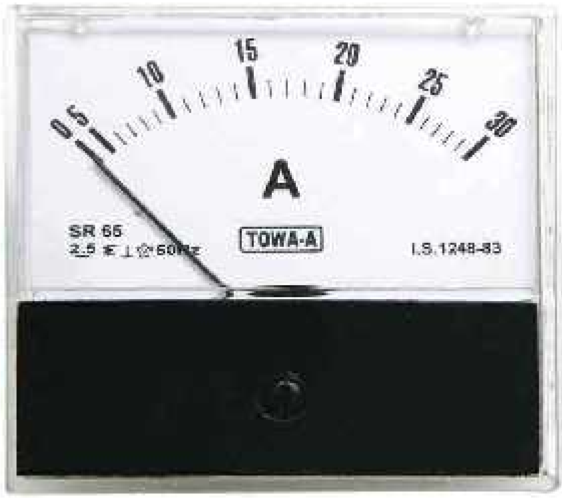

Figure 2.11 Dc ammeter

- **speed sensor (inductive sensor):**

The inductive sensor consists of a bar magnet with a soft-magnetic pole pin supporting an induction coil with two connections. When a ferromagnetic ring gear (or a rotor of similar design) turns past this sensor, it generates a voltage in the coil which is directly proportional to the periodic variation in the magnetic flux. A uniform tooth pattern generates a sinusoidal voltage curve. The rotational speed is reflected in the periodic interval between the voltage's zero transition points, while the amplitude is also proportional to rotating speed. The air gap and the tooth dimensions are vital factors in defining the (exponential) signal amplitude. Teeth can still be detected without difficulty up to air-gap widths of one half or one third of a tooth interval. Standard gears for crankshaft and ABS wheel-speed sensors cover gaps ranging from 0.8 to 1.5 mm. The reference point for the ignition timing is obtained either by omitting a tooth or by bridging a gap between teeth. The resulting increase in distance between zero transitions is identified as the reference point and is accompanied by a substantial increase in signal voltage (the system registers a larger tooth.) [2].

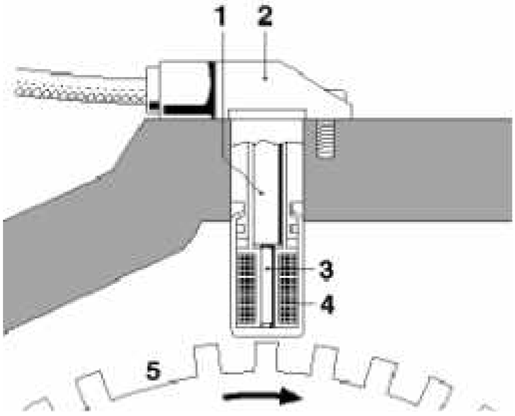

Figure 2.12 Inductive sensor

1- Permanent magnet 2- Housing 3- Soft irons Core 4- winding 5- Ring gear (iron) with reference point.

Speed sensor will produce an output signal that can be monitored and measured on the oscilloscope. Figure 2.8

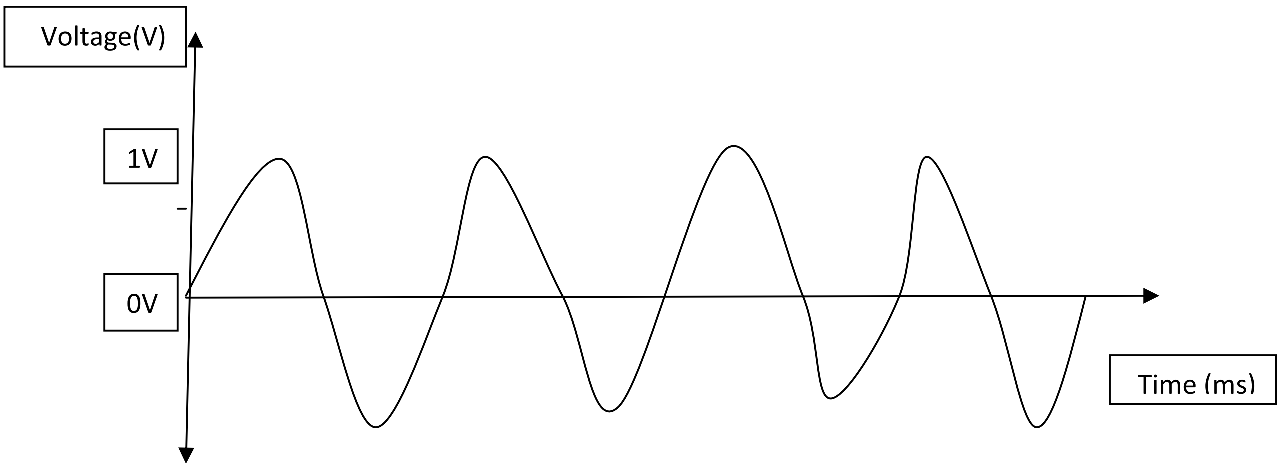

Figure 2.13 Wheel speed sensor waveform [4]

3

CHAPTER THREE

Conceptual Design

3.1 Introduction

This chapter describes the main parts of the system, general block diagram of the system, and block diagram for each part .

3.2 General Block diagram

General block diagram for any system describes the main component of the system and how its integrated with each other to produce the objectives of the system.

For the Break energy regeneration system the general block diagram is shown in next figure 3.1 which describe the main component of the system in three parts:

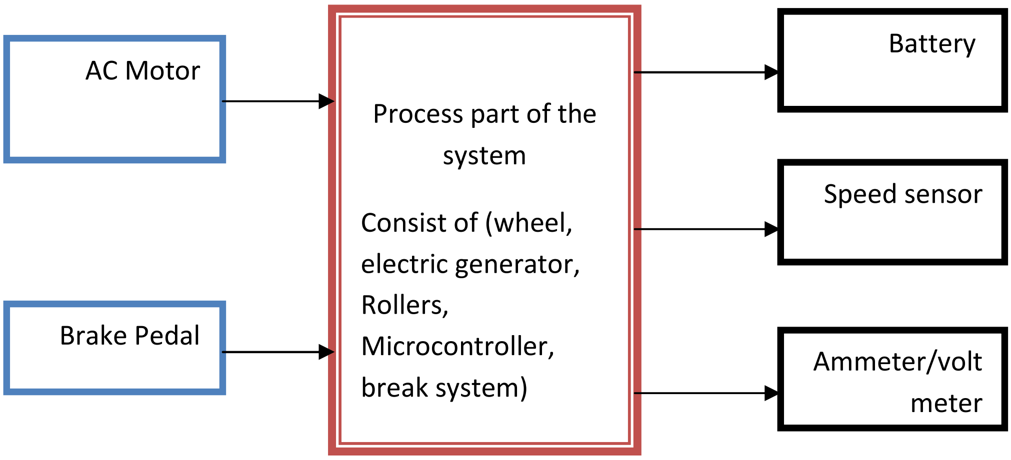

Figure 3.1: General block diagram .

- Input part : the main components for input motion, pressure to the Break energy regeneration system is :
  - AC Motor
  - Break Pedal: used as input pressure to the break system.

- Process part : describe the component that will be used as the controller for all the system parts and processes , the main components for this part are :
  - Wheel
  - Electric generator.
  - Relay system.
  - Break system.

- Output part: describe the main components that will be used to show the output result for the system and to make specific actions, the output parts are:

  - Battery : for store the output electricity for the system

- Ammeter/Voltmeter: for measuring the Ampere and the volt on the battery.
- Speed sensor: used to measure the output speed of the wheel on the process part.

3.3 Input System Design

This part describes each component used as input component , and analyses it from what is needed and how its integrated with the process part of the system , and describe its input data and its outputs as subsystem in the main system .

3.3.1 AC Motor

This section showing the AC motor as subsystem in Break energy regeneration system , the input for this subsystem is an AC 220v and 50 Hz electric power applied to the voltage regulator to control the voltage of the Ac motor as described in previous chapter.

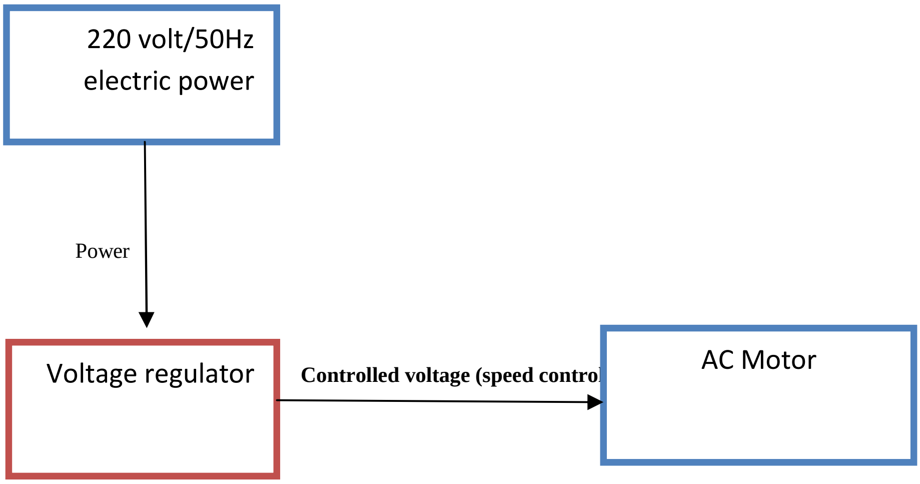

Figure 3.2 : AC Motor Functional Block Diagram .

3.3.2 Brake Pedal

The brake pedal is a subsystem that used to enter the pedal pressure into break system in the main system as specified in the previous section ,

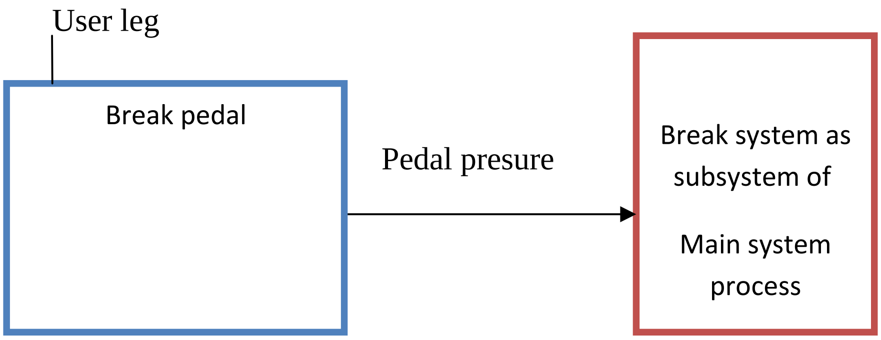

Figure 3.3 : Brake Pedal Functional Block Diagram .

3.4 Output System Design:

This section describe each block connected with main process part of the system as output part ,and generally it describe the block diagram for each block as subsystem of the Break energy regeneration system .

3.4.1 Battery Interfacing :

Battery used in Break energy regeneration system to store the charging energy that comes from the generator subsystem of the main process part of the system as specified in the previous chapter 2 .this chapter analyze how Battery connected with the generator subsystem as functional block diagram in the following figure .

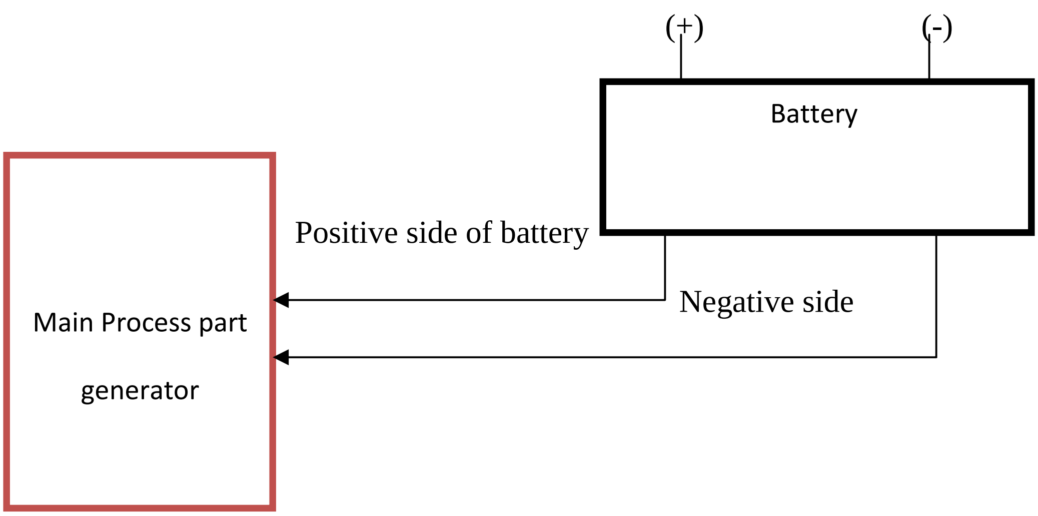

Figure 3.4: Battery connection with the generator .

3.4.2 Speed Sensor

Speed sensor used in Break energy regeneration to read the wheel speed in the process part of the system in order to record the data from it and having the relation between speed of the wheel and the generated energy as well be described in next section .

This chapter analyze the speed sensor as subsystem , and how it interfacing with the wheel as subsystem in the main process , as showing in the following figure .

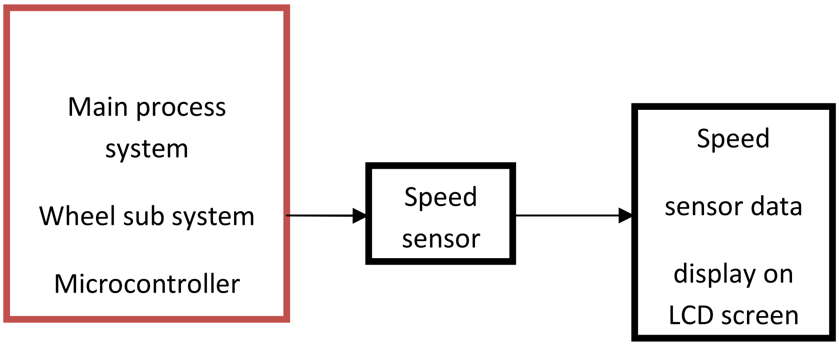

Figure 3.5 :speed sensor Block Diagram.

3.4.3 Ammeter and voltmeter :

These devises used to measure the voltage and the current on the battery that used in the system to store the data that is needed to have the relation between speed of the wheel part of main system and the electric energy that comes from the system output .

describing how this part integrated to battery on the system and with main system process part to store the voltmeter and ammeter data is shown in the following figure .

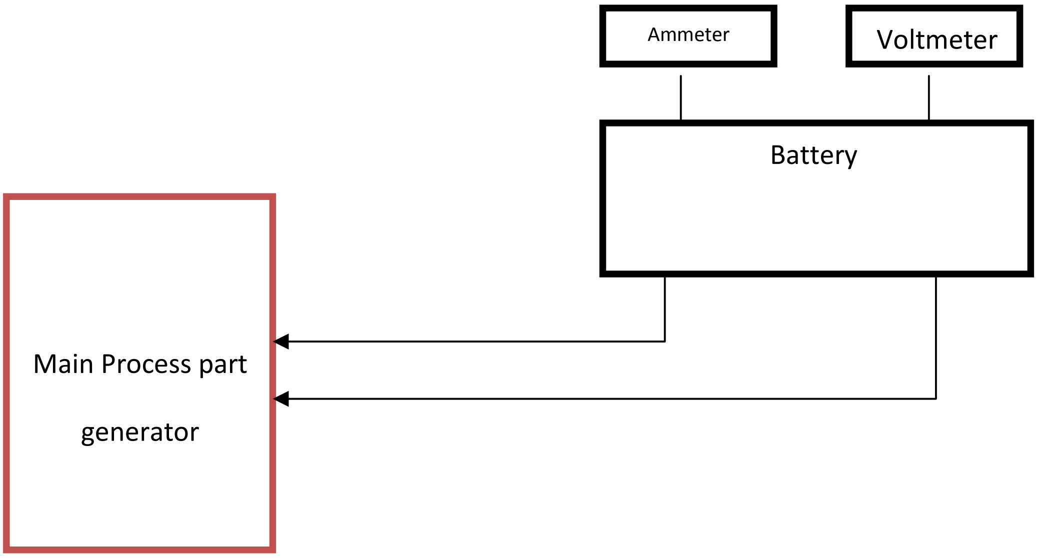

Figure 3.6 : Ammeter And Voltmeter Block Diagram.

3.5 Detailed Block Diagram :

After the team analyzed each subsystem as shown in the previous sections , the full functional block diagram for the Break energy regeneration system is drawn , as shown in figure 3.7 system functional block diagram .

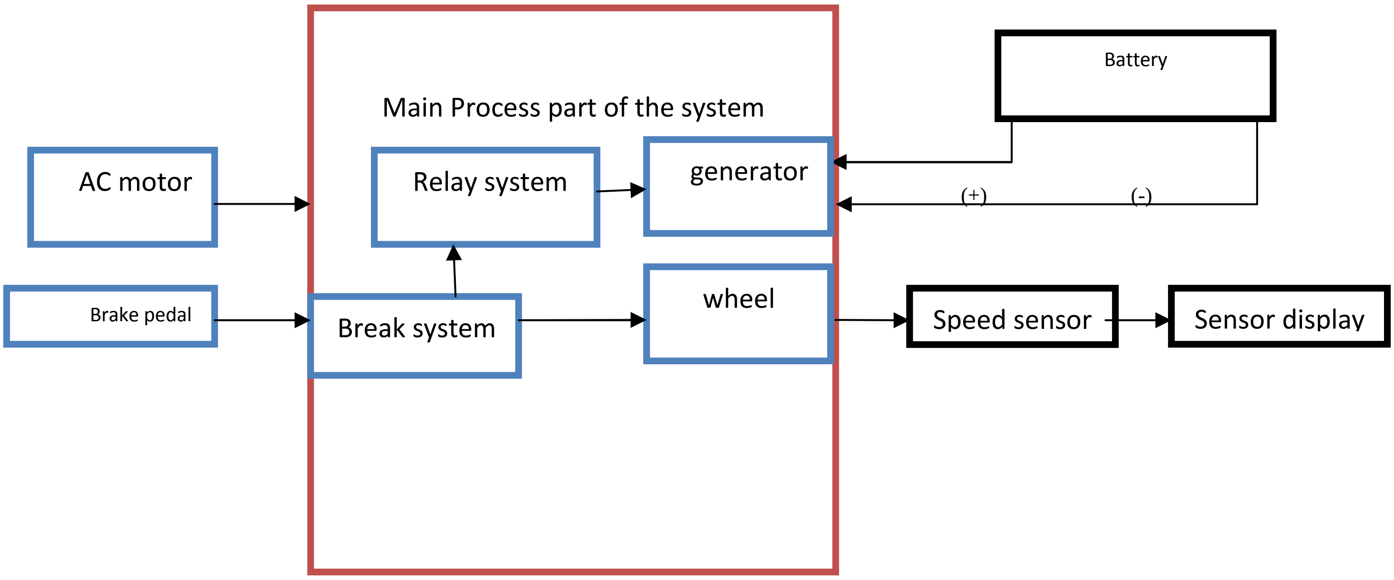

Figure 3.7 : Break energy regeneration functional block diagram.

3.6 Detailed process and schematic diagram of the system

This section describe the system process part as subsystem connected with the input and output part of the system, and it describe the main schematic diagram of the system which included and described in to two subsections : section 3.6.1 subsystem process part , section 3.6.2 schematic diagram.

3.6.1 Subsystem Process Part:

This subsection describe the main system part that is used to map between the input part and the output part of the system in order to get the required output data, and to build the relationship between the input part and the output result of the system which specified in next parts:

- **Break system:** the break system that is used in the system get the pedal break pressure as input for it and transform the pedal pressure into system control speed through the break piston that is entry on the wheel in order to decelerate the wheel speed, the break system is also connected with the Relay system through connection wire to the relay circuit that is connected with clutch pulley that is transform the motion to the generator as it well described next.

- **Relay System:** it consist from Relays that is used to opposite the pulley motion that is connected with the generator and with the wheel of the system, through electric clutch on the pulley which will be described in more detail next chapter.

- **Generator:** the generator used in the system is a DC generator which take the applied motion on it from the relay system that connected with the pulley clutch and convert it to dc energy which is stored in the Battery.
- **Wheel:** the wheel used to measure the wheel speed and to move the pulley clutch in order to get the motion of the generator which it produce the output of the system, the wheel connected with the pulley clutch with special shaft ,after the brake is applied to the wheel the motion is transfer to the pulley clutch through the relay system order as described in the previous sections which moves the generator, the useful from this operation is that the pulley

clutch is gain the wheel motion which helps to get more energy to the generator for the charging process.

3.6.2: Schematic Diagram of The System

System general schematic diagram represents all of the component that is used to perform the system operation in order to get the required result from the system , the system component connection and design is represented in next figure:

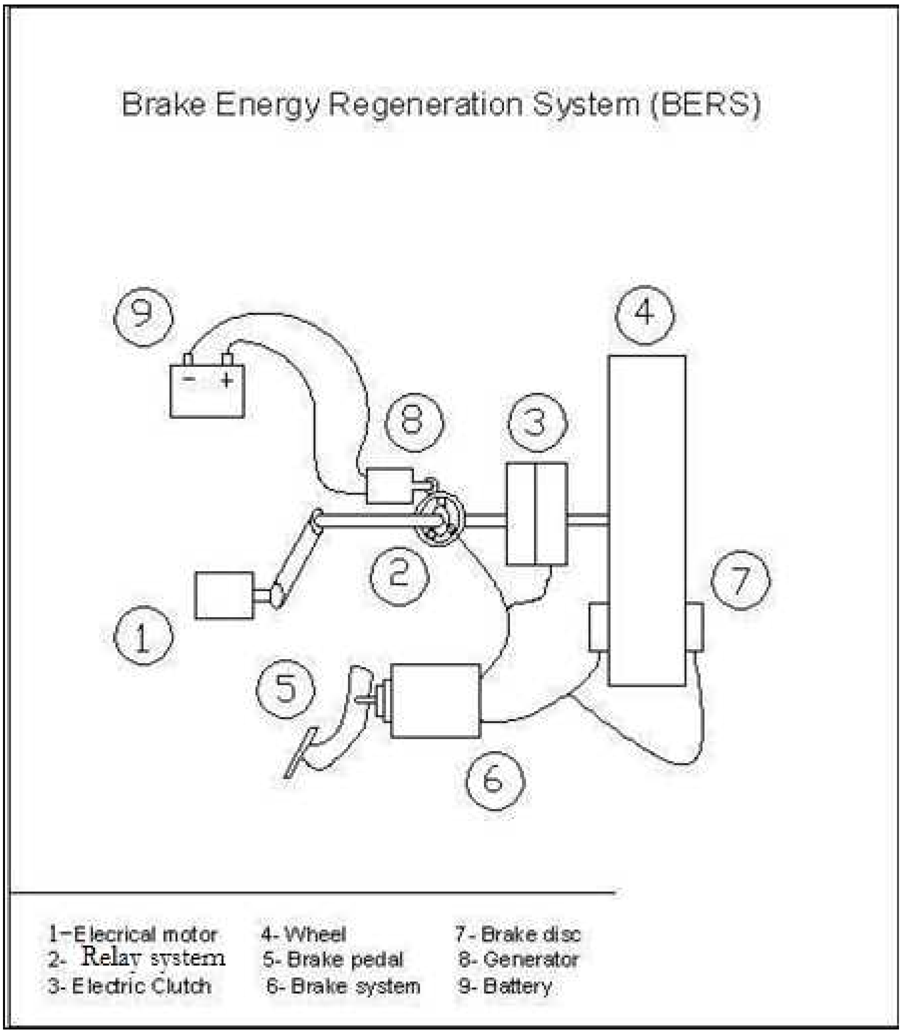

Figure 3.8 Break Energy Regeneration Schematic Design.

4

CHAPTER FOUR

Detailed Schematic System Design

4.1 Introduction .

4.2 System Input Schematic Design .

4.3 System output Schematic Design .

4.4 Process Part Interfacing Design .

4.1 Introduction

This chapter shows the schematic design for each part independently , and convert each block diagram in the previous chapter (chapter 3: System Design) into a schematic diagram ; more details about each interfacing peripheral devises of the system is described in the following sections.

4.2 System Input Schematic Design

As described on the previous chapter , the input system part is divides into two blocks : Electric motor diagram , and Brake pedal diagram . this section discuss the schematic diagram for each block , and convert each block into mechanical form to be implementing in the later chapters as the following two subsections : 4.1.1 Electric motor Interfacing schematic Design , and 4.1.2 Brake pedal Interfacing Schematic Design.

4.2.1 Electric Motor Interfacing Schematic Design .

This subsection show how the Electric motor interface with main system shaft through the rolls that connected with the shaft in order to move the wheel of the system for the energy transformation as will be described in next sections, the electric motor movies the wheel depending on the values of voltage that comes from the voltage regulator which control the speed of the motor and the moved wheel in the system, the connected shaft is moved the wheel through different sizes of rolls in order to move the wheel with the required speed that is designed by the project team, next sections describe more details about this process, next figure shows the electric motor connected with the main system shaft.

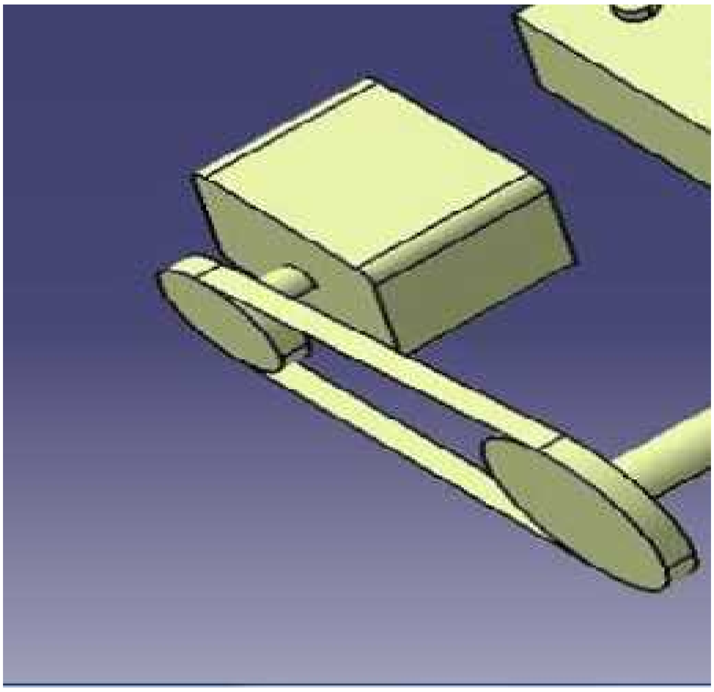

Figure 4.1 Electric motor Schematic Design.

4.2.2: Brake Pedal Interfacing Schematic Design.

This subsection show how the brake pedal that is connected with the breaking system and operate as electronic signal and a servo pressure for control the wheel speed as describe in the previous chapter, however the pedal send the electric signal for the relay system in order to convert and transform the shaft motion from the wheel to the pulley clutch in order to start the generator movement for the charging process that will be described in next section, next figure shows the schematic design for the break pedal as input to the system used by the system user.

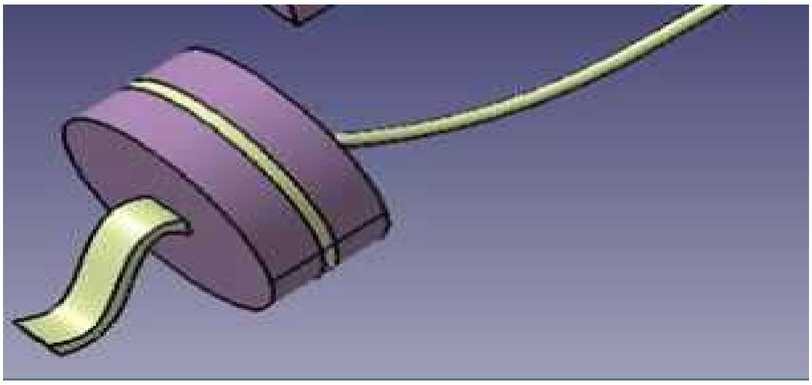

Figure 4.2 Brake Pedal Schematic Design.

4.3 System output Schematic Design

As described on the previous chapter , output of the system part is divides into three blocks : LCD Display Interfacing for speed sensor , Battery Interfacing and Ammeter voltmeter Design this section discuss the schematic diagram for each block , and convert each block into electrical and mechanical form in order to be implementing in the later chapter as the following two subsections : 4.3.1 LCD Interfacing schematic Design , and 4.3.2 Battery Interfacing Schematic Design. And 4.3.3 Ammeter voltmeter interfacing with the system battery.

4.3.1 LCD Interfacing Schematic Design [9]

This subsection describe the LCD and how it interface with the microcontroller by connected it in pins level , the connected pins in the microcontroller side is chosen by the data sheet for the LCD screen in order to be work correctly when the data is send to it by the micro controller signals, the LCD screen has 8 pins for the data from D0 to D7 and a RE (Read) and WR (write) pins to get the control signals from the Arduino microcontroller and it has the VCC and GRD pins for power the screen, the screen is connected with the Microcontroller is 16*4 that's mean the screen has four rows and 16 columns to be written on , the microcontroller connected with the LCD screen is send the control signals to write or read from the screen after it import some libraries which is important in software part as it well described. The interfacing circuit schematic Design is described in the next Figure , Figure 4.3 : LCD Screen Interfacing Schematic Design.

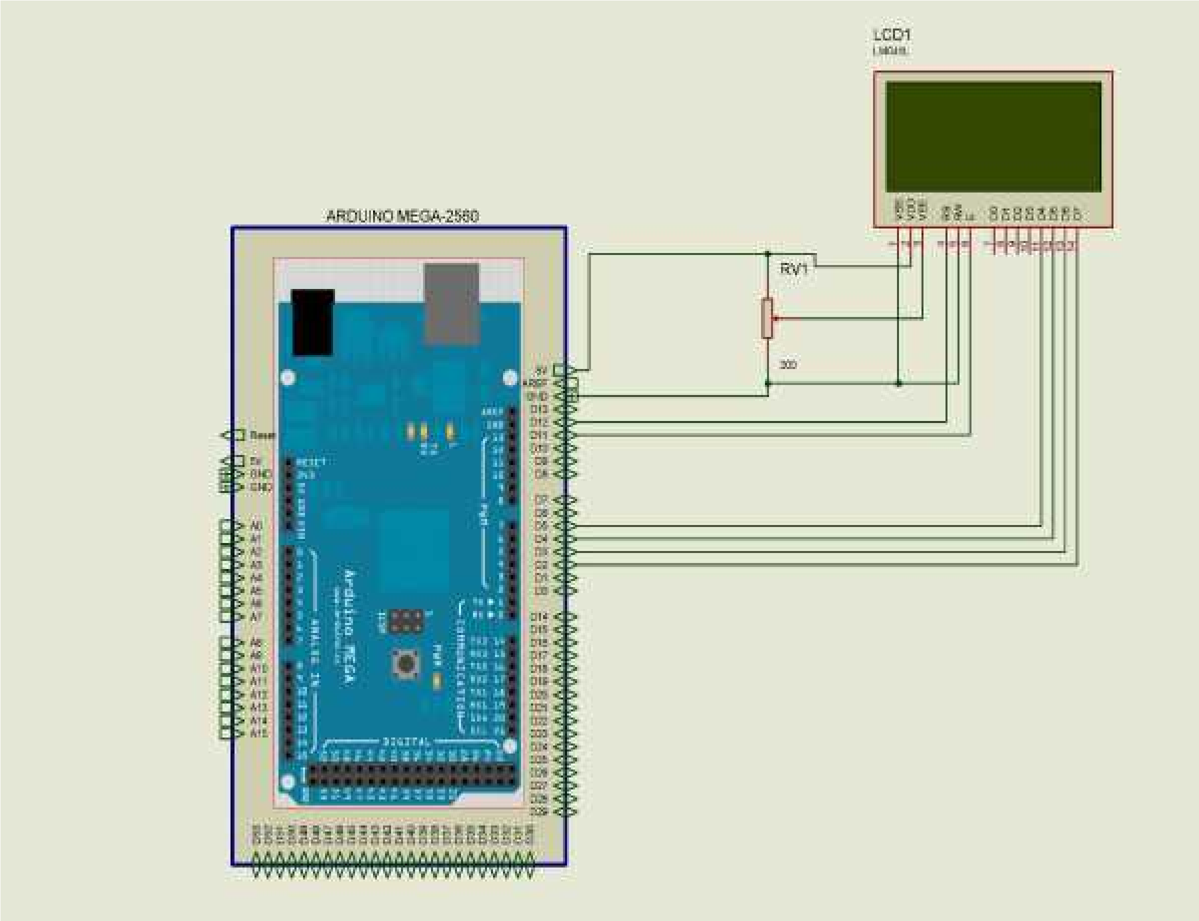

Figure 4.3 : LCD Screen Interfacing Schematic Design.

4.3.2 Battery Interfacing Schematic Design:

As described and shown in the previous chapter the battery that is used in the system is 12 v battery which it charged from the electric generator when the mechanical motion transformed from the main system shaft to the electric generator which the voltage and the useful current from this operation which applied to the battery is measured through the voltmeter and the ammeter as will described in next section, next figure shows the schematic diagram for the battery that is interface with the system.

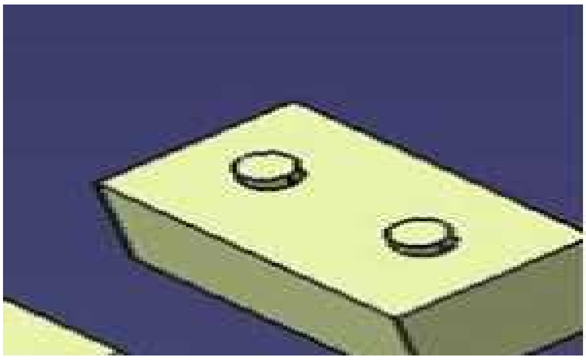

Figure 4.4 : Battery Interfacing Schematic Design.

4.3.3 Ammeter Voltmeter Interfacing Design:

As described in the previous chapter the Ammeter and Voltmeter connected with the battery in order to measure the current and the voltage, however the ammeter is connected with the battery in series to measure the value of the changed in amount of current the happened to the battery depending on the value of charging of the electric generator, the voltmeter connected in parallel with the battery for measuring the amount of voltage change during charging and discharging process.

4.4 Process Part Interfacing Design

This section describe all the process part and how it operate in order to satisfy the system requirement, the main process part is described independently and depending on the interfacing operation the main process parts are describe in next subsections as 4.4.1wheel interfacing design,4.4.2 electric generator interfacing design,4.4.3 relay system interfacing design , 4.4.4 pulley with electric clutch interfacing design

4.4.1 Wheel Interfacing Design

As described in the previous chapter the wheel represent the main part of the system that is moved depending on the main shaft of the system that is moved according to the Electric motor motion, the break piston connect on the wheel for decelerates the wheel speed through the oil pressure in the brake piston that comes from the break servo ,however the wheel motion through the main system shaft is depending on the pulley clutch as shown in next figure ,the next sub sections describes more details about this operation.

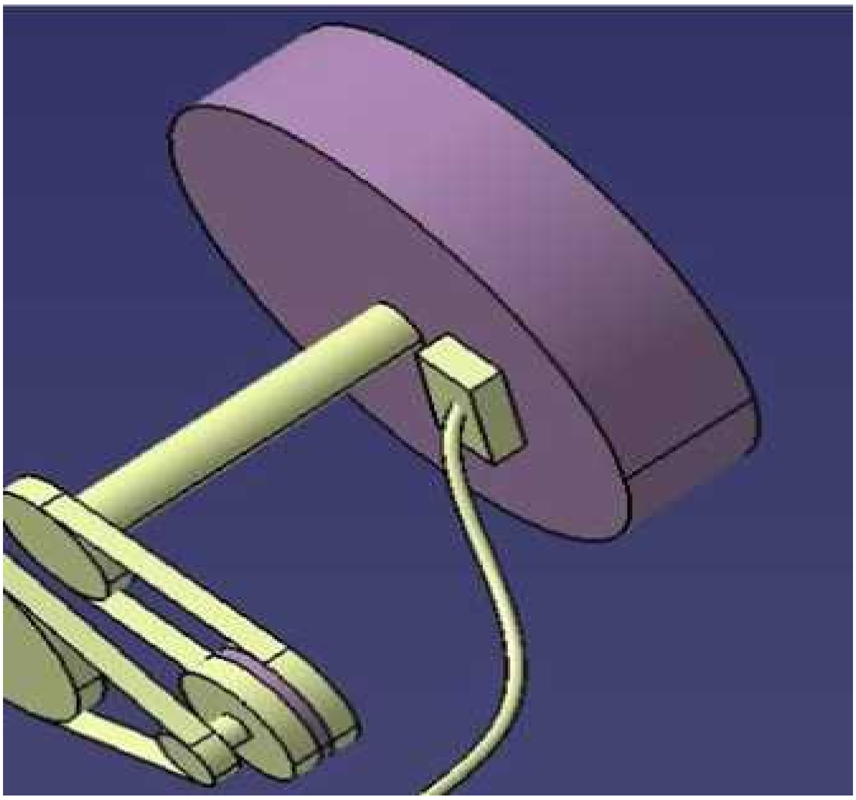

Figure 4.5 : Wheel Interfacing Schematic Design.

4.4.2 Electric Generator Interfacing Design

As described in the previous chapter the electric generator represent the main component that is responsible for charging the system battery depending on the main system shaft ,the generator start to move when the user press on the break pedal that send an electronic signal to the relay system that convert the motion to the generator through the pulley with the electric clutch as will be described in next sub sections next figure shows the electric generator schematic design.

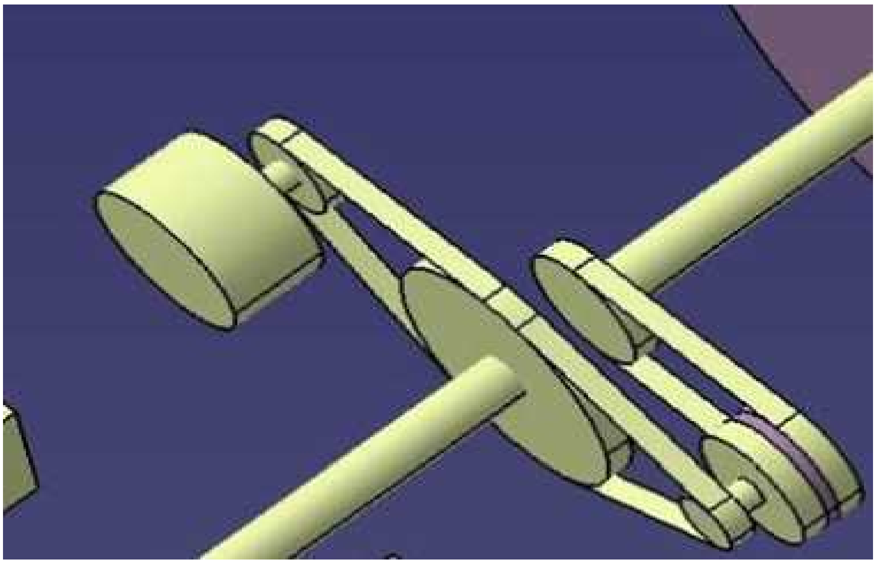

Figure 4.6 :Electric generator Interfacing Schematic Design.

4.4.3 Relay System Interfacing Design

According to the previous chapter the relay used in the system in order to operate as switch for moving the main electric pulley clutch in order to opposite the direction of the pulley movement from the wheel to the electric generator in order to start charging for the system battery the electric pulley clutch is described in more details in next sub section next figure show the relay system interfacing design.

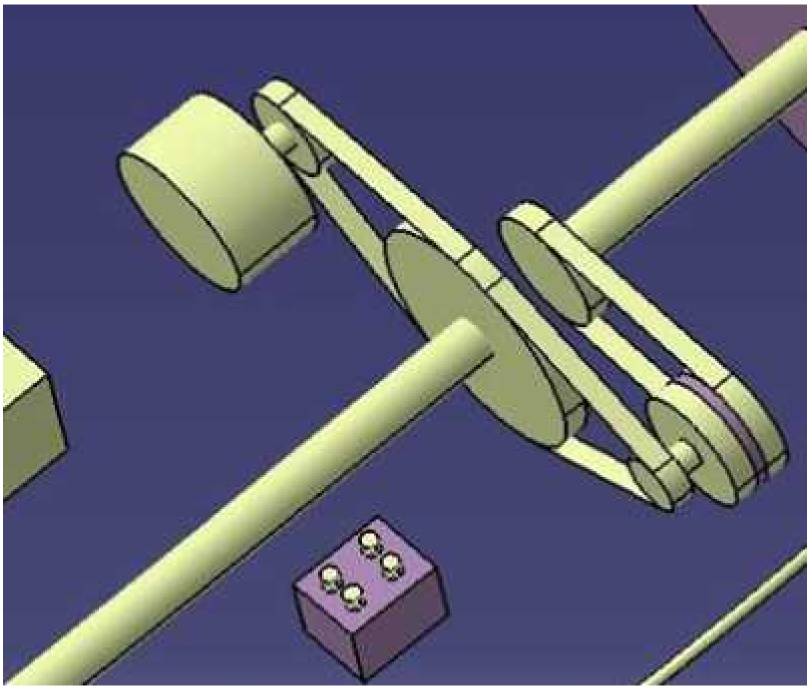

Figure 4.7 Relay system Interfacing Schematic Design.

4.4.4 Pulley With Electric Clutch Interfacing Design

According to the previous chapter the pulley with electric clutch represent the main component that is responsible for converting the mechanical movement from the wheel movement to the generator movement for the charging process depending on the switching that comes from the relay system which connected with the electric signal that comes from the main process of the brake pedal for the input of the system next figure shows the Pulley with electric clutch schematic design.

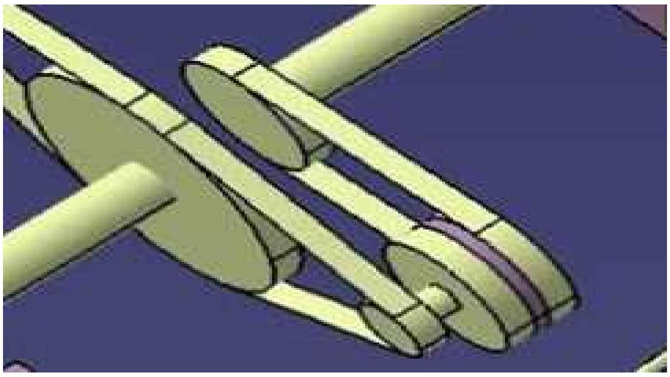

Figure 4.8 Pulley with electric clutch Interfacing Schematic Design.

5

CHAPTER five

System Implementation

5.1 Introduction

This chapter describe the main steps for implementing the system components, the main mechanical and electric component details will be describe in this chapter according to system design in the previous chapters, this chapter contain the main three section for implementing the system parts and it described as follow:

5.2 Input Breaking System Implementation

This section provide the implementation of the main part that represent the breaking system as input for the main system which the brake pedal provide the main input for the mechanical and electrical components as described in the previous chapters ,next subsection describe each part implementation as follow.

5.2.1 Servo Brake Implementation

The team implement the break part by connect each part with the main servo that is used to provide the oil pressure through the main pump depending on the user pedal pressure through servo, the oil is goes through the main pipe to the break piston for decelerate the wheel speed which is required for transform the output energy as describe before next figure describe the servo implementation.

Figure 5.1 Servo Implementation

5.2.2 System Wheel Implementation

The wheel used in the system is 14 inch wheel ,the team connect all the required part on the main drum for implement the break system, however the main wheel is connected with the main system shaft as describe in the previous chapter which earn it movement from the electric pulley clutch as will be described in next section, next figure shows the wheel implementation with the system shaft.

Figure 5.2 System Wheel Implementation

5.3 Pulley and Main Shaft Implementation

This section describe how the team members implement the main reels of the system that is used to move the system parts with the main system shaft as will be described in next subsections.

5.3.1 Electric Clutch Pulley Implementation

This subsection describe how the team connect the clutch pulley with the main system shaft in order to operate as switch for changing the movement from the wheel to the electric generator for starting the charging process, the movement of the main shaft is changed according to the Ac motor with different speed the team connect these part for testing processes that will be described in next chapter ,next figure describe the electric clutch pulley implementation on the system as shown .

Figure 5.3 Electric Clutch Pulley Implementation

5.3.2 Relay with Electric Clutch Pulley Implementation

According to the design chapter the relay operate as switch for changing or opposite the shaft movement from the wheel on the decelerate operation to the electric generator through rolls for starting the charging process, the team members connect the relay with the brake pedal and with the pulley clutch for this operation as describe in next figure.

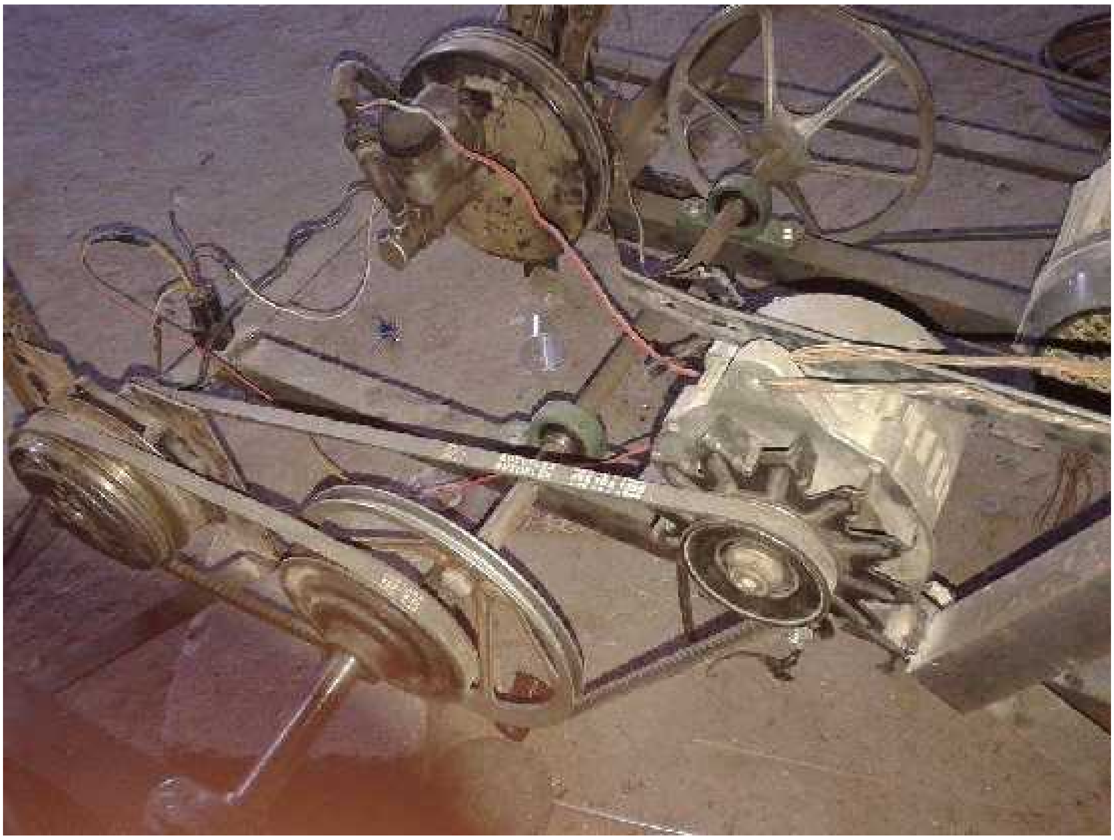

Figure 5.4 Relay With Electric Clutch Implementation

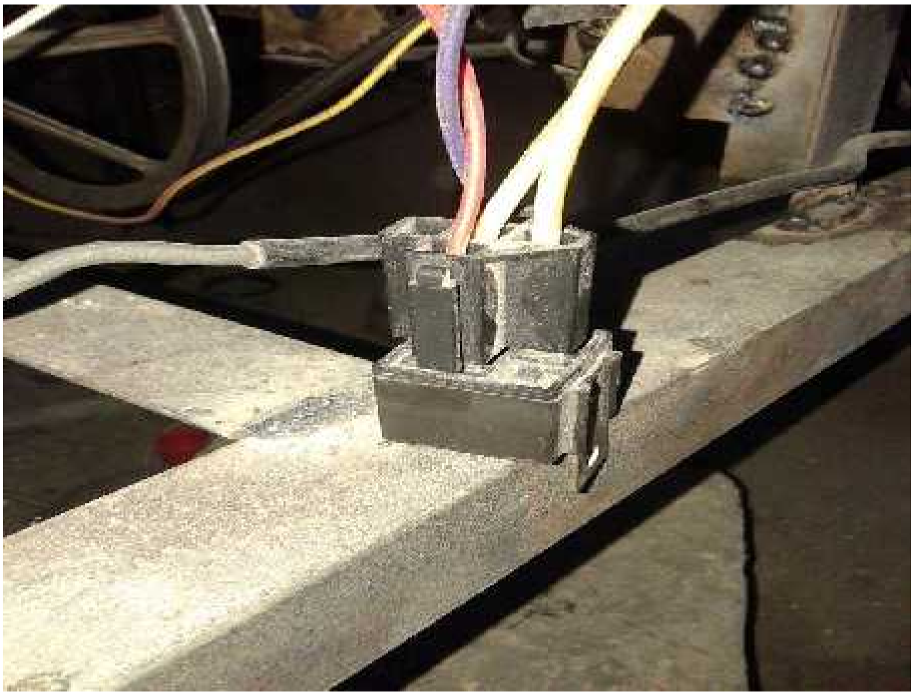

Figure 5.5 relay Implementation

5.3.3 Electric Motor and Clutch Pulley Implementation

The team used the electric motor for move the main system shaft depending on some speeds according to the applied voltage from the voltage regulator as described before, the motor connect with the system shaft through pulley which provide the movement for the wheel and for the electric generator as shown in next figure.

Figure 5.6 Electric Motor Implementation

5.4 Electric Components Implementation

This section describe how the team connect the electric components for taking the output from the system as will be described in next subsection, the electric component represented by the system battery and the ammeter for measuring the electric current ,voltmeter for measuring the output voltage and the electric generator for charge the system battery ,LCD screen for display the speed of the system wheel.

5.4.1 Measuring Components And The System Battery Implementation[10]

According to the previous chapters the used battery in the system is 12 v ,the team connect the battery and the measuring component represented by the ammeter and voltmeter for displaying the output result according to the charging processes ,next figure describe how the team connect these part with the battery to display the result from the system.

5.4.2 Lcd Screen Implementation

LCD screen used to be as the main user interface that provide the special data for the users to monitor the speed of the wheel in the system which is executed by the Arduino microcontroller.

LCD screen connection depends on the data sheet of the LCD that is used in the system which is 16*4 screen, the wire is connecting with the screen by meld it and then it connected with the Arduino microcontroller after the special pins is specified ,the Arduino software import a special library to print the menu and the special messages on the LCD screen depending on the system state, that library is <LiquidCrestalLCD.h> which shown in figure 5.7 the Arduino software for LCD define.

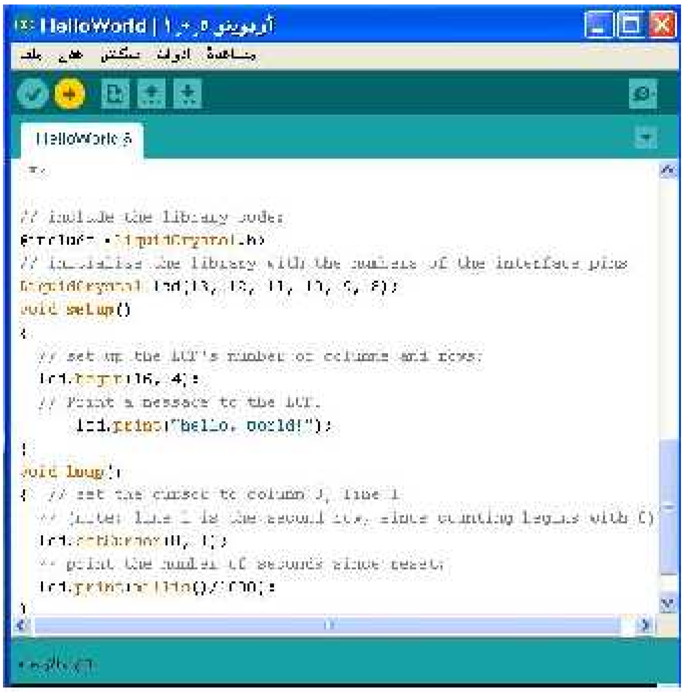

Figure 5.7 the Arduino software for LCD define[7]

The hardware connection of the LCD screen that is used as the main user interface part is shown in figure 6.4,the connection is depending on the main data sheet of the LCD screen and on the digital pins that is used to send and receive the data from and into microcontroller, however the chosen pins is choose to be close enough from the LCD screen in order to avoid the screen failure in printing the messages or the main menu as programmed.

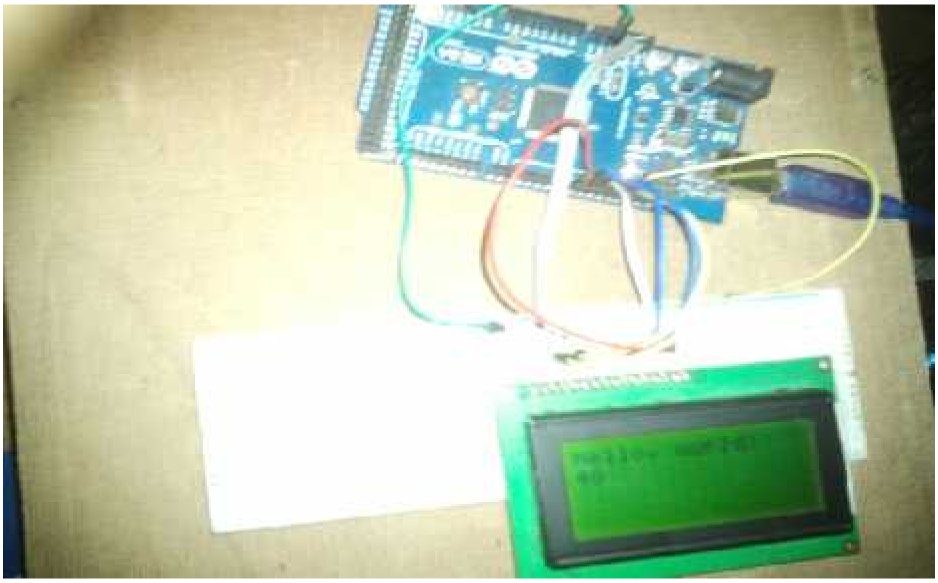

Figure 5.8 LCD Screen Connection With Arduino Mega 2560 Microcontroller.

5.4.3 Arduino Microcontroller Implementation.

The Arduino microcontroller used in the system to control all of the connected peripheral devices with it in order to manage the system operation, the Arduino micro controller is connected with the pc through USB serial port and start to be programmed through Arduino special software as described before, next figure shows the Arduino microcontroller connected with PC and ready to programmed.

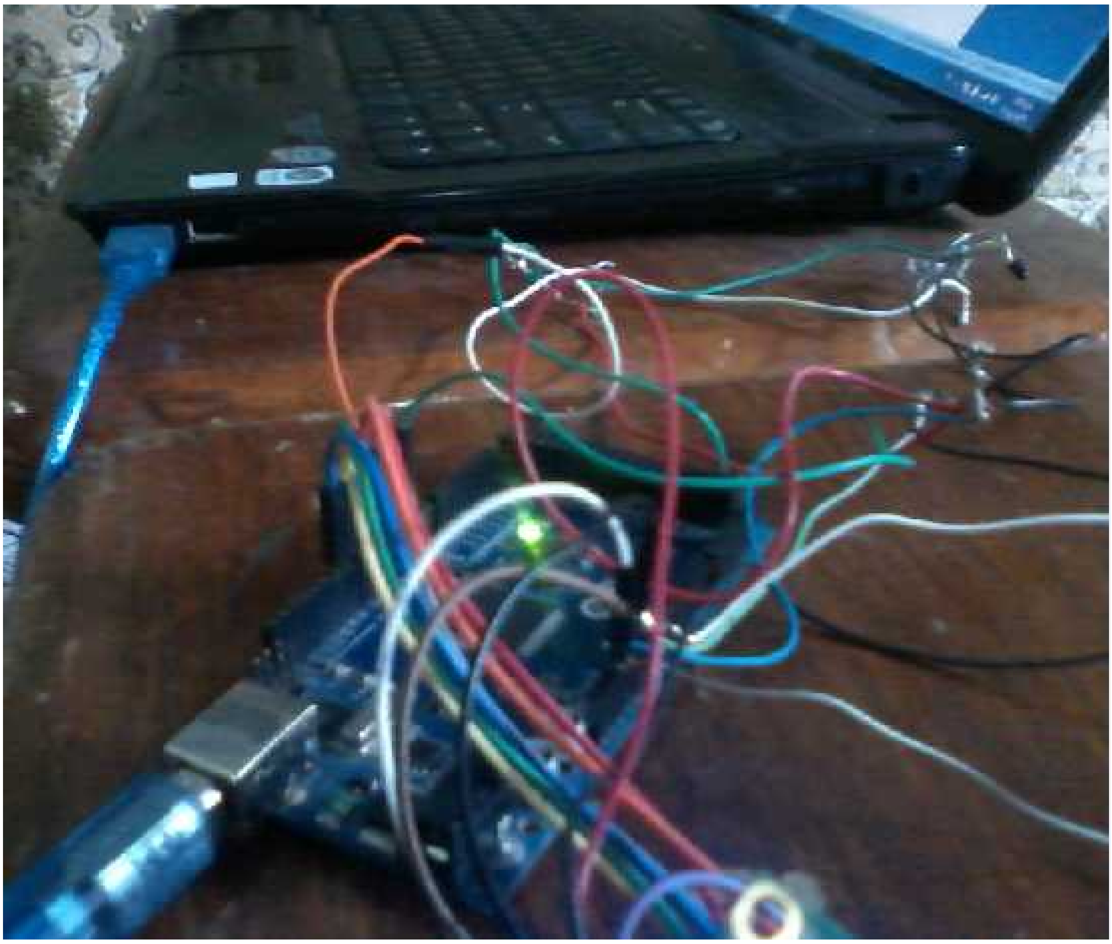

Figure 5.9 Arduino Microcontroller Implementation.

6

CHAPTER Seven

Conclusion And Future Work

6.1   Conclusion.

6.2   Future Work.

6.1 Conclusion

At the end of system implementation, the team became familiar with the components that were used to build the system, the main results that the team achieved were:

- The team learned the main steps to implement the system according to some calculations and found a good result from transforming the break energy into useful electric energy.

- The main idea of the project talks about different concepts such as electrical and mechanical component implementation and the microcontroller programming, the team became familiar with these entire concepts.

- The system was built with different techniques in order to provide more useful energy results from the system operations.

6.2 Future Work

The system can be modified in the future in many ways to achieve more requirements and to be more developed, some of these modifications are:

- Improve the system breaking system inside the wheel system.
- Improve the measurement instrument to be digital display.
- Improve the system technique to provide flexible movement for all of the system parts.