CHAPTER I

INTRODUCTION

1.1 Background

At this time the rainy season often occurs in big cities. So that if it rains occur for a long time, many places experience flooding, and it becomes a frightening problem for urban communities. This is the result of several factors including the culture of littering in waterways.

Viewing the problems above, various efforts have been made by the government in order to be able to cope with flooding due to piles of garbage. At this time, the world of education is required to play a role in community service, one of which is forcing every student in the field of technology (engineering) in order to be able to utilize their knowledge in the manufacture and operation of technological devices to answer various problems that exist in today's society.

The development of innovation in the world of manufacturing and technology today has increased in following developments of the modernization era. To be able to compete with countries in various worlds, especially in the world of education. In this case, it will discuss the planning and process of making a garbage scraper machine by utilizing solar power, which may have a carrying capacity of 5 kg. The process of making a garbage scraper is carried out as a prototype for research and to be developed in the future.

For the purposes of this final project, the author also conducted surveys and research on the mechanical engineering laboratory of the Medan Area University in order to get ideas and materials that are more effective to use for making a garbage scraper. However, to complete the insight, the author also looks for mechanical engineering manuals in the Medan Area University's library to find out engineering theory and the site work practical.

1.2 Problem Formulation

Based on the background, this Final Project focuses on the discussion:

1. How to design a microcontroller-based river waste cleaner prototype by solar energy.
2. How to make a prototype of a microcontroller-based river waste cleaner by solar energy.
3. What are the advantages and disadvantages of the device made as the form of a service to the midst of society.

1.3 Design Objectives

The purpose of this design is that students may design an innovative device, starting from the selection of materials, making dimensions of sketches, planning a work system in order to obtain the best possible results and being able to understand whether the results of the device's work process are as planned. Thus, it is hoped that it can open up students' insight and hone their ability to understand it.

1.4 Problem Limitation

Due to the wide range of issues related to design, then the building design of the device in the planning of this final project is limited, namely not discussing if the water discharge increases, not discussing solar cells as a whole, and not discussing the microcontroller system as the controlling device. With this limitation, it is hoped that it will cover the main things regarding the building design of a garbage cleaner.

CHAPTER II

LITERATURE REVIEW

2.1 Shaft

The shaft is one of the equipment used to transmit power, this device rotates in a clockwise direction where the shaft used for this design has the same diameter. Where its function is to continue the rotation by pulling a load. From a physical point of view, the shaft is made of round steel which is rotated and pulled.

The general definition referred to as a shaft is a metal rod with a circular cross section that serves to move rotation or support a load with or without transmitting power. The shaft is held in place by two or more shaft bearings or shaft holders, and the rotating parts that support the shaft: flywheel, gear wheel, tire wheel, friction wheel, etc. The shaft also has 3 shaft functions, namely: the supporting shaft, the transmission shaft, the combined support and transmission shaft. The function of the shaft in a machine functions to transmit power together with rotation. Each rotating machine element, such as rope claws, engine belt pulleys, cable discs, cable drums, road wheels and gears, is mounted on a rotating basis over a fixed bearing shaft or fixed on a rotating support shaft. For the example is a rotating support shaft, namely the wheel shaft of cart turning faucet.

Types of Shafts Based on the Loading:

a. Transmission Shafts

The transmission shaft is better known as the shaft. Shafts will experience repeated torsional loads, alternating flexural loads or both. On the shaft, power can be transmitted through gears, belt pulleys, chain sprockets, etc.

b. Axle

The axle is a shaft that does not get a torsional load, sometimes it may not even rotate. As installed between the wheels of a freight train.

c. Spindle

The spindle shaft is a relatively short transmission shaft, for example on the main shaft of a machine device where the main load is a torsion load. In addition to torsional loads, the spindle shaft also receives axial loads. The spindle shaft can be used effectively if the deformation that occurs in the shaft is small.

2.1.1 Important Matters in Shaft Planning

To plan a shaft, the following points need to be considered:

a. Shaft Strength

A transmission shaft can experience torsional or axial loads or a combination of torsion and axial as described above. There are also shafts that are subjected to tensile or compressive loads such as propeller shafts or turbines, and others.

Fatigue, impact or stress concentration effects when the diameter of the shaft is reduced (stepped shafts) or when the shaft has keyways, must be observed.

A shaft must be designed to be strong enough to withstand the above loads.

b. Shaft stiffness

Even if a shaft has sufficient strength, too much bending or torsional deflection will result in inaccuracy (in tools machine) or vibration and sound (for example in turbines and gearboxes).

Therefore, in addition to the strength of the shaft, its stiffness must also be considered and adjusted to the type of machine that will be served by the shaft.

c. Critical Rotation

When the engine speed is increased, at a certain rate of rotation it can become an extraordinary vibration. This cycle is called the critical cycle. This can happen to turbines, piston motors, electric motors, etc., and can result in damage to the shaft and other parts. If possible, the shaft should be designed accordingly so that its working speed is lower than its critical rotation.

d. Corrosion

Corrosion-resistant materials (including plastics) should be selected for the propeller shaft and pump when in contact with a corrosive fluid. The same applies

to shafts that are threatened with cavitation, and engine shafts that often stop for a long time. To a certain extent, protection against corrosion can also be carried out.

e. Shaft Material

Shafts for general machinery are usually made from cold drawn and defined bar steel, machine construction carbon steel produced from “killed” ingots. However, this material alignment is a bit inaccurate and can be deformed due to residual stresses in the terrace. But cold pulling makes the shaft surface getting hard and the strength increases. The prices listed in the table are obtained from experimental rods with a diameter of 25 mm. In this regard it must be keep in minds that for shafts whose diameter is much larger than 25 mm, these prices will be lower than those in the table due to the influence of mass.

Shafts used to transmit high rotational and heavy loads are generally made of skin-hardened alloy steel which is highly resistant againts wear off. Some of them are nickel chrome steel, molybdenum nickel chrome steel, chrome steel, molybdenum chrome steel, and others. (G4102, G4103, G4104, G4105 in Table 1.2). However, the use of special alloy steel is not always recommended if the reason is only high rotation and heavy load. In such cases it is necessary to consider the use of carbon steel which is properly heat treated to obtain the required strength (in Table 1.1). Forged steel (G3201 is forged from milled ingot and called SF material; strength guaranteed) is also frequently used. Difficult-shaped shafts such as crankshafts, nodular cast iron or other cores have been widely used.

Table 1.1 Carbon steel for machine construction and cold-finished bar steel for shafts (Sularso, 1983)

Standards and Types	Symbol	Heat Treatment	Tensile strength (kg/mm^2)	Remarks
Carbon steel for construction machine (JIS G 4501)	S30C	Normalization	48	
	S35C	"	52	
	S40C	"	55	
	S45C	"	58	
	S50C	"	62	
	S55C	"	66	
Cold finished steel bar	S35C-D	-	53	Cold drawn, grinded, milled or combination of those things
	S45C-D	-	60	
	S55C-D	-	72	

Table 1.2 Alloy steels for shafts (Sularso, 1983)

Standards and Types	Symbol	Heat Treatment	Tensile strength (kg/mm^2)
Nickel chrome steel (JIS G 4102)	SNC 2	-	85
	SNC 3	-	95
	SNC21	Skin Hardened "	80
	SNC22		100
Molybdenum nickel carbon steel (JIS G 4103)	SNCM 1	-	85
	SNCM 2	-	95
	SNCM 7	-	100
	SNCM 8	-	105 90
	SNCM22	Skin Hardened	100
	SNCM23	"	120
	SNCM25	"	
Chrome steel (JIS G 4104)	SCr 3	-	90
	SCr 4	-	95
	SCr 5	-	100 80
	SCr21	Skin Hardened "	85
	SCr22		

Molybdenum chrome steel (JIS G 4105)	SCM 2	-	85
	SCM 3	-	95
	SCM 4	-	100
	SCM 5	-	105
	SCM21	Skin Hardened	85
	SCM22	"	95
	SCM23	"	100

In general, steel is classified into soft steel, clay steel, mild steel and hard steel. Among them, clay steel and mild steel are widely chosen for shafts. The carbon content is as shown in Table 1.3.

Mild steel on the market is generally somewhat less homogeneous in the middle, so thar it cannot be recommended to be used as an important shaft. Slightly hard steel is generally in the form of killed steel as mentioned above. This type of steel when it is given properly heat treatment, it could be an excellent shaft material.

Table 1.3 Shaft materials for rail vehicles. (Sularso, 1983)

Class	Degree of C (%)
Mild steel	0.15
Clay steel	0.2-0.3
Slightly hard steel	0.3-0.5
Hard steel	0.5-0.8
Extremely hard steel	0.8-1.2

2.1.2 Shaft with Torsion Load

In the following, we will discuss the design of a shaft that receives the main load in the form of torque, such as in a motor shaft with a clutch.

If it is known that the shaft to be tensioned does not receive any other load except torque, then the diameter of the shaft can be smaller than imagined.

However, if it is estimated that there will be loading in the form of bending, pulling, or stressing. For example, if a belt, chain or gear is mounted on a motor shaft, then the possibility of additional loading needs to be taken into account in the safety factors are taken. The planning procedure is given in a flow diagram. The things that need to be considered will be described as below.

First, take a case where power P (kW) must be transmitted and shaft rotation of n_1 (rpm) is given. In this case it is necessary to check divided by the mechanical efficiency n of the transmission system to obtain the required prime mover. A large amount of power may be required at start, or a large load may continue to operate after the start. Thus, it is often necessary to correct the required average power by using a correction factor in the design.

If P is the nominal output power of the drive motor, then various factors of safety can usually be taken into account in the design, so that the first correction can be taken is small. If the correction factor is f_c (Table 1.4) then the design power Pd (kW) as a benchmark is

$$P_d = f_c P \text{ (kW)} \qquad (1.1)$$

Table 1.4 Power correction factors to be transmitted fc (Sularso, 1983)

Power to be transmitted	*f*c
Average power required	1.2-2.0
Maximum power required	0.8-1.2
Normal power	1.0-1.5

If the power is given in horsepower (PS), it must be multiplied by 0.735 to obtain the power in kW.

If the torsional moment (also known as the design moment) is T (kg.mm) then.

$$P_d = \frac{(T/1000)(2\pi n_1/60)}{102} \quad (1.2)$$

Thus,

$$T = 9{,}74 \text{ x } 10^5 \frac{P_d}{n_1} \quad (1.3)$$

If the design moment T (kg.mm) is applied to a shaft diameter d2 (mm), then the shear stress τ (kg/mm2) that occurs is:

$$\tau = \frac{T}{(\pi d_s^3/16)} = \frac{5{,}1\,T}{d_s^3} \quad (1.4)$$

The allowable shear stress τ_a (kg/mm^2) for general use in shafts can be obtained in various ways. Here τ_a is calculated on the basis of the torsional fatigue limit that the magnitude is taken about 40% of the tensile fatigue limit which is approximately 45% of the tensile strength σ_B (kg.mm^2). Thus, the torsional fatigue limit is 18% of the tensile strength σB, according to the ASME standard. For this 18%, the safety factor is taken as 1/0.18 = 5.6 this is taken for SF materials with guaranteed strength, and 6.0 for S-C materials with mass influence, and alloy steel. This factor is expressed by S*f*1.

The shaft diameter shall be selected from Table 1.5. In the place where the rolling bearing will be installed, choose a diameter larger than the appropriate

value in the table to match with the inner diameter of the bearing. From the selected bearing can be determined the required filet radius on the shaft ladder.[1]

Table 1.5 Shaft Diameter (Sularso, 1983)

4	10	*22,4	40	100	*224	400
		24		(105)	240	
	11	25	42	110	250	420
					260	440
4,5	11,2	28	45	*112	280	450
	12	30		120	300	460
		*31,5	48		*315	480
5	12,5	32	50	125	320	500
				130	340	530
		35	55			
*5,6	14	*35,5	56	140	*355	560
	(15) 16			150	360	
6	(17)	38	60	160	380	600
	18			170		
*6,3	19		63	180		630
	20			190		
	22			200		
			65	220		
7			70			
*7,1			71			
			75			
8			80			
			85			
9			90			
			95			

Description: 1. The * sign indicates that the concerned number is selected from a standard number.
2. The numbers in brackets are only used for the section where the rolling bearing will be installed.

[1] Buku Dasar Perencanaan dan Pemilihan Bahan hal. 13

2.2 Bearing

Bearing is a device where the shaft rests on its axis and rotates with the holder and the shaft. Without bearings, the friction that occurs is greater depending on the loading, support, working temperature and loading conditions as well as the rotation that occurs on the shaft. Due to friction will increase the heat on the shaft and the seat.

The type of bearing type HB6310RS can be seen in Figure 2.1.

Figure 2.1 Bearing type HB6310RS (www.melrosewheelchairs.com)

a. Bearing Scheme

A bearing has parts that are part of the whole bearing itself that can lighten the rotation of the shaft, such as faces, inner ring, outer ring, ball bearing, outer ring raceway, inner ring raceway and cage diameter. As showed in Figure 2.2

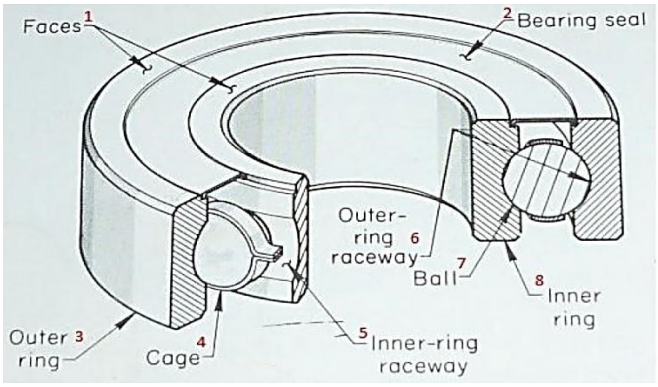


Figure 2.2 Main components of bearing
(http://developmentsciencetechnology.blogspot.com

Caption on Figure 2.2:

1. Faces
2. Bearing seal
3. Outer ring
4. Cage
5. Inner-ring raceway
6. Outer-ring raceway
7. Ball bearing
8. Inner bearing

b. Bearing Function

The function of the bearing is to hold the loaded shaft so that the rotation or back and forth movement can take place smoothly, safely and for a long time, and also the function of the bearing is also able to support a shaft so that the shaft can rotate toward its axis of rotation without experiencing excessive friction. Bearings must be strong enough to allow the shaft and other machine elements to work properly.

To support the loaded shaft, then bearings are used, so that rotation or back and forth movement can be run smoothly and durable. The position of the bearing must be strong, so that the engine elements and the shaft could work properly.

Based on the movement of the bearing toward the shaft, the bearings are divided into two things as follow:

a. Sliding bearing, where there is a sliding motion between the shaft and the bearing due to the shaft surface is supported by the bearing surface with a layer of lubricant.
b. Rolling bearings, where rolling friction occurs between rotating and stationary parts through rolling elements such as rollers or needles..

Based on the direction of the load on the shaft, the bearings are divided into the three things as follow:

a. Radial bearings, where the direction of the load supported by a bearing is perpendicular to the shaft.
b. Axial bearings, where the direction of the bearing load is parallel to the axis of the shaft.
c. Special rolling bearings, where these bearings support a load that is parallel to and perpendicular to the axis of the shaft.

The following will explain the various types of bearings above as follows:

1. Sliding Bearing

According to the shape and location of the bearing-supported shaft. One of them is a sliding bearing. As for the types of sliding bearings are:

a. Radial bearings, can be in the form of cylindrical, elliptical.

b. Axial bearing, can be in the form of a Michel collar hinge.

c. Special bearings, these bearings are more spherical in shape.

2. Axial Bearing

Axial bearings are used to resist axial forces. As for the kinds, namely palm bearing and collar bearing. In palm bearings, the pressure given by the shaft palm plane on the bearing plane is greater for a point is closer to the centre.

3. Rolling Bearing

The advantage of this bearing is having very little friction compared to sliding bearings. Types of rolling bearings include: First, single row deep groove radial ball bearings. Second, magneto radial ball bearings. Third, single row angular contract ball bearings. Fourth, double row self-established ball bearings.[2]

2.3 DC Motor

DC motor is an electromagnetic device that converts electrical energy into mechanical energy. This mechanical energy is used to, for example, rotate a pump impeller, fan or blower, to drive a compressor, to lift materials, etc. Electric motors are also used in homes (mixers, electric drills, wind fans) and in industry. Electric motors are sometimes called the "work horse" of industry because it is estimated that they use about 70% of the industry's total electrical load.

[2] eprints.undip.ac.id-41546

DC motors require a direct voltage supply to the field coil to be converted into mechanical energy. The field coil in the dc motor is called the stator (the non-rotating part) and the armature coil is called the rotor (the rotating part). If there is a rotation of the inner armature coil in a magnetic field, then there will be a voltage (GGL) that changes direction in every half turn, so it is an alternating voltage. The working principle of direct current is to reverse the voltage phase of the wave that has a positive value using a commutator, thus the current is reversed with the armature coil rotating in a magnetic field. The simplest form of motor as in Figure 2.3 has a coil of one winding that can rotate freely between the poles of a permanent magnet.[3]

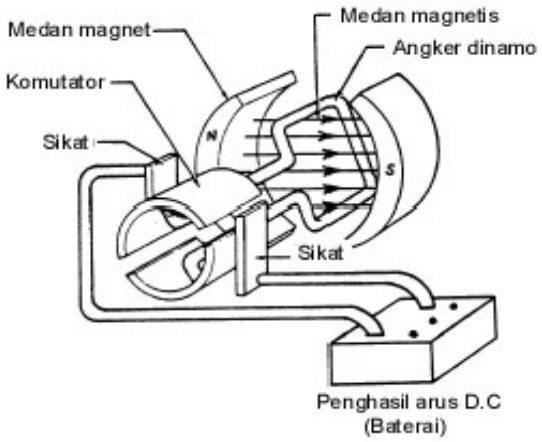


Figure 2.3 Simple DC Motor
(staff.ui.ac.id/system/files/users/chairul/makalahmotordc.doc)

The working mechanism for all types of motors in general:

[3] Mesin Arus searah: Generator dan Motor DC

- An electric current in a magnetic field will give a force.
- If the current-carrying wire is bent into a loop, then the two sides of the loop, i.e., at right angles to the magnetic field, will experience forces in opposite directions.
- The pair of forces produces torque / torque to rotate the coil.
- Motors have several loops on the dynamo to provide a more uniform rotational power and the magnetic field is generated by an electro-magnetic array called the field coil.

In dc motor, the area of the field coil which is electrified will produce a magnetic field that encircles the armature coil in a certain direction. The conversion of electrical energy into mechanical energy (motor) or vice versa takes place through a magnetic field, thus the magnetic field here in addition to function as a place to store energy, as well as a place for the energy change process takes place, the area can be seen in Figure 2.4 below.

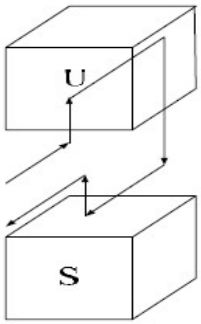


Figure 2.4 DC Motor's Working Principle

In order the process of changing mechanical energy can take place perfectly, then the source voltage must be greater than the motion stress caused by the opposing reaction. By providing current to the armature coil which is

protected by the field, it causes rotation of the motor. In understanding a motor, it is important to understand what is meant by motor load. Load in this case refers to the rotation power output / torque according to the required speed. Loads can generally be categorized into three groups:

- A constant torque load is a load where the demand for energy output varies with the operating speed but the torque doesn't. Examples of loads with constant torque are conveyors, rotary kilns, and constant displacement pumps.
- A load with variable torque is a load with a torque that varies with operating speed. Examples of loads with variable torque are centrifugal pumps and fans (torque varies as the square of speed).

Electrical Energy Equipment: Electric Motors.

- A constant energy load is a load whose torque demand changes and inversely proportional to speed. An example of a constant power load is machine devices.

Motor Rotation's Direction Principle

To determine the direction of motor rotation, the left-hand Flaming method is used. The magnetic poles will produce a magnetic field with a direction from the north pole to the south pole. If a magnetic field cuts a conducting wire electrified by direct current with four fingers, there will be motion in the direction of the thumb. This force is called the Lorentz force, which is equal to F.

The motor principle: the flow of current in a conductor under the influence of a magnetic field will produce motion. The magnitude of the force on the conductor will increase if the current through the conductor increases.

DC motor construction has 2 basic parts, namely:

1. A fixed / stationary part called the stator. This stator produces a magnetic field, either generated from a coil (electromagnetic) or a permanent magnet.
2. The rotating part is called the rotor. This rotor is in the form of a coil where an electric current flows. The electromagnetic force in a DC motor arises when there is a current flowing in a conductor located in the magnetic field. The magnetic field itself is created by permanent magnets. Magnetic force lines flow between the two magnetic poles from the north pole to the south pole. According to Lourentz's force law, the current flowing in a conductor located in the magnetic field will cause a force. The force F, arises depending on the direction of the current I, and the direction of the magnetic field B.

2.4 Belt Conveyors

Conveyor – is a mechanical system that has the function of moving goods from one place to another. The usage is widely used in industry for the transportation of very large and sustainable goods. Under certain conditions, conveyors are widely used because they have economic value compared to heavy transportation such as trucks and transport cars. Conveyors can mobilize goods in large quantities and continuously from one place to another. The relocation must have a fixed location in order the conveyor system has economic value. The weakness of this system is having no flexibility when the location of the goods being mobilized, thus it is no longer fixed and the number of incoming goods is discontinued.

Conveyors have various types that are adapted to the characteristics of the goods being transported. The types of conveyors include Apron, Flight, Pivot, Overhead, Load propelling, Car, Bucket, Screw, Roller, Vibrating, Pneumatic, and Hydraulic.

The function of the belt conveyor is to transport in the form of units or bulk with a sufficiently large capacity, and according to the name, the media used is in the form of tires. The construction of the conveyor belt is:

a. Horizontal conveying direction construction

b. Diagonal or inclined conveying direction construction

c. Horizontal and diagonal conveying direction construction

The characteristics and performance of the conveyor belt are:

a. Can operate horizontally or tilted with maximum angle up to 18^{o}.

b. The belt is supported by roller plates to carry the material.

c. High capacity

d. Multipurpose

e. Can operate continuously

f. Adjustable capacity

g. Its speed up to 600 ft/m

h. up and down

i. Easy maintenance

The disadvantages of conveyor belts include:

a. Certain distance

b. Relatively expensive cost

c. Limited inclination angle

A. Belt Conveyor Parts

If the belt is long, it is necessary to use a training roller, if the belt is short without a training roller, it is not a problem. In training rollers, circuit breakers are often installed, to maintain when the belt receives maximum load, then the belt will touch the training and resulting the current to be cut off.

a. Feed hopper serves to keep the material can be limited to exceed the capacity at the inlet time.
b. The outlet chuter is used for material dispensing.
c. Idle drum functions to follow the rotation of other drums.
d. The take up functions to adjust the tire tension so that it is always attached to the drum, because the longer the tire used, the longer the tire will be, if the tension is not adjusted, the tire will become loose.
e. Belt cleaner functions to clean the belt so that the belt is always in clean condition.
f. The front scrapper functions to prevent material from entering the idle drum with the belt.

Impact roller (main supporting roller), serves to prevent the belt from being hit by a load, for example, a hard load, then the front is generally often given a sprocket of rubber so that the belt can last for a long time.

Number of main supporting roll:

1. Single roll, serves to transport material in the form of units.
2. Double roll, serves in order the transportation reaches the maximum load and the material does not spill.
   a. For the size of the belt width is quite small.
   b. For the size of the belt width is quite wide.

The smaller the width of the belt, the stiffer it is, because the thickness of the belt is larger. If wider the belt width, then the weaker it is, so that 5 rolls are often used, in order the curvature of the roll is suitable with the situation.

For diving units, drums are often coated by:

a. With rubber material that may cause friction rate is large.
b. With grooves or trenches, its function is to remove air trapped in the drum, if there is air in the drum, then the coefficient of friction is low and may cause slippage.

The idle drum construction is cylindrical, often uncoated, for high speed of convex-shaped power. The shape of the drum is made not in full, due to reduce the material sticked to the drum, so that the drum does not change its shape and has a larger diameter.

Take Up, serves to tighten the belt so it doesn't loosen. There are various forms of take-up, for example:

a. Screw take-up, this take up is still using a manual system, when the belt is loose then manually tightened it. This take up only applies to short belt range distances, that is between 5 meters to 10 meters.

b. Gravity take-up, this take up is moved automatically, and its range distance is medium.

c. Counter weighted vertical gravity take-up, take up that moves automatically.

B. Belt Conveyor's benefits

The conveyor consists of standard parts with advanced technology, simple and easy to maintain. The SBM Vibration Machine can be used in both fixed and mobile crushing plants. This machine is widely used in mining, metallurgy and coal industries, transferring sand, bulk materials or packaged materials. Based on the differences in the goods to be transferred, the transfer system can be stand-alone or multi-conveyor or combined with other transfer devices. Belt conveyors can be installed horizontally or studded to meet different transfer requirements.[4]

2.5 Motor Power Window

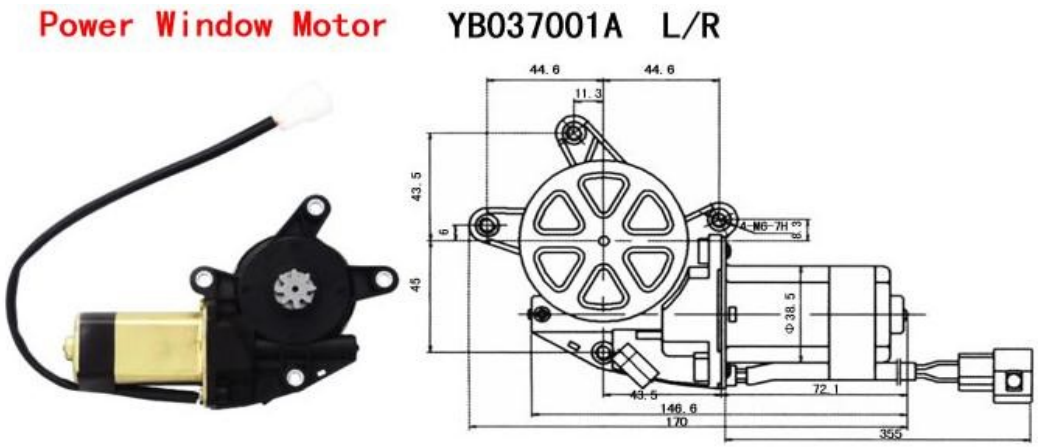
The regulator driving motor rotates clockwise or the opposite direction moves the regulator to be converted into a back-and-forth motion. The type of motor used in the power window system is a DC motor. Electric motors use electrical energy and magnetic energy to produce mechanical energy. The operation of the motor depends on the interaction of two magnetic fields. It is simply said that electric motors work on the principle that two magnetic fields can be interacted to produce motion. The purpose of the motor is to produce a driving force (torque). Basically, some applications that use DC motors must be able to adjust the speed and direction of rotation of the DC motor itself. In order to be

[4] Conveyor Belt technique design and calculation, 1994

able to adjust the speed of a DC motor, you can use the PWM (Pulse Width Modulation) method, while to adjust the direction of rotation you can use an H-bridge circuit consisting of 4 transistors. But the market has provided IC L293D as a DC motor driver that can adjust the direction of rotation and provided a pin for input from PWM to regulate the speed of the DC motor. To understand more about generating a PWM signal using the Timer feature on the AVR microcontroller, you can read about it in the AVR tutorial post about PWM. Before discussing the L293D IC, it would be nice if we firstly discussed the DC motor driver using an analogue circuit.

If you want a DC motor that can be adjusted in speed without being able to adjust the direction of rotation, then we can use a transistor as a driver. To adjust the rotational speed of the DC motor, PWM used, which is generated through the timer feature on the microcontroller. Most of the power supply for DC motors is 12 V, while the PWM output from the microcontroller is a maximum of 5 V.

Therefore, transistors are used as voltage amplifiers. Below is a picture of a DC motor driver using a transistor. One type of motor that is often used in the control field is a DC motor. The DC motor will rotate if it is electrified by DC voltage and current. The following Figure 2.5 is a DC motor and an H bridge used in the design of this device:



SPECIFICATION

Voltage Rating (V)	No Load		Load Rating			Locked Torque (Kgf.cm)	Locked Current (A)
	Speed (r.p.m)	Current (A)	Torque (Kgf.cm)	Speed (r.p.m)	Current (A)		
12	85±25	≤3	30	70±20	≤7	85±25	≤20

Figure 2.5 Motor Power Window
(http://topreviews-michalehoopes.blogspot.co.id)

The DC motor control system that is often used in control systems as shown in the figure is the H-Bridge which basically consisted of 4 transistors that function as a switch. DC motor settings include speed and direction. The direction setting is by reversing the H-bridge input logic voltage. While the DC motor speed control system uses the PWM (Pulse Width Modulator) principle, which is a method of regulating the rotational speed of a DC motor by adjusting the duration of the active switching time (Duty Cycle). DC motor is a component that requires a large enough current to drive it. Therefore, DC motors usually have their own drive. In this final project, the DC motor will be driven using PWM which has been integrated with the H-Bridge circuit. With the H-Bridge circuit owns this PWM input, then in addition to the direction, we can also control the rotational speed of the DC motor.

2.6 Distance

Distance is a number that shows how far an object changes position through a certain path. In the field of mathematics, distance must meet certain criteria. Unlike position coordinates, distance cannot be negative. Distance is a scalar quantity, while displacement is a vector quantity. The distance travelled by the object must be distinguished with the distance from one point to another.

2.7 Torque

Any moment vector that coincides with the axis of a machine part is called a torque vector, because this moment causes the machine part to twist on its axis. Rods that receive such moments are also called torsion bars. For analysis, the following assumptions are made:

1. The bar is loaded by pure torsion, and the section under study is sufficiently far from the point of load action and from changes in diameter.
2. Adjacent cross-sections which were originally flat and parallel, after twisting are considered to remain flat and parallel, and any radial lines are considered to remain straight.
3. Materials used, following Hooke's law.

The equation for a rod with solid circular cross section is:

$$J = \frac{\pi d^4}{32} \tag{1.5}$$

where d is the diameter of the bar. For pipe cross section.

$$J = \frac{\pi}{32}\left(d^4 - d_i^4 \right) \tag{1.6}$$

where d_1 is the inner diameter, often expressed as ID.

In using the equation, the torque T must often be calculated from the power and rotation of the moving shaft. For convenience, here are three formulas that can be used:

$$H = \frac{2\pi Tn}{(33\,000)(12)} = \frac{FV}{33\,000} = \frac{Tn}{63\,000} \quad (1.7)$$

$$T = \frac{63\,000H}{n} \quad (1.8)$$

If the unit used is SI, the formula that can be used is:

$$H = T\acute{\omega} \quad (1.9)$$

where H = power

T = torque, N.m

ώ = angular velocity, rad/s

2.8 Velocity (V)

In physics, the term rate / velocity expresses how far an object moves during a certain time interval. A velocity is a derived quantity that does not depend on direction, so velocity includes scalar.

a. Average speed

The average speed of a moving object is defined as the displacement travelled by the object divided by the time travelled.

$$\text{Velocity} = \frac{Distance}{Time\ Travelled} \quad (1.10)$$

or

$$V = \frac{S}{t} \tag{1.11}$$

b. Instantaneous Velocity

Instantaneous velocity is the average velocity over a very small-time interval. Mathematically, the instantaneous velocity is the ratio of displacement to the time interval, if the time interval approaches zero. Mathematically, the instantaneous velocity is the limit of the displacement ratio with the time interval if the time interval approaches zero.

$$\upsilon = \frac{\Delta x}{\Delta t} \tag{1.12}$$

This limit is called the derivative of x with respect to t, which under calculus conditions (differential/integral) is written *dx/dt*.

c. Average Acceleration

Average acceleration is defined as the ratio of the change in velocity with the interval time needed for the change. It is mathematically written:

$$\bar{a} = \frac{V_2 - V_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t} \tag{1.13}$$

The acceleration is a vector quantity, but for one-dimensional motion is only necessary to use the (+) and (-) signs to indicate the direction of the coordinate system used.

d. Instantaneous Acceleration

Instantaneous acceleration is the limit of the ratio for the change in velocity to the time interval of the change, with the time interval approaching

zero. If a velocity-time graph is drawn, the instantaneous velocity at t is defined as the slope of the line tangent to the current curve.

Acceleration is the derivative of velocity with respect to time, and is usually written with the notation *dx/dt*. Since velocity is the derivative of position with respect to t, then acceleration is the second derivative of x with respect to t, mathematically.

An object is said to be moving in a straight line if its velocity is constant. Constant velocity means the magnitude of the speed or velocity and the direction of the speed is always constant. Because the magnitude of the velocity/speed and the direction of the velocity are always constant, it can be said that the object is moving in a straight line at a constant speed.

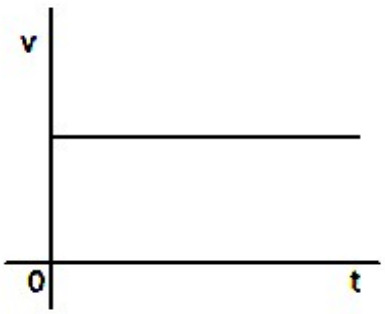


Figure 2.6 Velocity - Time
(http://kinematics.weebly.com/motion-straight-change-regular.html)

Based on the graph above, it appears that the magnitude of the velocity is constant in each unit of time. The graph of velocity to time can be seen from Figure 2.6 above. The magnitude of the constant velocity is indicated by a straight line, starting from t = 0 to the t end.

2.9 Light Sensor

a. LDR (Light Dependent Resistor)

LDR is a form of component that has a change in resistance whose magnitude depends on the light. Light Dependent Resistors utilize semiconductor materials whose electrical characteristics vary according to the received light. The materials used are Cadmium Sulphide (CdS) and Cadmium Selenide (CdSe). These materials are very sensitive to light in the visible spectrum, with peaks around 0.6 m for CdS and 0.75 m for CdSe. A typical CdS LDR has a resistance around 1MΩ in complete darkness and less than 1KΩ when placed under a bright light source. The symbol of the Light Dependent Resistor can be seen as shown in Figure 2.7 below:

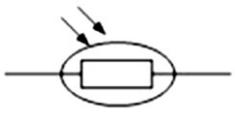


Figure 2.7 LDR symbol (https://depokinstruments.com)

The characteristics of LDR consist of two kinds, namely Recovery Rate and Spectral Response:

- Recovery Rate

When an LDR is brought from a room with a certain level of light strength into a dark room, then the resistance value of the LDR will not immediately change its resistance in the dark room. However, the LDR will only be able to reach the price in the dark after a certain time interval. Recovery rate is a practical measure

and having an increase in resistance value within certain time. This price is written in K/second, for current-type LDR, its price is greater than 200 K/second (during the first 20 minutes starting from a light level of 100 lux), the speed will be higher than the opposite direction, i.e., moving from a dark place to a bright place which takes less than 10 ms to reach a resistance corresponding to a light level of 400 lux.

- Spectral Response

LDR does not have the same sensitivity for every wavelength of light that falls on it (i.e., colour). Materials commonly used as conductors of electric current are copper, aluminium, steel, gold, silver. Of the five materials, copper is the most widely used because it has good conductivity.

b. Photodiode

Photodiode is a type of diode that serves to detect light. Unlike ordinary diodes, these electronic components will convert light into electric current. The light that can be detected by this diode ranges from infrared, ultraviolet light, up to X-rays. Photodiodes are made of semiconductors with popular materials are silicon (Si) or gallium arsenide (GaAs), and others include InSb, InAs., PbSe. These materials absorb light with characteristic wavelengths including: 2500 – 11000 for silicon, 8000 - 20000 for GaAs. When a photon (a unit of energy in light) from a light source is absorbed, it raises an electron and produces a single

pair of charge carriers of an electron and a hole, where a hole is part of the lattice of the semiconductor that loses electrons. The direction of current through a semiconductor is the opposite of the motion of the carrier's charge. This method in a photodiode is used to collect photons - causes charge carriers (such as current or voltage) to flow/to be formed at the electrode parts. The shape of the Photodiode as shown in Figure 2.8 below:

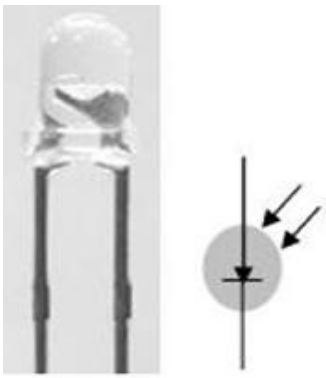


Figure 2.8 Photodiode (https://zefrone.blogspot.co.id)

c. Phototransistor

Phototransistor is a transistor when exposed to light will flow electrons so that there will be a current strengthening of the transistor. The shape of the Phototransistor is shown in Figure 2.9 below.

Figure 2.9 Phototransistor (http://igelectronics.com)

d. Optocoupler

An optocoupler is a type of component that uses light as a trigger on/off. Opto means optic and coupler means trigger. So that it can be interpreted that the optocoupler is a component that works based on the optical light trigger. The opto-coupler included in the sensor, which consists of two parts, namely the transmitter and receiver. Shape of the optocoupler as shown in Figure 2.10 below.

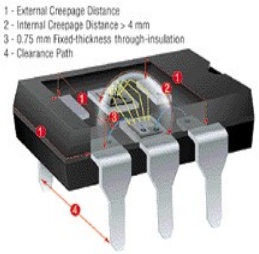


Figure 2.10 Optocoupler (http://www.electronicproducts.com)

The transmitter is built from an infrared led to get better resistance than using ordinary LEDs. This sensor can also be used as an insulator from a low voltage circuit to a high voltage circuit. In addition, it can also be used as a detector for the presence of a transmitter and receiver's barrier by providing a test space in the middle between the LED and the phototransistor. This use can be applied to detect motor rotation or detect diskette marking holes on computer disk drives.

2.10 ATMega 8

Here we focus on the discussion of the function of pins, clocks, fuse bits, etc. A little about the discussion that the ATmega8 microcontroller is an 8-bit AVR family of microcontrollers. Several types of microcontrollers have "families" with these ATmega8, including ATmega8535, ATmega16, ATmega32, ATmega328, and others. What makes the difference between the microcontrollers I mentioned earlier are the memory size, the amount of GPIOs (input/output pins), peripherals (USART, timers, counters, and so on). The shape of the ATMega8 microcontroller is shown in Figure 2.11 below.

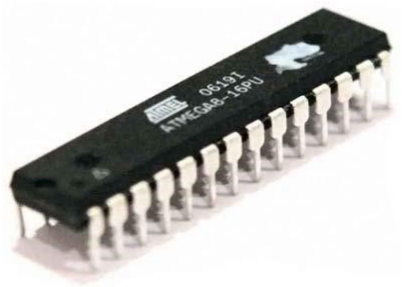


Figure 2.11 ATMega8
(https://www.elprocus.com/avr-atmega8-microcontroller-architectureapplications/)

In terms of physical size, ATmega8 has a smaller physical size compared to some of the microcontrollers mentioned above. However, in terms of memory and other peripherals, the ATmega8 is not inferior to the others because the size of the memory and peripherals is relatively similar with the ATmega8535, ATmega32, etc., it's just that the amount of GPIOs is less than the microcontroller I mentioned above. For further understanding I will discuss below:

a. Pin Functions and Requirements

The pinout microcontroller ATmega8 IC with the DIP package can be seen in Figure 2.12.

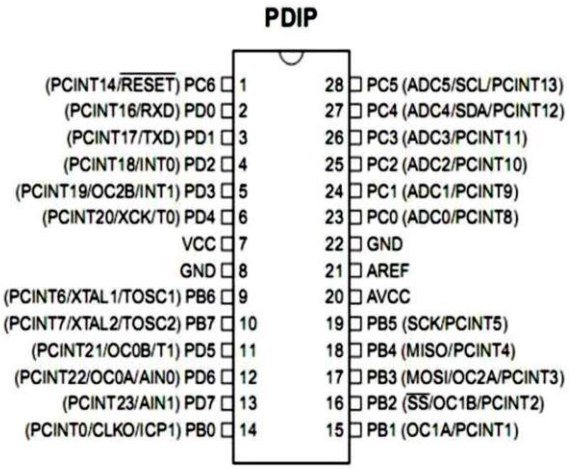


Figure 2.12 Atmega8's Pin Configuration
(http://www.circuitstoday.com/avr-atmega8)

ATmega8 has 28 pins, each of which has a different function as a port or other functions. The following will explain the function of each leg of ATmega8.

• VCC

It is a digital voltage supply.

• GND

It is ground for all components that require grounding.

• Port B (PB7...PB0)

In the Port B there are XTAL1, XTAL2, TOSC1, TOSC2. The number of Port B is 8 pins, starting from pin B.0 to B.7. Each pin can be used as input or output. Port B is an 8-bit bi-directional I/O with an internal pull-up resistor. As input, the pins on port B are externally lowered, it will bring out current if the pull-up resistor is activated. Specifically, the PB6 can be used as a Crystal input (inverting

oscillator amplifier) and an input to the internal clock circuit, depending on the Fuse bit setting used to select the clock source. Meanwhile, PB7 can be used as a Crystal output (oscillator amplifier output) depending on the Fuse bit setting used to select the clock source. If the clock source is selected from the internal oscillator, PB7 and PB6 can be used as I/O or if using Asynchronous Timer/Counter2 then PB6 and PB7 (TOSC2 and TOSC1) are used for the timer input line, (Richard Barnelt, et al," Embedded C Programming and The Atmel AVR).

• Port C (PC5…PC0)

Port C is a 7-bit bi-directional I/O port with a pull-up resistor located inside each pin. The number of pins is only 7, starting from pin C.0 to pin C 6. As an output, port C has the same characteristics in terms of absorbing current (sink) or bringing out current (source).

• RESET/PC6

If the RSTDISBL Fuse is programmed, then PC6 will function as an I/O pin. This pin has different characteristics from the pins found in other C ports. However, if the RSTDISBL Fuse is not programmed, then this pin will function as a reset input. And if the voltage level entering this pin is low and the pulse is shorter than the minimum pulse, it will result in a reset condition even though the clock is not working.

• Port D (PD7…PD0)

Port D is an 8-bit bi-directional I/O with an internal pull-up resistor. The function of this port is similar with the other ports. It's just that on this port there are no

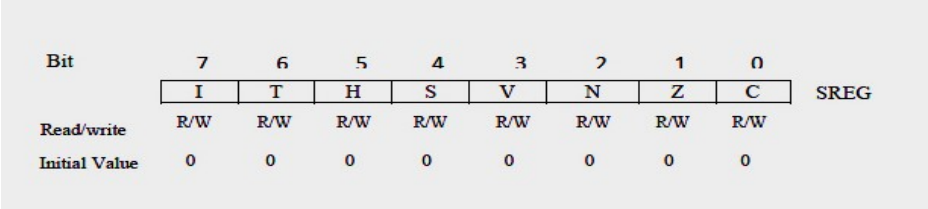
other uses. This port only functions as input and output or commonly referred to as I/O.

• AVcc

This pin serves as a voltage supply for the ADC. For this pin must be connected separately with VCC because this pin is used for analogue only. Even if the ADC on the AVR is not being used, it is still advisable to connect it separately from the VCC. If ADC is used, then AVcc must be connected to VCC through a low pass filter.

• AREF

It is the reference pin if using the ADC. In the AVR, the status register contains some information about the result of the execution of the arithmetic instruction. This information is used for altering the program flow with aims of improving operating performance. This register is updated after the ALU (Arithmetic Logic Unit) operation, it is as written in the datasheet, especially in the Instruction Set Reference section. In some cases, this can eliminate the requirement use for dedicated comparison instructions and can result in improvements in speed and simpler and shorter code. This register is not automatically saved when entering an interrupt routine and also when executing a command after returning from an interrupt. However, this must be done through software. Here is Figure 2.13 status register.



Bit	7	6	5	4	3	2	1	0	
	I	T	H	S	V	N	Z	C	SREG
Read/write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Figure 2.13 ATmega8 Register Status (https://www.elprocus.com)

• Bit 7(I)

It is the Global Interrupt Enable bit. This bit must be set for all interrupt commands to be executed. For individual interrupt commands will be explained in another section. If this bit is reset, then all interrupt commands, both individual and general, will be ignored. This bit will be cleared the hardware after an interrupt is executed and will be reset by the RETI command. This bit can also be set and reset via SEI and CLL's applications and instructions.

• Bit 6(T)

It is Copy Storage bits. The bit instructions of Copy Instructions BLD (Bit Load) and BST (BitStore) use this bit as the origin or destination for the bit that has been operated on. A bit from a register in the Register File can be copied into this bit using the BST instruction, and a bit in this bit can be copied into a bit in the register of the Register File using the BLD command.

• Bit 5(H)

It is the Half Carry Flag bit. This bit indicates a Half Carry in some arithmetic operations. This bit works in BCD arithmetic.

• Bit 4(S)

It is sign bit. This bit is always an exclusive among Negative Flag (N) and two's Complement Overflow Flag (V).

• Bits 3(V)

It is the bit of Two's Complement Overflow Flag. This bit provides a two's complement arithmetic function.

• Bit 2(N)

It is the Negative Flag bit. This bit indicates a negative result in a logical or arithmetic function.

• Bit 1(Z)

It is the Zero Flag bit. This bit indicates a zero result “0” in an arithmetic or logical function.

• Bit 0(C)

It is the Carry Flag bit. This bit indicates a carry or remainder in arithmetic or logic.

b. ATMega AVR Memory

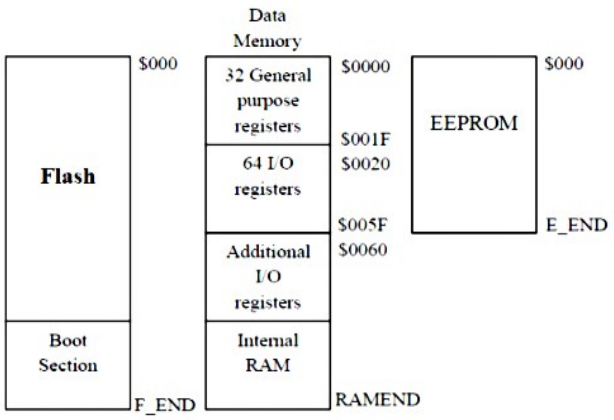


Figure 2.14 Atmega Memory Map
(http://www.robotics-university.com)

In Figure 2.14 above, the ATMega Memory is divided into three, namely:

1. Flash Memory

Flash memory is ROM memory where program codes are located. The word flash here indicates the type of ROM that can be written and erased electrically.

Flash memory is divided into two parts, namely the application and the boot sections. The application section is the application program code section exists. The boot section is a section used specifically for initial booting that can be programmed to write application sections without going through a programmer/downloader, for example through USART.

2. Data Memory

Data memory is RAM memory used for program purposes. The data memory is divided into four parts, namely: 32 GPR (General Purpose Register) is a special register is tasked to assist program execution by the ALU (Arithmetic Logic Unit), in assembler instructions, each instruction must involve GPR. In C language it is usually used for global variables or function return values and values that can ease the ALU works. In terms of everyday computer processors, GPR is known as "cache memory".

I/O registers and Additional I/O registers are registers that are specifically used to control various peripherals in the microcontroller such as port pins, timers/counters, usart and others. This register is in the MCS51's microcontroller family known as SFR (Special Function Register).

3. EEPROM

EEPROM is a data memory that can settle when the chip is off (off), used for data storage purposes that are resistant to single power interference.

c. Timer/Counter 0

Timer/counter 0 is a timer/counter that can count pulse/clock sources either from inside the chip (timer) or from outside the chip (counter) with a capacity of 8-bit or 256 counts.

Timers/counters can be used to:

1. Regular timer/counter
2. Clear Timer on Compare Match (other than Atmega 8)
3. Frequency generator (other than Atmega 8)
4. External pulse counter

d. Serial Communication on Atmega 8

The AVR Atmega 8 microcontroller has a USART port on Pin 2 and Pin 3 to communicate data between the microcontroller and the microcontroller or the microcontroller with a computer. USART can function as synchronous and asynchronous data transmission. Synchronous means that the clock used between the transmitter and receiver is one clock source. While asynchronous means that the transmitter and receiver have their own clock sources. USART consists of three blocks, namely the clock generator, transmitter, and receiver, (Sumardi ,Belajar AVR Mulai dari Nol, 2013).

2.11 Capacitor

According to Istiyanto (2013: 22), the shadows of two conductors are haphazardly shaped and neutral. The connection of the two conductors with a battery so that a potential difference ΔV arises between them and the charge on each conductor +Q and -Q why the charges on the two conductors must be equal in magnitude, but opposite in sign? The arrangement of these two conductors is called a capacitor.

Capacitors are different from accumulators in storing electric charge, especially there is no chemical change in the capacitor material, the amount of capacitance of a capacitor is expressed in farads. Another definition of a capacitor is an electronic component that can store and release an electric charge. The structure of a capacitor is made of 2 metal plates separated by a dielectric material. Dielectric materials are commonly known such as vacuum air, ceramics, glass, electrolytes and others. If both ends of the metal plate are given an electric voltage, then positive charges will collect on one of the metal legs (electrodes) and at the same time negative charges will collect on the other metal end. Positive charges cannot flow towards the negative end of the pole and conversely negative charges cannot flow towards the positive end of the pole, because they are separated by a non-conductive dielectric material. This electric charge is "stored" as long as there is no conduction at the ends of the legs. The ability to store electric charge in a capacitor is called capacitance or capacity.

Capacitance is defined as the ability of a capacitor to accommodate electron charges. Coulombs in the 18^{th} century calculated that 1 coulomb = 6.25 x

1018 electrons. Then Michael Faraday postulated that a capacitor will have a capacitance of 1 farad if with a voltage of 1 volt can carry a charge of 1 coulomb of electrons. It can be written by the formula:

Q = CV (1.14)

Where: Q = electron charge in C (coulombs)

C = capacitance value in F (farads)

V = the magnitude of the voltage in V (volts).

Capacitor Forming Principle:

- If two or more plates are facing each other and are limited by insulation, then the plate is electrified, a capacitor will be formed (the insulation which is the boundary between the two plates is called a dielectric).
- The dielectric material used is different, so the naming of the capacitor is based on the dielectric material. The plate area of the opposite dielectric material and the distance between the two plates affect the capacitance value.
- In a circuit where there is no stray capacitor. Such property is called parasitic capacitance. The cause is the presence of adjacent components in adjacent electrical conductor lines and adjacent coils of wire.

Capacitance Quantity

The capacity of a capacitor is the ratio of the amount of electric charge to the capacitor voltage.

C=Q/V (1.15)

If calculated by the formula C = 0.0885 D/d.

Then the capacity is in pico farads, D = the plates area of the mutual facing and mutual affecting in cm^2, d = the distance between the plates in cm. If the voltage between the plates is 1 volt and the magnitude of the electric charge on the plates is 1 coulomb, then the ability to store electricity is called 1 farad.

Actually, capacitors are made with units below 1 farad. Most electrolytic capacitors are manufactured from 1 microfarad to several millifarads.

The types of capacitors according to the material and construction:

Capacitors, like resistors, have capacitance values that are fixed and some are variable. Air dielectric capacitors, their capacitance changes from the maximum to the minimum value. We often encounter variable capacitors in radio receiver circuits in the tuning and oscillator sections. In order to change the capacitance in the two parts simultaneously, a double variable capacitor is used. Dual variable capacitors are two variable capacitors with one dial.

Based on the dielectric, capacitors are divided into several types, including:

• ceramic capacitors

• film capacitor

• electrolytic capacitor

• tantalum capacitors

• paper capacitor

Based on the polarity of the poles on the capacitor electrodes can be divided into 2 types namely:

- Non-Polar Capacitors, capacitors that do not have polarity on both electrodes and do not need to be distinguished their electrode legs in the installation of the electronic circuits.
- Bi-Polar Capacitors, namely capacitors that have positive and negative polarities on the electrodes, so it is necessary to pay attention the installation of the electronic circuit and may not be reversed.

Electrolytic capacitors and tantalum capacitors are capacitors having poles, often referred to as polar capacitors. Film capacitors consist of several types, namely polyester film, poly propylene film or polysterene film.

2.12 Resistor

According to Surya (2010: 24), resistors are basic electronic components used to limit the amount of current flowing in a circuit.

The function of the resistor can be assumed to a piece of board that used to block the flow of water in ditches. By using the resistance of this board, the bias current of water is blocked. We can apply this assumption in the electrical resistance. The larger the board used to block water; the less water will flow. Electric current or electric flow is expressed in amperes (A), while voltage is expressed in volts (V).

Thus, resistors function for:

- blocking partial electric current in order to comfort with the needs of an electronic circuit.
- reducing the voltage as required by the electronic circuits.

- Dividing the voltage.
- Cooperating with transistors and capacitors in a circuit to generate high and low frequencies.

The function of the resistor that blocks the electric current is possible because the resistor has the ability to inhibit the rate of electrons in electronic circuits. The resistance emerged by this resistor causing the current in the circuit to decrease. The amount or value of the electrical resistance of a resistor has been designed in advance by the manufacturer. However, the value of the existing resistance may change if the resistor is operated at an inappropriate temperature. Based on the type of resistance, resistors are divided into:

1. Fixed resistor, the resistance value is fixed:
   a. Metal wire resistors, for example resistance of metal wire rolled on the surface of a glass tube pipe.
   b. The charcoal resistors, these resistors are most widely used in a series of electronic transistors.
2. Variable resistors:

The resistance value can be changed as needed; the variable resistor is also called a potentiometer.

   a. Charcoal variable resistor which is a potentiometer, can be rotated or shifted.
   b. Metal wire variable resistor.

Based on the material of manufacture, resistors are made of materials such as:

1. Metals, such as iron, tungsten and aluminium

2. Metal alloys, for example nichrome

3. Non-metallic materials, such as carbon, metal-coated ceramics.

4. Semiconductor

Charcoal resistors are colour coded to make it easier in determining their sizes. The colour code was created by the RMA (radio manufactures association) which is an association of radio manufacturers in Europe and America. The colour code set by this RMA determines the size of the resistor (resistance). Resistors are measured in ohms, in everyday practice, electronics enthusiasts should be able to determine the size of the resistor when reading the resistor colour code. To test the truth, we can use the ohmmeter on the AVO-meter.

2.13 Solar Cells (Photovoltaic).

Solar cells or solar panels are devices to convert solar energy into electrical energy. Solar cells are usually packaged in a unit called a module. In a solar module consists of many solar cells that can be arranged in series or parallel. While what is meant by solar is a semiconductor element that can convert solar energy into electrical energy on the basis of the photovoltaic effect. Solar cells have become popular lately, apart from the depletion of fossil energy reserves and the issue of global warming. The energy produced is also very cheap because the energy source (the sun) can be obtained for free. Solar cells can be seen in Figure 2.15. Solar Cell scheme is simple, which converts sunlight into electrical energy. Where sunlight is a form of energy from natural resources, which is DC current,

enters the charger controller and is stored in the battery. And if the mechanical device used is AC, then the inverter required to convert DC into AC current.

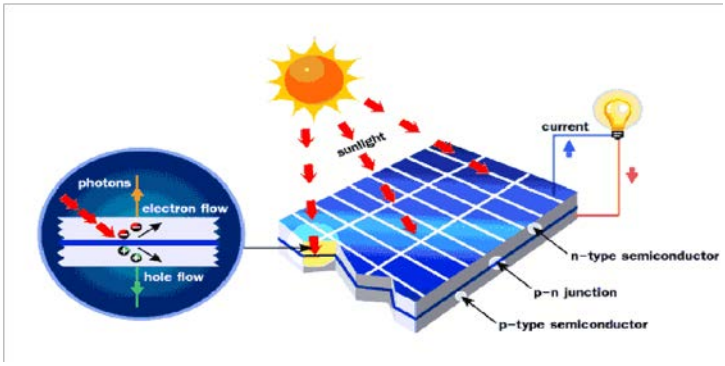


Figure 2.15 Solar Cell Schematic (https://technologysurya.wordpress.com)

CHAPTER III

DEVICE DESIGN METHOD

3.1 Time and Place

The implementation place for designing devices is carried out at the Mechanical Engineering Laboratory, Medan Area University. The implementation time for designing this device is done from October 1 to November 30, 2016. The schedule of the design process can be seen in Table 1.6 below:

Table 1.6 Schedule of the initial design process up to completion

No	ACTIVITIES	October				November			
		I	II	III	IV	I	II	III	IV
1	Design Drawings with AutoCAD								
2	Survey and Purchase of Tools and Materials								
3	Material Cutting and Printing								
4	Frame Making Process								
5	IC System Learning								
6	Solar Panel Learning								
7	Device Assembly								
8	Device Work System Testing								

9	Work System Revision								
10	Device Testing								

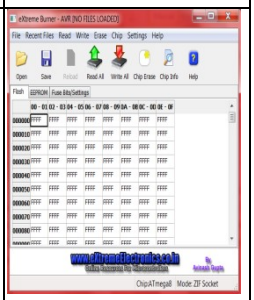
3.2 Device's Construction Design

The system design and building design is carried out by determining the general specifications of the series of tools and materials used, as well as the system block diagram of the ATmega8 microcontroller design and the power system used to operate the device.

3.3 Materials and Tools

There are several types of tools used to support the process of making this device up to completion, including:

No.	Tool's name	Specifications	Images
1.	BOSCH Drill [GBM 350]	1. Input Power = 350 watts 2. No Load Speed = 2500 rpm 3. Output Power = 150 watts 4. Cordless Weight = 1.1 kg	
2.	Lakoni Falcon 120E 900 Watt's Welding machine	1. Electrical Power = 900 watts 2. Output Current = 10 – 120 Ampere 3. Welding Wire Diameter = 2.0 – 4 mm 4. Socket Size = 25mm 5. Cooling Dimensions= 270 x 200 x 110mm 6. Duty Cycle = 60% (at 120A), 100% (at 100A)	

No.	Tool's name	Specifications	Images
3.	Maktec MT240 Cut Grinder	Electrical Power = 2000 watts No Load Speed = 3800 rpm Cut Stone Diameter = 355 mm/14" Dimensions = 500 x 280 x 620 mm	
4.	Amperemeter	1. Operating Voltage = DC 4.5 – 30V 2. Voltage Measurement = DC 0-100V 3. Minimum Resolution = 0.1V 4. Refresh Rate = ± 500ms 5. Accuracy = 1% 6. Operating Current = 20 mA 7. Working Temperature = -10 to 65 ^{0}C	
5.	Downloader	eXtreme Burner AVR is an application that can be operated on Windows and Linux based OS which has a Freeware license and can be downloaded	
6.	Toolset	1. Screwdriver 2. Pliers 3. hammer 4. Meter 5. Wrench	
7.	Laptop Lenovo	Processor = core i3 3110M 2.4 GHz Memory = 2 GB DDR3 Hard Disk = 500 GB SATA HDD Graphics = nVidia GT 610M 1GB	

No.	Tool's name	Specifications	Images
8.	Code Vision AVR	Software used to program microcontrollers is now common. CodeVision AVR has the advantage of other compilers, which is providing code wizard and with this facility makes us easier to initialize the microcontroller that we use.	

Several types of materials are used to support the process of making this device up to its completion, including:

No.	Tool's name	Specifications	Images
9.	Iron elbow	Dimensions = 25 x 25 mm Thickness = 3 mm Length = 6 mm Weight = 6.72 Kg	
10.	*Acrylic*	50% lighter than glass 17x more impact resistant than glass Does not react to sunlight Resistant to the weather outside the area 100% will be recycled Resistant to chemical reactions compared to most other plastic materials Environmentally friendly & non-toxic Easy to clean & maintain	

No.	Tool's name	Specifications	Images
11.	Shaft	Shaft material = S45C	
12.	*Pulley*	1. Diameter As = 1 inch 2. Pulley Outside Diameter = 4 inches 3. Aluminium Material	
13.	*Bearing*	1. Material: Steel, Metal 2. Outer Diameter:26mm 3. Inner Diameter:10mm 4. Thickness:8mm 5. Type: 6000-2Z 6. Pre-lubricated	
14.	*Fan Belt*	1. Premium Quality 2. V-belt thickness: 6 mm. 3. Width of the outer V-belt = 10mm. 4. Inner V-belt width = 6mm. 5. The circumference of the outer circle of the V-belt is 120.1 cm. 5. The circumference of the inner circle of the V-belt is 115.7 cm.	
15.	Power Window	1. Voltage = 12 V 2. Speed No Load = 85 + 25 rpm 3. Current = ≤ 20 4. Torque = 30 kg.cm	

No.	Tool's name	Specifications	Images
16.	Solar Cell	1. Type = Polycrystalline 2. This type has advantages for areas are often cloudy. 3. The voltage of ± 0 volts - 19 volts are used by the controller in order can be used. 4. Dimensions: 35cm x 49cm x 2.5cm 5. Brand: Series	

3.4 Work Procedure

A. Image Reading

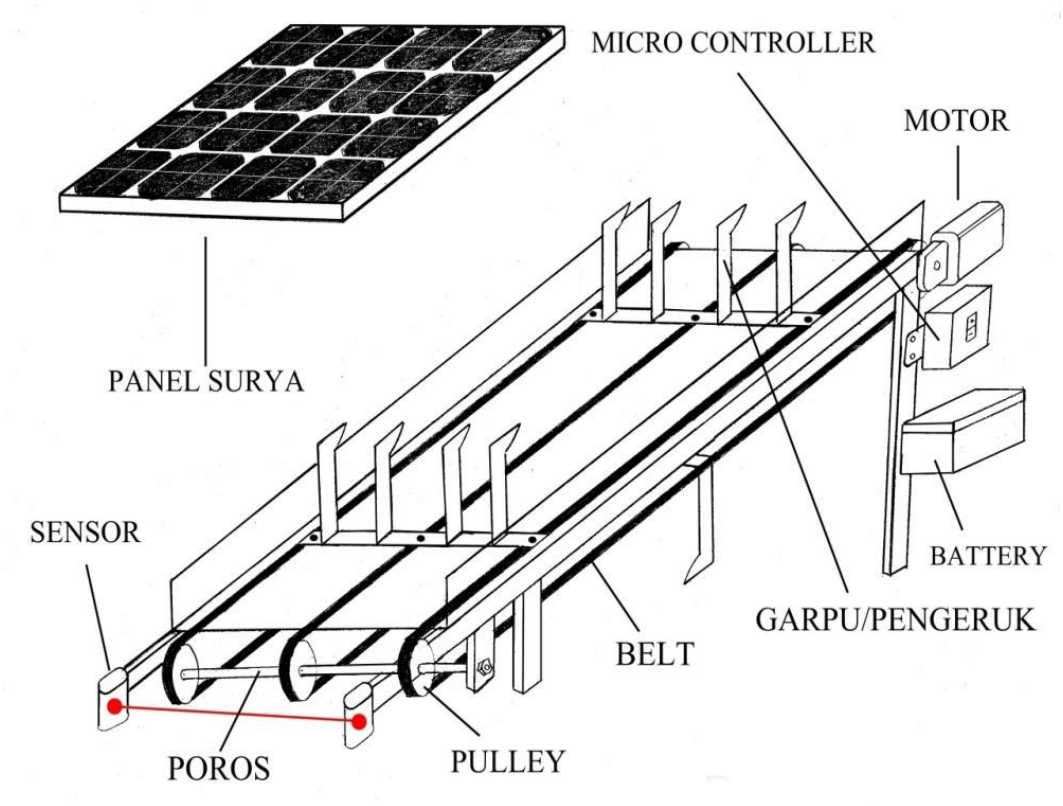


Figure 3.1 Set Up for the Garbage Cleaning Device Model

Before designing a garbage cleaning device, the first step that must be considered is to understand in advance the scheme of the design drawing and also the size specifications by reading the image that can be seen in Figure 3.1. In order when started to work, it might reduce the risk of errors that occur. So that it can also simplify the assembly process.

B. Controller Installation

Figure 3.2 Cyber Board for Microcontroller

Microcontroller that is installed using acrylic material as the controller protection from splashing water, can be seen in Figure 3.2 above. This is made due to an electrical circuit exist on the microcontroller, the circuit is composed of various components and cables. As we known that water can conduct electric

current, where water has polarized particles into positive ions and negative ions which are conductive. So that if water wets the microcontroller circuit it will make the electrical circuit becomes chaotic. Electric current will flow in all directions irregularly, then there will be a short current flow. And thus, the electronic circuit system is damaged. To prevent the microcontroller box from being submerged in the water, the controller box is installed on the top of the device.

The materials used in the controller consist of a relay, an IRFZ44 mosfet, a microcontroller. During this process, all components of the materials that are part of the microcontroller firstly installed in pairs of cyber boards and then all components are glued and trimmed using solder and tin. The remaining wires during soldering are then cut with cutting pliers for maximum results.

C. Solar Cell Installation

Figure 3.3 Solar Cell Installation

The prototype project for this river waste cleaning tool to be made requires a solar cell as a power source. In Figure 3.3 above, the installation above is a 20 Wp Solar Cell. This type of solar cell has advantages for areas that are often

cloudy. The size of the installed Solar Cell has dimensions: 35 cm x 49 cm x 2.5 cm with a voltage of ± 0 volts - 19 volts and a controller is used so that it can be used due to conform with the requirement in order to be more effective and efficient use, with a power of 12 volts. The battery power used to accommodate the energy source produced is 12 volts, 7.2 AH.

D. Programming on the Microcontroller

The first step in making the program is shown in Figure 3.4 by selecting the File =>Menu =>New Project =>Ok Then ticking AT90, ATtiny, ATmega, then a menu will appear as below:

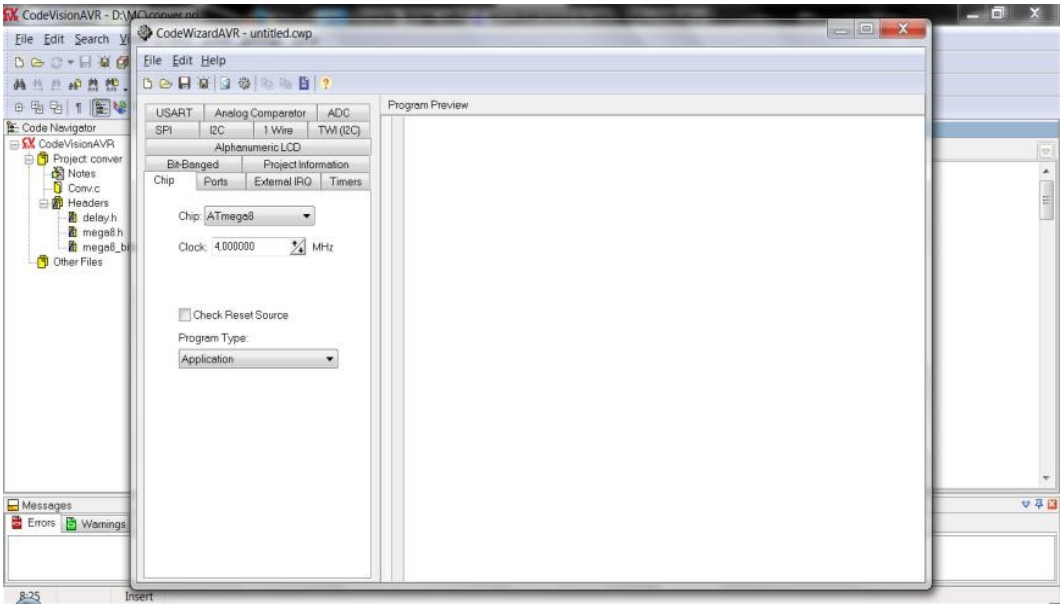


Figure 3.4 Code Vision AVR Homepage

The second step is to continue making the microcontroller program as shown in Figure 3.4 by determining:

1. Chip (ATmega8), Clock 4,000000 MHz is selected based on the crystal used.

2. On port B can be seen in Figure 3.5 below.

Bit 0 out	Bit 4 in
Bit 1 out	Bit 5 in
Bit 2 out	Bit 6 in
Bit 3 out	Bit 7 in

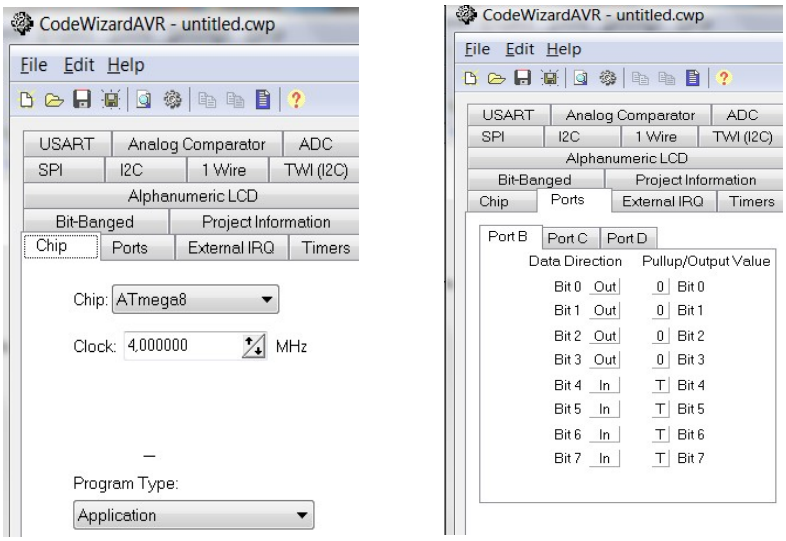


Figure 3.5 AVR Code Wizard page

3. After the second step is complete, select Project Information to fill in the name of the project that we built earlier.
4. The next step is File => Generate, Save and Exit => Create New Folder (project name) => Save 3 times then the results will be as shown in Figure 3.6 below.

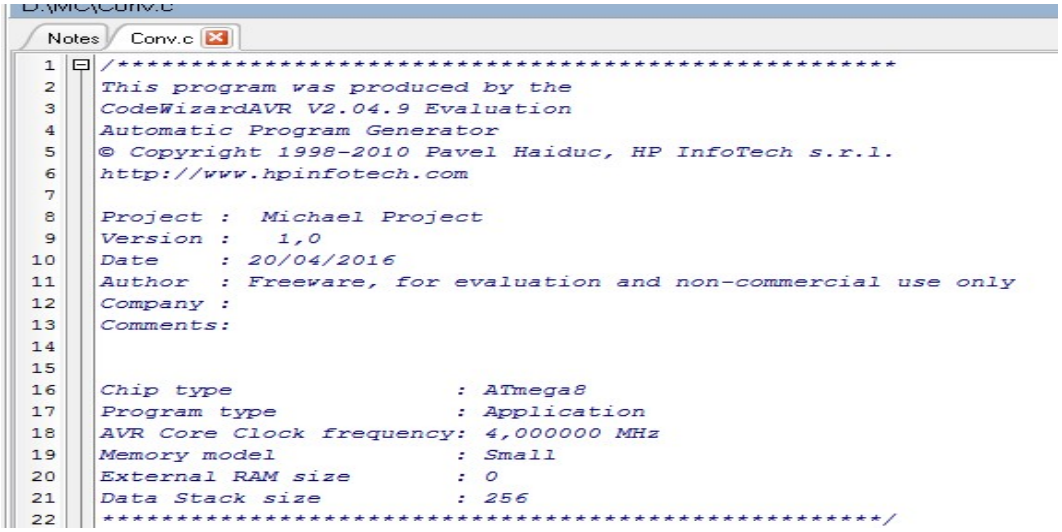


Figure 3.6 Display of Waste Cleaning Device's Project Results in AVR

E. Device's Work Process Block Diagram

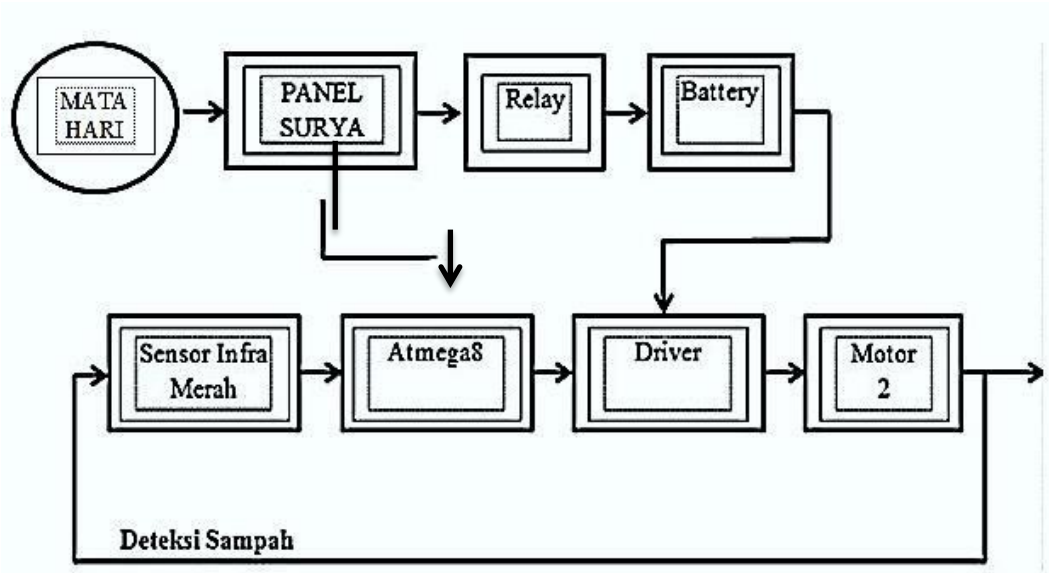


Figure 3.7 Block Diagram Image

In Figure 3.7 above, the block diagram describes the process flow, starts from input to output. There are 2 system inputs, namely solar energy and the presence or absence condition of the waste. The energy input is converted by a

solar panel from sunlight into electrical energy. The output of the solar cell is used for charging the battery where the charging process is controlled by the microcontroller ATmega8, the output battery is used to run the circuit including the driving motor. The input of the condition of the presence or absence of garbage is detected by the infrared sensor. Where if the sensor detects no obstruction between the infrared transmitter and the sensor logic, the sensor output will be zero. And vice versa if there is garbage between the sensors, then the microcontroller will read sensor output's logical value of 1. If the value is logic 1, then the sensor will cause the microcontroller to activate the motor, through the current amplifier. In this sensor logic 0 = 0 volts, and logic 1 = 5 volts.

3.5 Device Design's Flow Chart

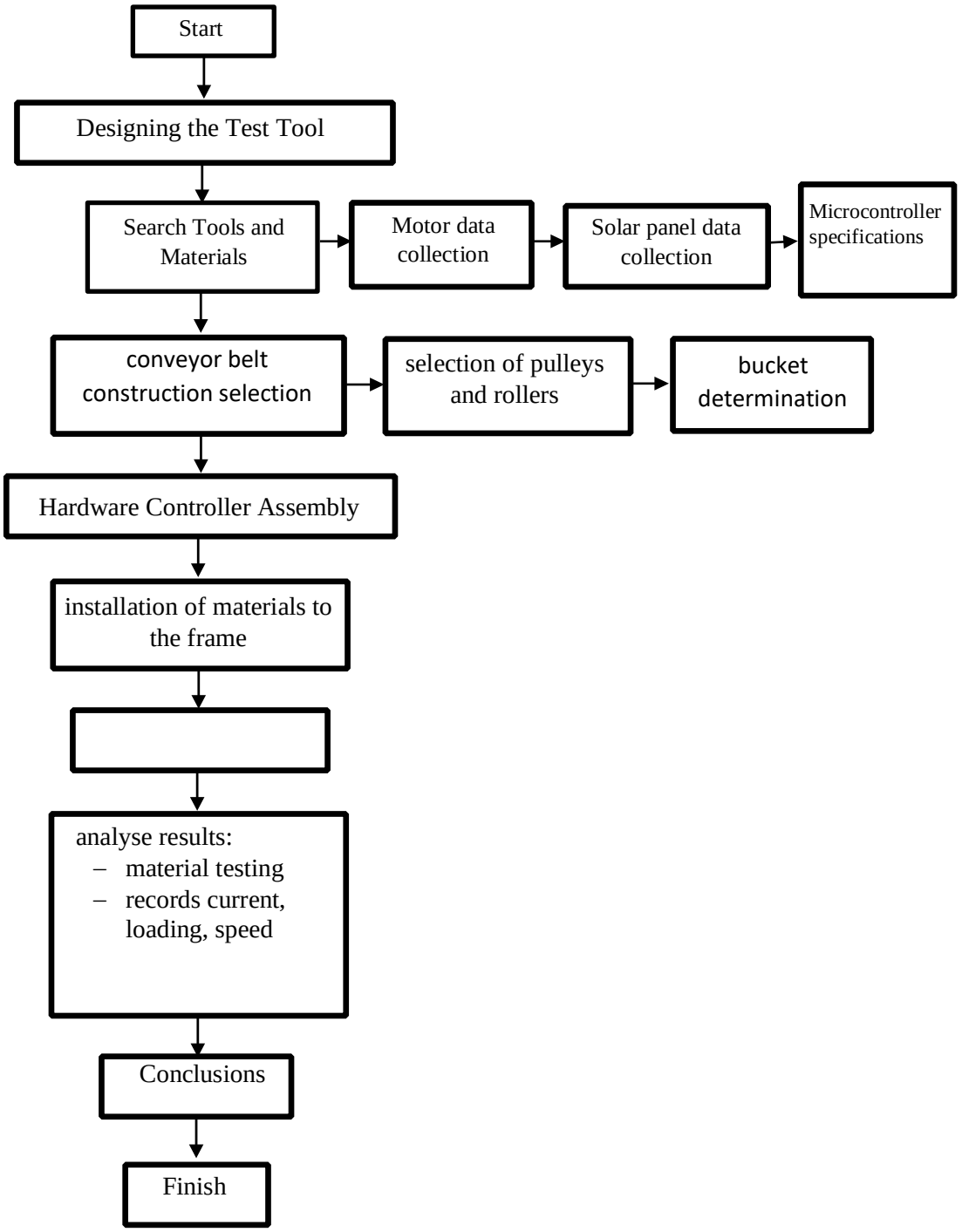


Figure 3.8 Device Design's Flow Chart Image

3.6 Device Work's Flow Chart

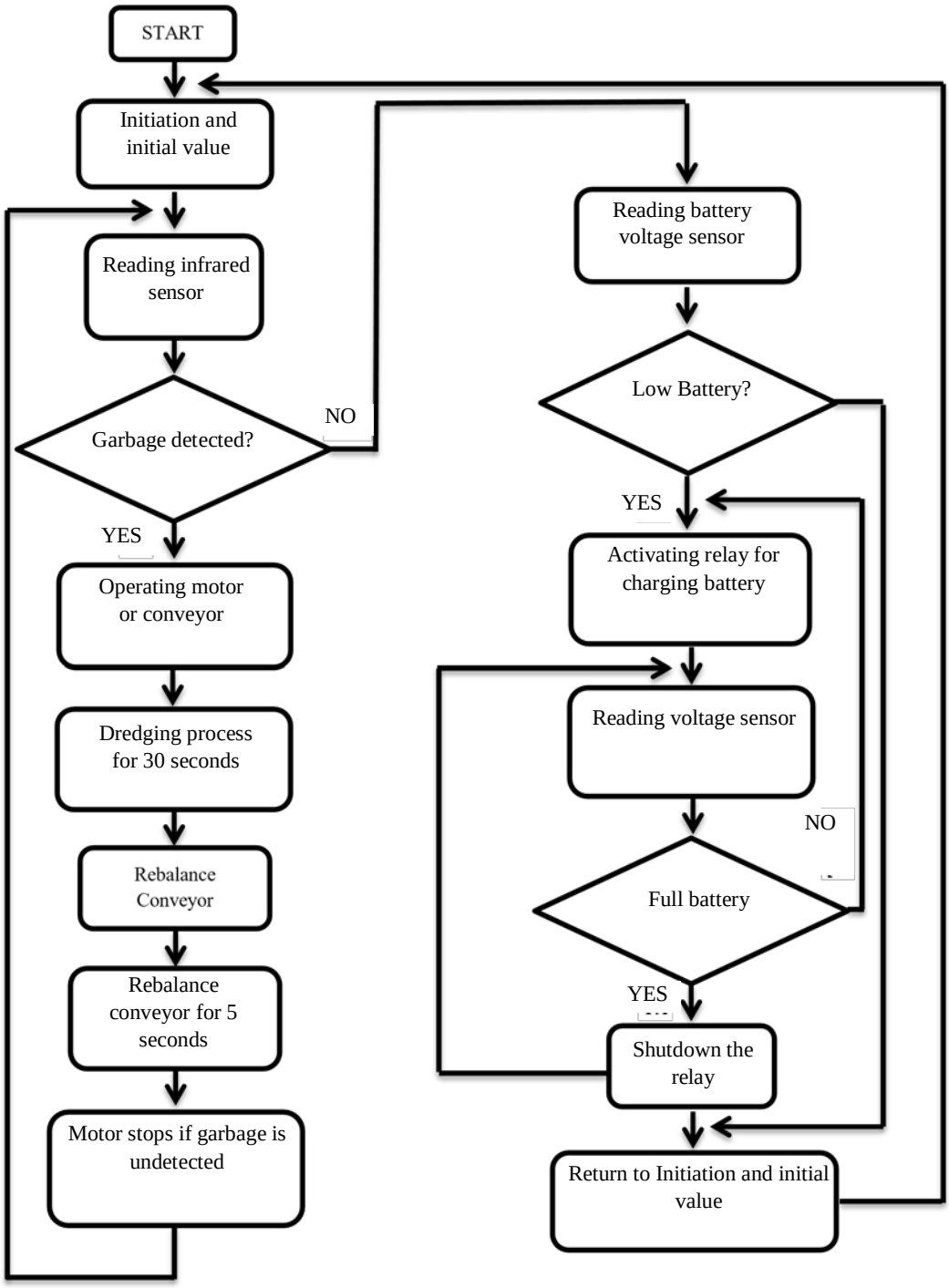


Figure 3.9 Device Working System's Flow chart

Device Work Flowchart Description

From the flowchart above, it is seen any diagram in Figure 3.9 that explains the flow of the program created, namely the flow of the system work process starting from initialization and initial values, namely determining input and output and initial conditions, then the controller reads the infrared sensor, which is a sensor that detects the presence of garbage in the water flow. if the sensor is blocked by the garbage, the sensor will be 1 or higher so the program will activate the conveyor motor to lift the garbage up. The work process of the conveyor is carried out in circulation within 30 seconds then it will be continued in the rebalancing process to stabilize the conveyor in 5 seconds. After that the motor will be stopped. The program will also detect the condition of the battery if the battery is weak, the controller will also activate the charger relay to recharge the battery with solar power.

CHAPTER V

CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

In accordance with the results of the design above, then several conclusions can be drawn to complement the results of the prototype design of a microcontroller-based garbage cleaning device with solar power as follows:

a. The design structure of the device frame image, drive transmission system, system diagram blog, propulsion system circuit, ATmega8 microcontroller circuit, and sensor circuit have been made.
b. The controller of the river waste cleaning device is designed to be based on a microcontroller by making PCB board components, flow charts, creating a framework for the device shape, connecting the entire circuit, and installation method for each component.
c. The controlling method in this microcontroller-based river waste cleaning device is designed using an infrared sensor system as an input or output control system. The input (input) in the device control system circuit is connected to the circuit output. While the output is connected to a relay that functions as an automatic switch to turn on and turn off the 2 driving motors.
d. In order for the driving motor to be active, the infrared sensor mounted on the bottom of the device is connected to a microcontroller. The sensor will detect the presence of garbage because the light source is blocked due to the garbage, then the sensor obtains a light source from infrared, and the

sensor output logic will be 0. When the line of light is blocked by a garbage object, the sensor voltage will rise up to 5 Volts.

e. The prototype power system circuit for a microcontroller-based garbage cleaning device is also connected to a solar panel, which is a solar power system becomes the source of power for the driving motor. The type of solar panel used is polyglass. The output of the solar cell is 12 V with a power of 20 Wp where during the energy reserve in the battery reduces, the relay connection automatically recharges the battery power reserve.

5.2 Suggestions

a. It is hoped that this controller can be updated again in the framework model so that it can last longer, because the controller is placed in the water flow.

b. This device shall be redesigned in shape and able to float if the volume of water increases.

c. This device can be developed even better in the purpose of making work systems, and the designs shall be used according to environmental conditions or according to water levels.

PROOFREADING

1.	step to do is the working	:	step is the working
2.	made in order to get data	:	made to get data
3.	point in order to easily	:	point to easily
4.	and obtained conformity	:	and obtain conformity
5.	intended in order to find out	:	intended to find out
6.	uses 2 motors work	:	uses 2 engines work
7.	the components in the chassis	:	the elements in the chassis
8.	with very interesting features	:	with exciting features
9.	consumption required	:	consumption needed
10.	with recognizing the type of microcontroller	:	with identifying the type of microcontroller
11.	recognized properly	:	recognized correctly
12.	other components	:	other features
13.	the relay will be turned off by the microcontroller.	:	the relay will be turned off by the microcontroller.
14.	When the light line is cut by a barrier object, the sensor	:	When a barrier object cuts the light line, the sensor
15.	1 point in order to run	:	1 point to run
16.	direction with the aim of clearing the stuck	:	ection to clear the stuck
17.	driving component, namely a component	:	driving component
18.	made to be able to reverse	:	made to reverse
19.	the conveyor so that it can dredge	:	the conveyor to dredge
20.	The motor is controlled by a microcontroller via a driver	:	A microcontroller controls the motor via a driver
21.	up to a maximum of 22 V	:	up to 22 V
22.	battery so that it can be used	:	battery to be used