

Automatic Rain Activated Wiper for Tricycle

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ABSTRACT

Tricycles otherwise called Keke Napep or Keke Maruwa are among the most accessible and available form of mobility as are readily found in almost every corner of the country. For those in the transportation business these vehicles are very profitable and therefore the business tends to draw more attention in the transportation sector. Tricycles are on the increase on Nigerian roads today creating more job opportunities from the dealers, operators and owners down to the craftsmen who perform maintenance of tricycles.

With the increasing number of tricycles on our roads, there is an increase in the probability of road accidents resulting from speeding, poor visibility during rainy periods, poor maintenance, etc. Wipers are generally considered to be essential features on all vehicles and tricycles are no exception. They are used to aid the driver's visibility especially during rainy periods. This aim of this work was to design an automatic rain activated wiper for motorized tricycles. The design of the automated wiper system that detects rain was actualized in this work and it performed effectively.

(Keywords: motorized tricycles, Keke Napep, windshield wipers, automatic wiper, transportation, safety, visibility)

INTRODUCTION

Tricycles are three wheeled vehicles which are designed to carry up to four people, the driver inclusive; one at the front (driver) and three at the back and the whole weight is balanced on three wheels with one wheel at the front and two at the back. The tricycle offers better comfort than the moped and is a better personal alternative to bus transportation.

The body of a tricycle is made of metal and an open frame which is covered by a canopy like material with curtains dropping down from the side. The tricycles are comprised of two cabins; the front cabin and the rear cabin. The front cabin, also called the drivers cabin, consist of the driver's seat, a handle bar with the gear shift and clutch lever on the left and throttle on the right, and a single pedal for the brake. Also on the handlebar buttons are found switches with functions for lights and some other controls. The dashboard houses the speedometer, the fuel gauge, and indicator lights. The driver is protected by a windshield which needs to be kept clean at all times for proper visibility. The rear cabin, also called the passengers cabin, consists of only the passenger's seat and a small cargo holding behind the passenger's seat.

The tricycle is powered by Daihatsu E series compact three-cylinder, internal combustion piston engine which was designed by Daihatsu which is a subsidiary of Toyota. The petrol driven series has a cast iron engine block and an aluminum cylinder head and are either single overhead cam or double overhead cam (Wikipedia, 2016).

The tricycle was designed by an aircraft designer Corradino D'Ascanio in 1947 at Piaggio. The inventor of the vesper came up with the idea of building a light three wheeled commercial vehicle to power Italy's post war economic reconstruction (Wikipedia, 2016).

In Nigeria, tricycles, also called Keke Napep or Keke Maruwa, were introduced into Nigeria's transportation system by General Buba Marwa while he was a colonial and military administrator of Lagos State during General Sani Abacha's military dictatorship. It was called Keke Napep when it was used as means of intervention in the national poverty eradication program (NAPEP)

during the President Olusegun Obasanjo's civilian regime (Madutorich, 2014). Since then, the tricycle has grown in the transportation business and filling gaps present in the Nigerian roads and is now popular in the transportation business.

A windshield wiper is a mechanical device which is found on most vehicles and is used to clean (remove) rain from the vehicle's windshield. According to the New International Webster Comprehensive Dictionary (2013 edition), a wiper is a cam having one or more slightly curved projection serving when mounted on a rocker shaft or rotating shaft to give a reciprocating (usually vertical) motion to another part.

Windshield wipers are an important and compulsory part of all vehicles because it aids the driver's visibility during bad weather. They are generally made of a metal arm and rubber blade, found mounted in front of the windshield and in some cars at the rear windshield and headlamps (Wikipedia, 2016).

The windshield wiper is driven by an electric motor and oscillates on the windshield which is made possible by a 4-bar mechanism (Optimal design lab; design.mech.yzu.edu.tw).

According to the theory of machines by J.J Vickers et al., (2003), a mechanism is a device designed to transform input force and the movement into desired output force and movement and is generally consist of moving component such as gears and gear train, cam and follower and linkages. This means that a mechanism is responsible for the transmission of power and without a mechanism a mechanical device will not function properly. Mechanisms can also be found in watches, clocks, windshield wipers, car transmission systems, doorways, windows, etc.

In the wiper system, the power is received from an electric motor. A linkage converts the rotational output of the electric motor into an oscillating motion of the wiper arm. A worm gear controls the force that the windshield wiper motor delivers to the driven arm by slowing down the speed of the electric motor by 50 times and multiplying (increasing) the torque by 50 times (nmbtc.com, 2014). For tricycles, there is a single arm wiper mounted in front of the driver's windshield.

Wipers have smaller arms or pressure point that distribute pressure from the wiper arm to the rubber blade flexed against the windshield to clean the windshield most completely. The rubber

blades also include a blade frame with intermittent slot and replacement hole in the frame which makes it easier to replace the rubber in the blade (nmbtc.com, 2014).

Wipers can be operated automatically. According to the New International Webster Comprehensive Dictionary (2013 edition), automatic was defined as having a self-acting mechanism by which certain operation are performed under pre-determined condition.

The history and evolution of the automatic wiper according to ipwatchdog.com (2014) started with Mary Anderson, a real estate dealer, cattle rancher, and wine maker who designed a wiper system using wood and rubber which can be operated by the driver from within the vehicle through the use of a lever installed close to the steering wheel. Pulling on the lever would initiate a spring mechanism that dragged the wiper arm across the windshield, cleaning away snow, rain, and derbies. On November 10, 1903 the U.S. Patent and trademark office issued U.S. Patent NO. 743,801, entitled window cleaning device to Ms. Anderson.

Another female inventor who made an important mark on the early development of windshield wipers is Charlotte Brigewood. She received a U.S. Patent in 1917 which was titled electric storm wind shield cleaner. The invention is believed to be the first electrically powered design and her design incorporated rollers instead of blades (Ipwatchdog.com, 2014).

Irish born inventor James Henry Apjohn (1845–1914) also patented an "Apparatus for Cleaning Carriage, Motor Car and other Windows" which was stated to use either brushes or wipers and could be either motor driven or hand driven. The brushes or wipers were intended to clean either both up and down or in just one direction on a vertical window. His invention had a priority date of 9 October 1903, in the UK.

In April 1911, a patent for windshield wipers was registered by Sloan and Lloyd Barnes, patent agents of Liverpool, England, for Gladstone Adams of Whitley Bay. The first designs for the windshield wiper are also credited to Polish concert pianist Józef Hofmann and Mills Munitions, Birmingham who also claimed to have been the first to patent windshield wipers in England.

Automatic windshield wipers which were blades were first introduced by a pair of brothers from Cleveland, OH, William M. and Fred Folberth.

The brother's invention provided driving action for the wiper by directing exhaust air from the engine manifold to an actuator which moves the wiper blades back and forth across the windshield. They also received U.S. Patent on June 20, 1922, U.S. patent no. 1420538 titled "windshield cleaner". Their design (blade) was more preferable to consumers than the rollers design but the method of using air from the engine manifold would cause the wiper to speed up or slow down with the vehicles (lpwatchdog.com, 2014).

Trico had a dispute with Folberth but was later settled and they (Trico) purchased Folberth's Cleveland company, The Folberth Auto Specialty Co. The hot air from the exhaust system quickly became standard equipment on automobiles, and the vacuum principle was in use until about 1960.

In the late 1950s, a feature common on modern vehicles first appeared, operating the wipers automatically for two or three passes when the windshield washer button was pressed, making it unnecessary to manually turn the wipers on as well.

On December 14, 1920, Oishe was issued U.S. Patent NO. 1,362175 entitled "cleaners for windshield and the likes for creating and improving the wiper mechanism" (lpwatchdog.com, 2014). The operating arm is spring pressured to ensure that the wiper maintained a constant force against the glass. They also introduced a rear window wiping system in 1926.

The intermittent wiper was the next step and was created by Robert Kearns of Detroit, an Engineering Professor at Wayne State University in Detroit, MI and received U.S. Patent NO. 3,351,836 entitled "windshield wiper system with intermittent operation" in November 1967 (Wikipedia, 2016). Kearns claimed his inspiration came from an incident that took place on his wedding night in 1953, when an errant champagne cork shot into his left eye, which was considered legally blind. Almost a decade later, he was driving his Ford Galaxie through a light rain, and the constant movement of the wiper blades irritated his already troubled vision. And so he modeled his own design based on the movement of the human eye as it blinks every few seconds rather than continuously. He later showed his design to Ford Motor Company and proposed manufacturing the design.

In the Kearns design, the interval between wipes was determined by the rate of current flow into a

capacitor. When the charge in the capacitor reached a certain voltage, the capacitor was discharged, activating the wiper motor for one cycle. After extensive testing, Ford executives offered a design similar to Kearns' intermittent wipers as an option on the company's Mercury line, beginning with the 1969 models. Kearns and Ford became involved in a multi-year patent dispute that eventually had to be resolved in court. A fictionalized version of the Kearns invention and patent lawsuit was used for the 2009 film *Flash of Genius* (Wikipedia, 2016).

In March 1970, Citroën introduced rain-sensitive intermittent windshield wipers on their SM model. When the intermittent function was selected, the wiper would make one swipe. If the windshield was relatively dry, the wiper motor drew high current, which set the control circuit timer to delay the next wipe. If the motor drew little current, it indicated that the glass was wet, setting the timer to minimize the delay (Popularmechanics.com, 2014).

STATEMENT OF PROBLEM

The existing wiper system was design for only four-wheel drives and due to the increasing number of tricycle on our roads, compacted nature and the need for the tricycle driver to concentrate on the road especially as traffic increases; the need for the automation of some features like the wiper control arises.

AIM AND OBJECTIVES OF THE STUDY

The main aim of this work is to design an automatic rain activated wiper for tricycle. The specific objectives are:

- To design a wiper system that will wipe an expected volume of rain off the windshield.
- To design a wiper system for a tricycle that detects rain fall and activates automatically.

The expected result is an automatic wiper system which is activated by rain upon dropping on the windshield. This can be applied to all tricycles which will improve the driver's concentration and increase safety.

POWER SYSTEM FOR THE WIPER

Wipers may be powered by a various means, even though most in use today are powered by an electric motor through mechanical

components, Vehicles with air operated brakes sometimes use pneumatic wipers, powered by tapping a small amount of pressurized air from the brake system to a small air operated motor mounted on or just above the windshield. These wipers are activated by opening a valve which allows pressurized air to enter the motor (Google .com/patents). Wipers can also driven by a vacuum motor powered by manifold vacuum. This had the drawback that manifold vacuum varies depending on throttle position, while Some cars, mostly from the 1960s and 1970s, had hydraulically driven wipers, most notably the '61-'69 Lincoln Continental (Wikipedia, 2016).

According to Wikipedia.org, on the earlier Citroën 2CV, the windshield wipers were powered by a purely mechanical system, a cable connected to the transmission; to reduce cost, this cable also powered the speedometer. The wipers' speed was therefore variable with car speed. When the car was waiting at an intersection, the wipers were not powered, but a handle under the speedometer allowed the driver to power them by hand.

Most wipers have pivots that are attached to a single arm, which in turn is attached to the motor. They are commonly found on many cars, trucks, trains, boats, airplanes, etc.

Another wiper design is pantograph-based, used on many commercial vehicles, especially buses with large windshields. Pantograph wipers feature two arms for each blade, with the blade assembly itself supported on a horizontal bar connecting the two arms. One of the arms is attached to the motor, while the other is on an idle pivot. The pantograph mechanism, while being more complex, allows the blade to cover more of the windshield on each wipe. However, it also usually requires the wiper to be "parked" in the middle of the windshield, where it may partially obstruct the driver's view when not in use. A few models of automobile sometimes employ a pantograph arm on the driver's side and a normal arm for the passenger. Triumph cars, Lexus and several US makes employ this method to cover more glass area where the windshield is quite wide but also very shallow. The reduced height of the windshield would need the use of short wiper arms which would not have the reach to the edge of the windshield. (Wikipedia.org, edited 2016)

OTHER WIPER APPLICATIONS

Rear Windshield Wiper

Some vehicles have wipers on the rear windshield. Rear-window wipers are mostly found on hatchbacks, station wagons, sport utility vehicles, minivans, and other vehicles with more vertically-oriented rear windows that tend to accumulate dust. It was first offered in the 1940s, they achieved widespread popularity in the 1970s after their introduction on the Porsche 911 in 1966 and the Volvo 145 in 1969. (Wikipedia.org, 2016)

Headlight Wipers

According to Wikipedia.org, in late 1968, Chevrolet introduced high pressure fluid headlamp washers on a variety of their 1969 models. In 1970, Saab Automobile introduced headlight wipers across their product range. These were operated on a horizontal reciprocating mechanism, with a single motor. They were later superseded by a radial spindle action wiper mechanism, with individual motors on each headlamp. Later in 1972, headlamp cleaning systems became mandatory in Sweden. Headlamp wipers have all but disappeared today with most modern designs relying solely on pressurized fluid spray to clean the headlights. This reduces manufacturing cost, minimizes aerodynamic drag, and complies with EU regulations limiting headlamp wiper use to glass-lensed units only. The majority of lenses today are made of plastic. (Wikipedia.org, edited 2016)

DIFFERENT TYPES OF WIPER WINDSHIELD WASHERS

Most windshield wipers operate together with a windshield washer; a pump that supplies a mixture of water, alcohol, and detergent (a blend called windshield washer fluid) from a tank to the windshield. The fluid is dispensed through small nozzles mounted on the hood. Conventional nozzles are usually used, but some designs use a fluidic oscillator to disperse the fluid more effectively. In warmer climates, water may also work, but it can freeze in colder climates, damaging the pump. Although automobile antifreeze is chemically similar to windshield wiper fluid, it should not be used because it can damage paint.

The earliest documented idea for having a windshield wiper unit hooked up to a windshield washer fluid reservoir was in 1931, Richland Auto Parts Co, Mansfield, Ohio. Uruguayan race car driver and mechanic Héctor Suppici Sedes developed a windshield washer in the late 1930s.

HIDDEN WIPERS

Some larger cars are equipped with hidden wipers (or depressed-park wipers). When wipers are switched off in standard non-hidden designs, a "parking" mechanism or circuit moves the wipers to the lower extreme of the wiped area near the bottom of the windshield, but still in sight. For designs that hide the wipers, the windshield extends below the rear edge of the hood, and the wipers park themselves below the wiping range at the bottom of the windshield, but out of sight.

RAIN-SENSING WIPERS

Some vehicles are now available with driver-programmable intelligent (automatic) windshield wipers that detect the presence and amount of rain using a rain sensor. The sensor automatically adjusts the speed and frequency of the blades according to the amount of rain detected. These controls usually have a manual override. Rain-sensing windshield wipers appeared on various

models in the late 20th century, one of the first being the Citroen SM. As of early 2006, rain-sensing wipers are optional or standard on all Cadillacs and most Volkswagens and are available on many other mainstream manufacturers.

BLADELESS ALTERNATIVES

A common alternative design used on ships, called a clear view screen, avoids the use of rubber wiper blades. A round portion of the windshield has two layers, the outer one of which is spun at high speed to shed water. High speed aircraft may use bleed air which uses compressed air from the turbine engine to remove water, rather than mechanical wipers, to save weight and drag. Effectiveness of this method also depends on water-repellent glass treatments similar to Rain-X.

THEORETICAL FRAMEWORK

Mechanisms are means of power transmission as well as motion transformers. A four-bar mechanism consists mainly of four planar links connected with four revolute joints. The input is usually given as rotary motion of a link and output can be obtained from the motion of another link or a coupler point (Natesan, 1994).

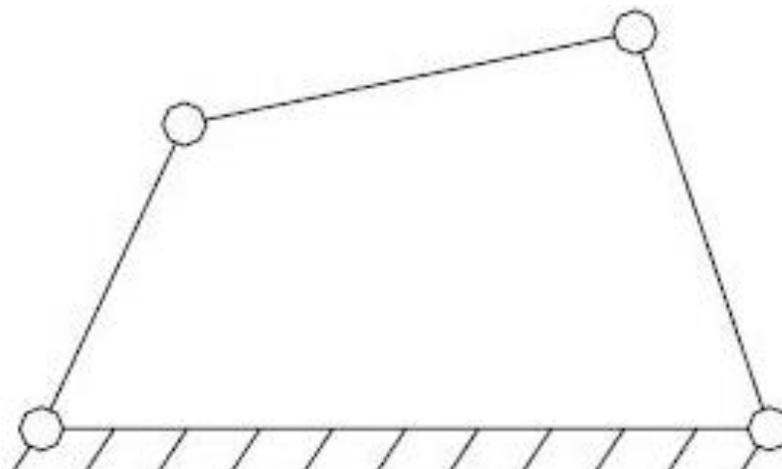


Figure 1.1

The Close-Loop Four-Bar Linkage.

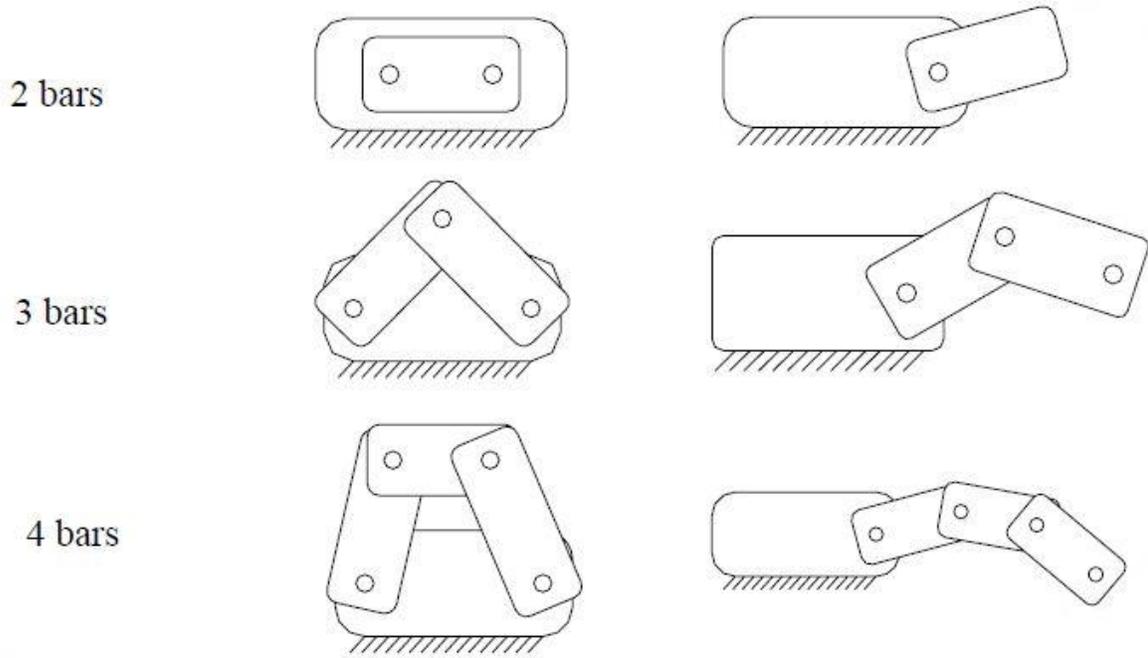


Figure 1.2
Linkage Mechanisms.

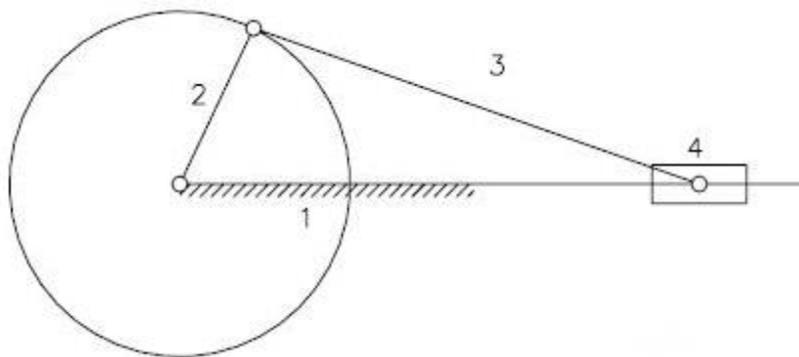


Figure 1.3
Slider Crank 4-Bar Mechanism

In a four-bar linkage, Grashof's Law determines whether there is a link that can rotate 360 degree. The Grashof's law states that for a four-bar linkage system, sum of the shortest and longest link of a planar quadrilateral linkage is less than or equal to the sum of the remaining two links, then the shortest link can rotate fully with respect to a neighboring link (me-mechanicalengineering.com).

- If the sum of length of the longest and shortest links is less than the sum of length of the other two links, there must be a link that can rotate 360 degree.
- If not, no link can rotate 360 degree.

When Grashof's Law is satisfied, there are 3 possible mechanisms: crank and rocker, double crank, and double rocker. (Optimal design lab; design.mech.yzu.edu.tw)

WIPER MECHANISM

Several mechanisms are used for operating the wiper. In automobiles, the most widely used mechanisms for operating wipers are rack and pinion and four bar mechanism. In this project, a 4-bar mechanism was used for the operating wiper. It converts the rotary motion into oscillating motion. The dimensions of links are calculated from Grashoff's rule.

Wipers should convert rotary motion of motor into oscillatory motion (i.e. crank and lever mechanism). Case 2 in the Table 1 is useful for wiper mechanism. Where S is shortest link, L is longest link; P&Q are other to links. (Viswanadh, et al., 2015).

Another important thing to consider when selecting the dimensions is transmission angle. It chosen according to the requirement that means the position of the wiper based on the transmission angle. For different dimensions the transmission angle will be different (ocw.metu.edu.tr)

Automatic control is the application of control theory for regulation of process without direct human intervention (Wikipedia, 2016).

According to *Automatic Control* by Ubani, a control system (automatic control system) is a system of devices or set of devices that manage, commands, directs or regulates the behavior of other devices or system to achieve a desired result. Control systems are either open or closed loop. In the closed loop control system, a feedback from the output affects the input.

According to Wikipedia.org, the main functions of an automatic control are to control, to sense, to measure, to compare, compute, and to correct.

Table 1: Grashoff's Rule.

CASE	(L+S) Vs. (P+Q)	FIXED LINK	TYPE OF MECHANISM
1	$(L+S) < (P+Q)$	Shortest link (S)	Double crank
2	$(L+S) < (P+Q)$	Link adjacent to Shortest	Crank & Lever
3	$(L+S) < (P+Q)$	Link opposite to Shortest	Double Lever
4	$(L+S) > (P+Q)$	Any link	Double Lever
5	$L+S = P+Q$	Any link	Change point

MATERIALS AND METHODS

Materials

The materials used in this project include aluminum and wooden frame, rubber blades, plastic bushings, 12 volts electric motor and glass. The input crank is made of plastic, while the coupling link was made of aluminum and the output link and shaft are galvanized steel. Galvanization is the process of applying zinc coating to steel to protect it from corrosion. The spring in the wiper arm is also galvanized, The wiper arm was painted to prevent corrosion. washers, screws, nuts and bolts made of steel were used.

The automatic control unit was made up of 2 switch, an IC; IC 555, a diode (IN 4007), 3 resistor (1K, 10K, 1M), a capacity of 0.1uf and a relay of 12 volts and 10A. A dot vero board was used to house the connections. The enter system

was powered by a 12-volt battery. The conduction sensor was made of two rows of conductive metal.

Design Layout

The glass frame is the main part of the system, because the wiper in the tricycle is mainly used for removing the rain and debris from the glass windshield. A conductive sensor is fixed on the wood stand. A wiper generally consists of an arm, pivoting at one end with a long rubber blade attached to the other. The blade is swung back and forth over the glass, pushing water from its surface. The wiper is located on the center of the glass. The motor is fixed behind the glass frame. The Conductivity sensor is designed for detection of rain water which is fixed to the glass frame. The wiper motor fixed to the glass frame so that it can clean the glass whenever rain occurs as seen in Figure 2.

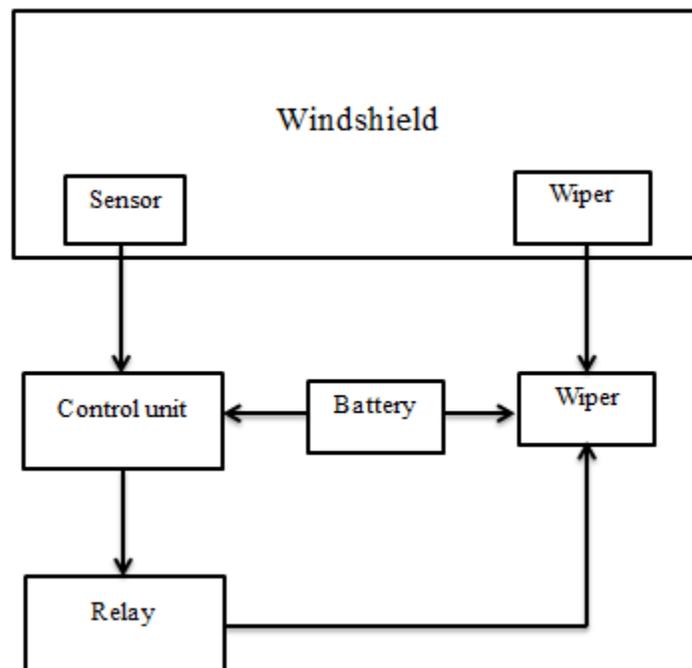


Figure 2.1
Design Layout.

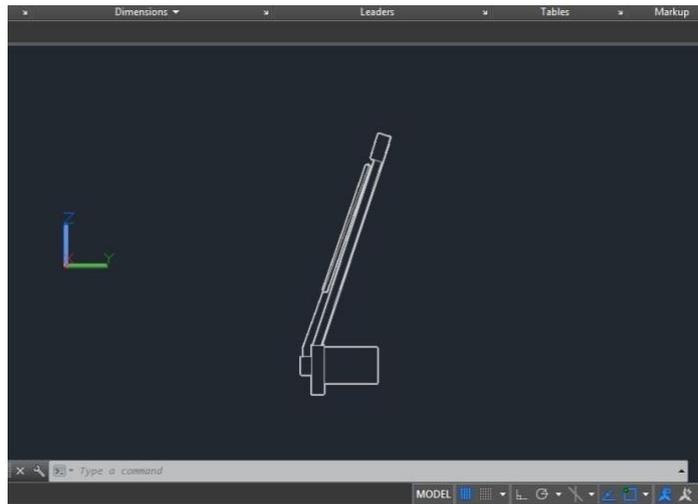


Figure 2.2

AutoCAD East (Right) View.

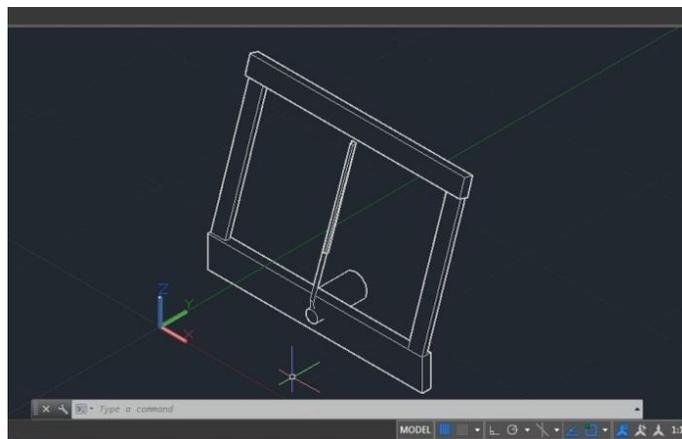


Figure 2.3

AutoCAD South-East Isometric View.

WORKING OF RAIN OPERATED WIPER

The battery supplies the power to the sensor as well as rain operated motor. Wiper motor is automatically ON during the time of rainfall. The sensor is fixed in the vehicle glass.

The conductive (Touch) sensor is used in this work. It senses the rainfall and giving control signal to the control unit. The control unit activates the wiper motor automatically as shown in Figure 3.

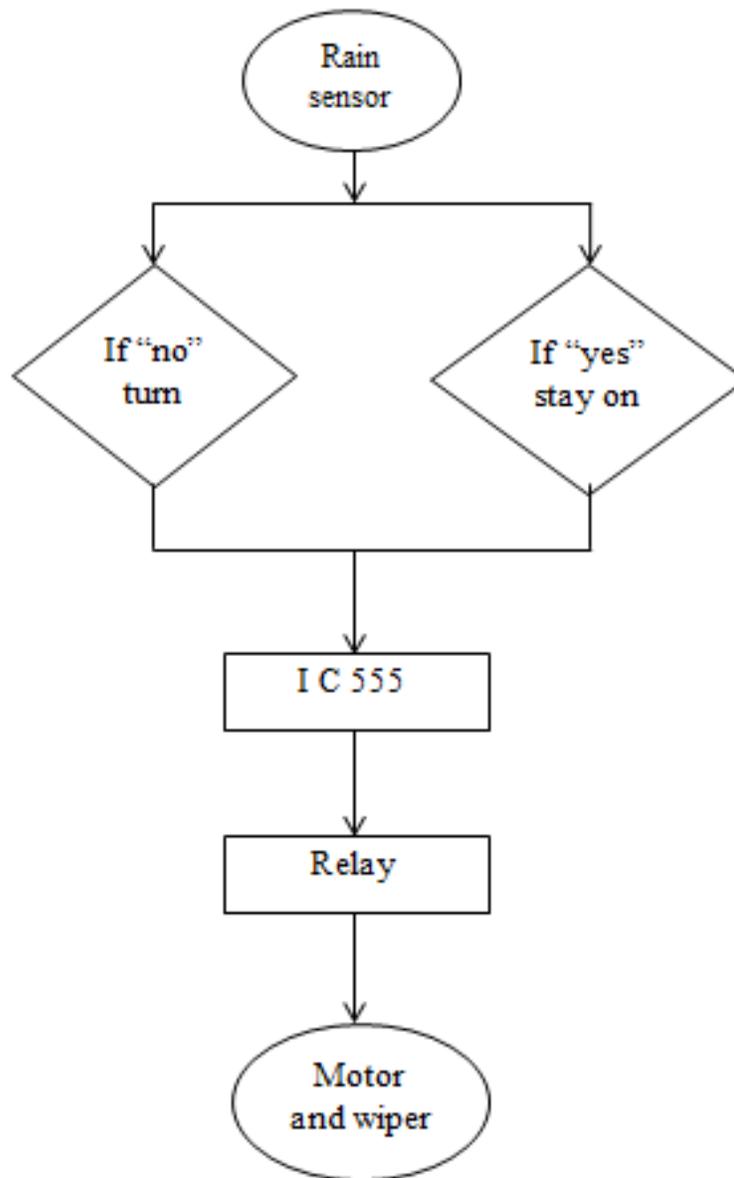


Figure 3: Flowchart of the Sensing and Automatic Unit.

WORKING OF THE AUTOMATIC CIRCUIT

The main component of this circuit is a 555 timer IC that works in mono-stable mode. Two metal sheets fixed at a small distance apart are used as rain detecting sensors. From the working of a mono-stable 555 timer, a negative voltage on the trigger pin will cause a high output.

When it rains, trigger pin gets a negative voltage. Output of one shot 555 (mono-stable) is connected to a relay through a transistor. The transistor acts as a switch for the relay to turn ON the wiper motor during rain.

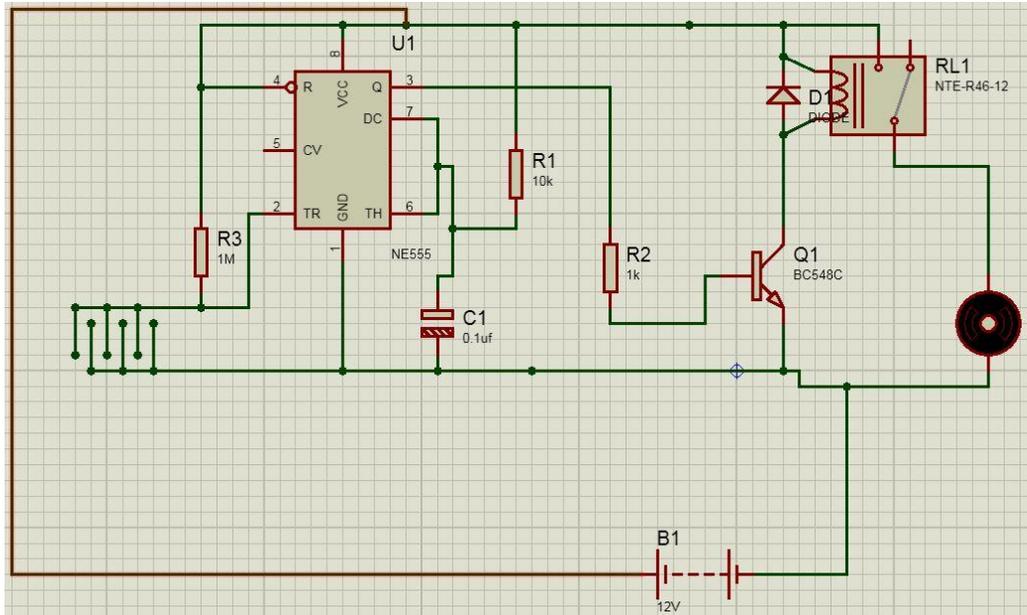


Figure 4: The Automatic Circuit Diagram.

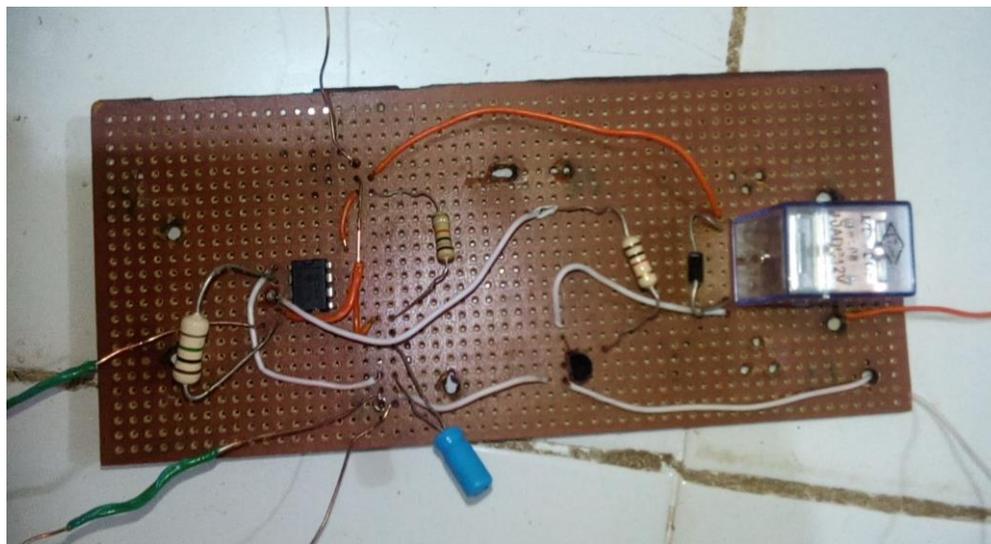


Plate 1: The Automatic Circuit.

COMPONENTS REQUIRED

IC 555

IC 555 timer is a one of the most widely used IC in electronics and is used in various electronic circuits for its robust and stable properties. It

works as square-wave form generator with duty cycle varying from 50% to 100%, Oscillator and can also provide time delay in circuits. The 555 timer got its name from the three 5k ohm resistor connected in a voltage-divider pattern which is shown in the figure below.

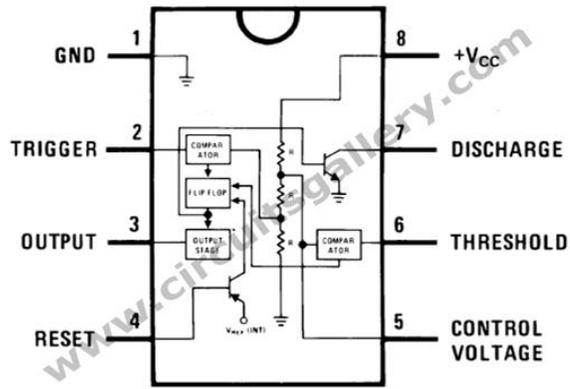
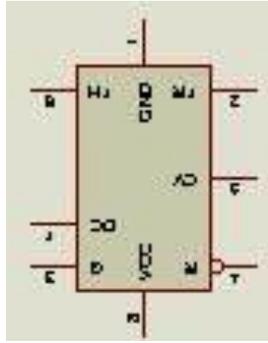


Figure 5: Relay.

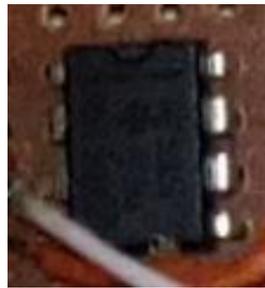


Plate 2: Relay.

Transistor BC 548

The BC548 transistor is a semiconductor that works to switch electronic signals, and in some cases amplify them. The strengths and weaknesses of the BC548 transistor are derived mainly from its design.

flow the reverse direction is blocked. They are like the one-way valve of electronics. If the voltage across a diode is negative, no current can flow, and the ideal diode looks like an open circuit. In such a situation, the diode is said to be off or reverse biased.



Figure 6: Transistor.



Figure 7: Diode.

Diode (1N4007)

The key function of an ideal diode is to control the direction of current-flow. Current passing through a diode can only go in one direction, called the forward direction. Current trying to



Plate 3: Diode.

Resistor (1K, 10K, 1M)

Resistors are electronic components which have a specific, never-changing electrical resistance. The resistor's resistance limits the flow of electrons through a circuit. They are passive components, meaning they only consume power and can't generate it. Resistors are usually added to circuits where they complement active components. Commonly resistors are used to limit current, divide voltages.

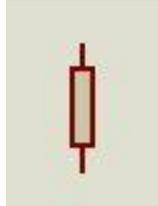


Figure 8: Resistor.



Plate 4: 1M Resistor.

Capacitor (0.1uf)

The capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery. Capacitors can be used to block DC current while passing audio signals, pulses, or alternating current, or other time varying wave forms. This ability to block DC currents enables capacitors to be used to smooth the output voltages of power supplies, to remove unwanted spikes from signals that would otherwise tend to cause damage or false triggering of semiconductors or digital components.



Figure 9: Capacitor.



Plate 5: Capacitor.

Relay (12V, 10A)

Relays work under the principal of electro magnetism. When the relay coil is energized, it acts like a magnet and change the position of a switch. The circuit which powers the coil is completely isolated from the part which switches the position of the switch ON/OFF. This provides electrical isolation.

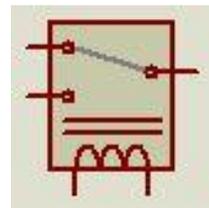


Figure 10: Relay.



Plate 6: Relay.

RAIN SENSOR (TWO METALS)

A rain sensor or rain switch is a switching device activated by rainfall. Optical rain sensors are the most common modern rain sensors and are based on the principle of total internal reflection: an infrared light is beamed at a 45-degree angle into the windshield from the interior — if the glass is wet, less light makes it back to the sensor, and the wipers turn on. Another type is the conductive sensor, in this case, two conducting metal are placed close such that a conducting liquid in this case rain drop, will close the circuit and this will result in sending a signal to a receiver.

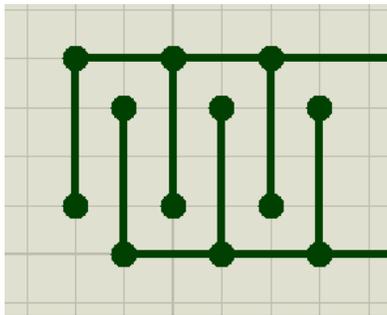


Figure 11: Rain Sensor.

METHODS

The materials were gotten from the shops and prepared according to dimensions. The sensor is placed on the windshield at the top-center. The whole setup was powered by a 12 volts DC battery. The electric motor which powers the mechanism was placed such that the crank link ground anchor a_1 is 6.5cm from the output link anchor with the input link $a_2 = 1$ cm, coupling link $a_3 = 6$ cm and the output link $a_4 = 4$ cm. The extended dead center and folded dead center were calculated as follows:

CALCULATIONS

Extended Dead Centers

Taken $a_1=6.5$ cm, $a_2=1$ cm, $a_3=6$ cm, $a_4=4$ cm,

Using the cosine rule:

$$\Phi = 184.12$$

$$a_4^2 = (a_2+a_3)^2 + a_1^2 - 2 \times (a_2+a_3) \times a_1 \times \text{Cos}\alpha$$

Making $\text{Cos}\alpha$ the subject and solving for α

Where α = angle to be solved

$$\text{Cos}\alpha = ((a_2+a_3)^2 + a_1^2 - a_4^2) / (2 \times (a_2+a_3) \times a_1)$$

$$\text{Cos}\alpha = 75.25/91$$

$$\text{Cos}\alpha = 0.8269$$

$$\alpha = 34.2184$$

$$\text{Cos}(\pi - \Psi_1) = (a_4^2 + a_1^2 - (a_2+a_3)^2) / (2 \times a_4 \times a_1)$$

$$\text{Cos}(\pi - \Psi_1) = 9.2/52$$

$$\text{Cos}(\pi - \Psi_1) = 0.1779$$

$$\pi - \Psi_1 = 79.75$$

$$\Psi_1 = 180 - 79.75$$

$$\Psi_1 = 100.25$$

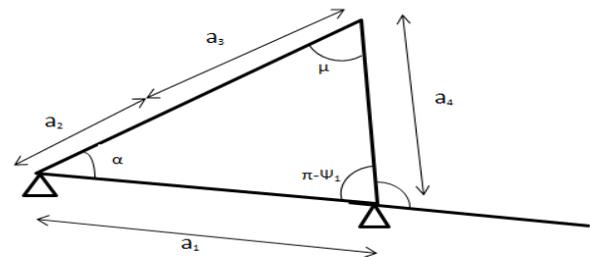


Figure 12.

Folded Dead Centers

$$\text{Cos}(\alpha + \Phi - \pi) = ((a_3 - a_2)^2 + a_1^2 - a_4^2) / (2 \times a_1 \times (a_3 - a_2))$$

$$\text{Cos}(\alpha + \Phi - \pi) = 51.25/65$$

$$\text{Cos}(\alpha + \Phi - \pi) = 0.7846$$

$$\alpha + \Phi - \pi = 38.32$$

$$\Phi = 38.32 + 180 - 34.$$

$$\cos(\pi - \psi_1 - \psi) = (a_4^2 + a_1^2 - (a_3 - a_2)^2) / (2 \times a_4 \times a_1)$$

$$\cos(\pi - \psi_1 - \psi) = 33.25/52$$

$$\cos(\pi - \psi_1 - \psi) = 0.6394$$

$$\pi - \psi_1 - \psi = 50.25$$

$$-\psi = 50.25 - 180 + 100.25$$

$$\psi = 29.8$$

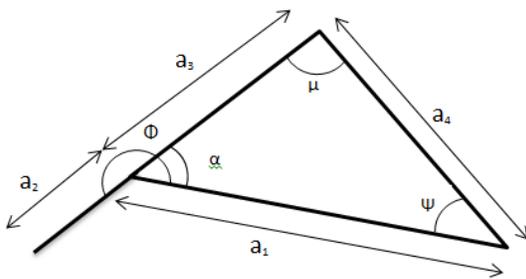


Figure 13.

Transmission Angle

$$\cos \mu_{\min \max} = (a_4^2 + a_3^2 - a_1^2 - a_2^2) / (2 \times a_3 \times a_4) \pm (a_1 \times a_2) / (a_3 \times a_4)$$

$$\cos \mu_{\min \max} = (8.75/48) \pm (6.5/24)$$

$$\cos \mu_{\min \max} = 0.1822 \pm 0.2708$$

$$\cos \mu_{\min} = 0.1822 + 0.2708$$

$$\cos \mu_{\min} = 0.4531$$

$$\mu_{\min} = 63.06$$

$$\cos \mu_{\max} = 0.1822 - 0.2708$$

$$\cos \mu_{\max} = 0.0885$$

$$\mu_{\max} = 95.08$$

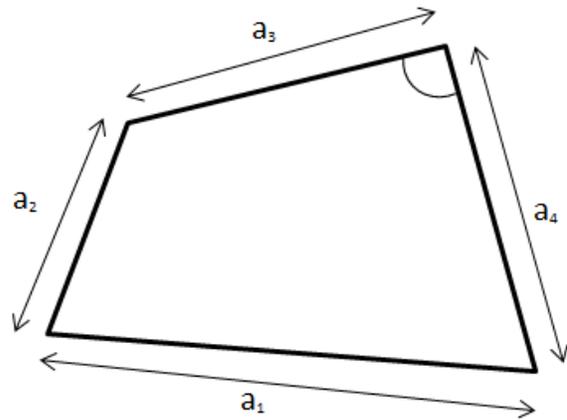


Figure 14.

RESULTS AND DISCUSSION

Assembling and Testing Analysis

In assembling the components, the following procedures were properly considered:

- i. Purposing of the entire materials / Components needed
- ii. Resistance check of the components bought with the help of ohmmeter before making the necessary connection with the components
- iii. Drafting out a schematic diagram on how to arrange the materials and components.
- iv. Testing the completed system to see if the design works and
- v. Finally, implementation of design of the project.

Having procured all the materials, the work processed into the arrangement of the components into the Vero board, proper soldering of the components then followed. The components were all soldered into the board after which it was correctly confirmed done. A case was gotten where the entire circuit was mounted follow by other external components.

Assembling

Having finished the construction and design of the sections of the system, the assembling and mounting onto the glass frame followed. The sections were properly laid out and assembled into the casing where the general coupling and linkages into the peripheral devices took place.

Testing of System Operation

In this stage, the system was due for testing and operation. The system operation was tested where all its required performance was maintained. First; the system was plugged in and powered with the switch which is indicated by the power indicator. The battery supplies the power to the sensor as well as wiper motor. The wiper motor is automatically ON during the time of rainfall. The sensor is fixed on the vehicle glass. It senses the rainfall and giving control signal to the control unit. The control unit activates the wiper motor automatically. The picture of the system after construction is as seen below:



Plate 7: Automatic Rain Activated Wiper.

CONCLUSION

Rain operated motor is consists of conduction sensor (tough sensor) circuit, control unit, wiper motor, and glass frame. The sensor is used to detect the rainfall. Once there is any rain on the glass, the sensor detects the water and gives the control signal to the wiper motor. "Automatic rain operated wiper", which is fully equipped by sensors circuit and wiper motor is a project which is fully equipped and designed for tricycles. The test result were good and the automatic rain operated wiper system is a fully automated. The operation remains an essential part of the system although it is subject to changing demands on physical input as the degree of mechanization and automation is increased.

RECOMMENDATIONS

Driving without good wiper blades is detrimental to the windshield and vehicle safety. There are many signs that faulty blades must be replaced immediately. Hardened or broken rubber causes streaks when the blades try to eliminate moisture. If you see a filmy mist after wiping, there might be debris or oil embedded on the rubber. You should also observe your blades' wipe pattern. If you see a series of streaks that may indicate the rubber has bent too far. A bad blade also creates screeching, whacking or throbbing sounds when in use. Make sure you inspect your blades. Avoid driving under heavy storm conditions to reduce chances of road accidents as heavy storm are capable of drenching the entire tricycle and the passengers. Also there is increase risk in fog conditions.

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