SELF-EXECUTING RAIN DETECTOR FOR WIPER CONTROL

C.S. Tomar[1], M. Gupta [2], J. Singh [3] and M. Singh [4]
Faculty of Engineering & Technology, Department of Computer Science and Engineering,
Manav Rachna International Institute of Research & Studies
japneet.singh064@gmail.com[1], krishtomar132@gmail.com[3], mayankgupta648@gmail.com[2],
meeta.sangwan@gmail.com[4]

ABSTACT

While technological advances have worked to increase the safety and convenience of modern vehicles, the fact remains that drivers today have more distractions than ever before. The prevalence of cell phones, MP3 players, and in-dash navigation systems have led to a multitude of potentially dangerous diversions literally at the driver's fingertips. In today's world, the safety and comfort of operators are the necessary objectives and new opportunities for automotive production. Now the wipers are manually operated based on the concept of manual switching. This may affect the safety of the driver while driving a car. So, therefore in this paper we have tried to propose a model that will automatically start/stop the wiper on the basis of the rain droplets being identified on the car windscreen glass. On water droplet, the car wiper will automatically be being operated leading to headache reduction of the driver to start/stop the same manually. A self-executing wiper and GWC selector also increases overall comfort by reducing interspheres. The rain detector in the vehicle is used to operate the windshield wipers self-executing ally if it detects rain on and above the windshield glass. This system detects raindrops on the windshield and turns on and off or self-executing ally twiddle the wiper system according to the level of rainstorm.

Keywords: *Self-executing, Sensing, Wiper, Arduino, Rain detector*

1. Introduction

Few decades ago, most of the people were connected to the world outside their homes in very limited ways, primarily with landline telephones, radios and televisions. The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at Carnegie Mellon University becoming the first internet connected appliance, able to report its inventory and whether newly loaded drinks were cold. The Internet of Things has certainly come a long way since Kevin Ashton coined the term in 1999, through the Auto-ID Center at MIT and related market-analysis publications. RFID was first seen by Ashton Kevin one of the prerequisite for IoT. Since, then the Internet has evolved significantly.

A major transformation is to extend "things" from the data generated from devices to objects in the physical space. The evolution that we have been witnessing in the last few years is an extension of this internet to all the things that surround us. The growth of the internet is an on-going process: only twenty-seven years it was connecting about a thousand hosts and had grown ever since to link billions of people through computers and mobile devices. The internet of Things has boost connectivity between objects, devices, people and environment. The internet of Things refers to the networked connection of everyday objects which are often equipped with ubiquitous intelligence. IoT will increase the ubiquity of the Internet of Things by integrating every object communicating with human beings as well as other devices. IoT describes a system where items in the physical world, and sensors within or attached to these items, are connected to the internet via wireless and wired internet connections. All kinds of ordinary household gadgets can be modified to work in an IoT system. Wi-Fi network adapters, motion sensors, cameras, microphones and other instrumentation can be embedded in these devices to enable them to work. Home automation systems already implement primitive versions of this concept for things like light bulbs, plus other devices like wireless scales and wireless blood pressure monitors that each represent early examples of IoT gadgets. Wearable computing

devices like watches and glasses are also envisioned to be key components in future IoT systems.

To complement this overview, it is worth noting three points that highlight the complex nature of IoT. First, it should not be seen as a mere independent system that operates with their own infrastructure. Second, IoT will be implemented in symbiosis with new services. Third, communications, including Machine-to-Machine(M2M) communication that potentially concerns 50-70 billion 'machines', of which only 1% are connected today. The advent of IoT is taking place in an ICT environment affected by several major trends. 'Scale' is one of them: the number of connected devices is increasing, while their size is reduced below the threshold of visibility to the human eye. 'Mobility' is another: objects are very more wirelessly connected, carried permanently by individuals and geo-localizable. 'Heterogeneity' and 'complexity' is a third trend: IoT will be deployed in the environment already crowded with applications that generate a growing number of challenges in terms of interoperability.

The idiom Internet of Things (IOT) mentions to the connection of diverse devices and physical objects around the world via the Internet. The term IOT was first introduced by Kevin Ashton in 1999. The subsequent section demonstrates the basics of IOT. It deals with several layers uses in the IOT and some basic terms relating to it Broggi, A(2005). This is crucially the extension of the assistance provided from the Internet. This module also instiagtes the IOT architecture. For example, when home contraption in our daily lives links to the Internet, the system can be refered as a Smart-Home in an IOT domain. I. Ide, Y. Mekada et al. (2005)The IOT is not only a profound vision of the future. It is already being implemented and its impact is not limited to professional progress.

For fast road safety, long, unobstructed vision and alert driving are essential. Modernism in engineering and technology have made road tour faster and more pleasant Park, J.-H et al. (2006). Therefore, interruption in the driver's consciousness, even for a snippet of a second, can cause an extensive accident. So here we present a self-executing rain detector for the windshield wiper and glass window control prototype (GWC) that activates self-executing ally by detecting rain and stops when it deactivates. V.S. Veerasamy(2009) This will not only help increase safety by reducing interruption, but will also increase overall condolence. This method has a finite detection zone (depending on the size of the windshield) and is suitable for the detection of moisture on the outer surface of the windshield. It will detect rain droplets or moisture on the windshield, it will self-executing ally start the windshield wipers using detectors. [16] Detectors based on these methods are built into the windshield and are potentially less expensive and less visible. The innovation presents a effortless and abstemious technology for the self-executing control of the serviceable of the wiper machine.

Therefore, there is a demand for a rain detector that would control the disadvantages of currently familiar detectors. It is also mandatory to advance the detector for a modified response. The system that will be delineate and developed by our team plays a dominant role in the safety, the long and clear vision of the driver during the rainfall season. However, it is necessary to have adequate linearity of the rain intensity for the range in which the driver wants to distinguish to wipe-out the wind-shield to facilitate driving. Among the conventional concepts concerning rain detectors, the mechanical detector monitored the contrast of amplitude and frequency of vibration by rain droplets. This system could reduce an additional task from the driver's workload and allow him to

better keep his eyes on the road and hands on the wheel in bad weather.

Technology Components Implementing IoT

Sensors: An electronic device that produces electrical, optical, or digital data derived from a physical condition or event. Data produced from sensors is then electronically transformed, by another device, into information that is useful in decision making done by "intelligent" devices or individuals. Types of sensors lee (2010). Purpose, Tanaka, S et al (1999). Accuracy, Park, J.-H et al. (2006). Reliability, Kore, S.S et al (2012). Range, Netzer (2000) Resolution, M. I. Mishchenko et al (2000). Level of Intelligence. IoT, by machine-to-machine communication, essentially refers to microprocessor and sensor-fitted gadgets or 'things' within a network talking to each other, swapping real-time data and information to perform specific actions. Examples of connect devices swapping live information with one another could include vehicle-to-vehicle communication, smart buildings, smart vending machines, and so on. The technology can also be applied to areas like manufacturing, retail, and healthcare among others

Networks: The second step of this implementation is to transmit the signals collected by sensors over networks with all the different components of a typical network including routers, bridges in different topologies, including LAN, MAN, WAN. Connecting technologies including Wi-Fi, Bluetooth, Low power Wi-Fi, Wi-Max, LTE and the recent promising technology Li-Fi. The driving forces for wide spread network adoption in IoT can be summarized as follows: lee(2010). High Data rate, Tanaka, S et al (1999). Low prices of data usage, Park, J.-H et al. (2006). Virtualization. Kore S.S (2012).

IPv6 deployment

Standards: The third stage in the implementation process includes the sum of all activities of handling, processing and storing the data collected from the sensors. This aggregation increases the value of data by increasing, the scale, scope, and frequency of data available for analysis but aggregation only achieved through the use of various standards depending on the IoT application in used. Types of standards: lee(2010). Technology standards includes network protocols, communication protocols and data aggregation standards. Tanaka, S et al (1999). Regulatory Standards set and administrated by government agencies like FTC, for example Fair Information Practice Principle.

Intelligent Analysis: The fourth stage in IoT implementation is extracting insight from data for analysis, Analysis is driven by cognitive technologies and the accompanying models that facilitate the use of cognitive technologies. Cognitive technologies include: lee(2010). Computer vision refers to computer's ability to identify objects, scenes, and activities in images. Tanaka, S et al (1999). Natural-language processing refers to computer's ability to work with text the way humans do, extracting meaning from text. [3]. Speech recognition focuses on accurately transcribing human speech.

Intelligent Actions: Intelligent actions can be expressed as M2M and M2H interfaces for example with the advancement in UI and UX technologies. Factors driving adoption of intelligent actions within the IoT: lee(2010). Lower machine prices. Tanaka, S et al (1999). Improved machine functionality. [3]. Machines "influencing" human actions through behavioral-science rationale. Kore S.S (2012). Deep learning tools. Companies like UNLIMIT led by Anil Ambani in collaboration with CISCO are leading the path to set up advance IOT features in India. Reliable connectivity and the ability to easily manage the multitude of connected services involved in smart cities are two key requirements to ensure the success of the Digital India initiative," Reliance Group said adding that the

combination of Reliance's mobile networks and cloud services along with Cisco Jasper IoT connectivity management platform will offer wide-ranging solutions for smart city initiatives across India. The main parts of an IoT is shown in Fig 1 below.

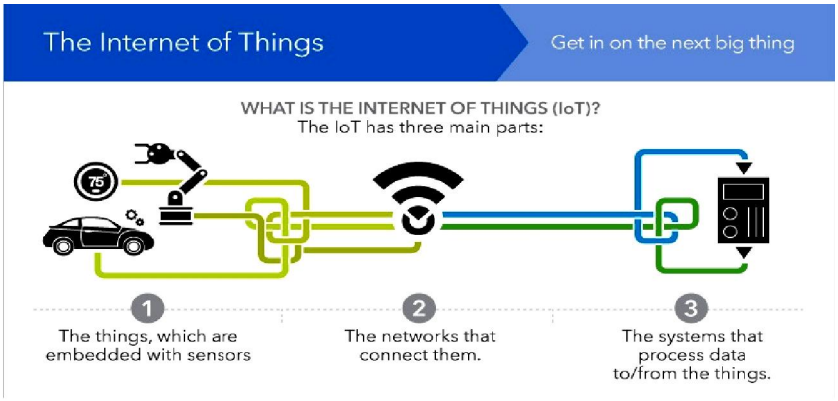


Fig 1: Parts of IoT

Advantages of IoT

Communication

IoT encourages the communication between devices, also famously known as Machine-to-Machine (M2M) communication. Because of this, the physical devices are able to stay connected and hence the total transparency is available with lesser inefficiencies and greater quality.

Automation & Control

Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings. Without human intervention, the machines are able to communicate with each other leading to faster and timely output.

Information

It is obvious that having more information helps making better decisions. Whether it is mundane decisions as needing to know what to buy at the grocery store or if your company has enough widgets and supplies, knowledge is power and more knowledge is better.

Monitor

The second most obvious advantage of IoT is monitoring. Knowing the exact quantity of supplies or the air quality in your home, can further provide more information that could not have previously been collected easily. For instance, knowing that you are low on milk or printer ink could save you another trip to the store in the near future. Furthermore, monitoring the expiration of products can and will improve safety.

Money

The biggest advantage of IoT is saving money. If the price of the tagging and monitoring equipment is less than the amount of money saved, then the Internet of Things will be very widely adopted. IoT fundamentally proves to be very helpful to people in their daily routines by making the appliances communicate to each other in an effective manner thereby saving and conserving energy and cost. Allowing the data to be communicated and shared between devices and then translating it into our required way, it makes our systems efficient.

Drawbacks of IoT

Compatibility

Currently, there is no international standard of compatibility for the tagging and monitoring equipment. I believe this disadvantage is the easiest to overcome. The manufacturing companies of these equipment just need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative needed.

Complexity

As with all complex systems, there are more opportunities of failure. With the Internet of Things, failures could sky rocket. For instance, let's say that both you and your spouse each get a message saying that your milk has expired, and both of you stop at a store on your way home, and you both purchase milk.

Privacy

With all the IoT data being transmitted among the various devices in huge amount so it is quite difficult to keep the privacy safe and the same may leads to losing the privacy.

2. Components Used

2.1. Rain Detector

The rain sensor used for rain detection, rain sensor or rain switch is a switch device activated by rain droplets. There are two major applications for rain detectors. The first-one is water control device attached to a self-executing irrigation system that stops the system in case of rain. The second-one is a device used to preserve the interior of a car from rain and support the self-executing mode of windshield wipers. An auxiliary application in non-manual satellite communication antennas is to cause a rain blower on the opening of the antenna power supply, to remove the water droplets from the mirror cover which keeps it under pressure simultaneously dry with air. This device image is shown in Fig 2.

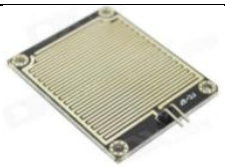


Fig:2 Rain detector

Fig:3 Wind Screen Wiper

Fig 3: Power Supply

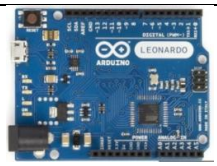


Fig 4: Microcontroller

Fig 5: Relay

2.2. Car wiper

A windshield wiper is a device used to abolish rain, snow, etc. Nearly all motor vehicles, including cars, trucks, buses, trains, ships and some airplanes, are equipped with such windshield wipers, which are conventionally allowed. A cleaner usually consists of a metal arm, centered at one end and accommodate with a long rubber blade attached to the other. The arm works with an electronic motor, often an electric motor, although some vehicles also use substitute energy. The blade moves back and forth on the glass, pushing water from its surface. The speed is ordinarily convertible, with several continuous speeds and often, one or more flawless configurations. Most cars use two synchronized arms, while many commercial vehicles use one or more excoriate arms. A typical car wiper is shown in Fig 3.

2.3. Power Supply

Used to provide power to the car, an motorized battery is a rechargeable battery that supplies electric power to the motor vehicle. Its main objective is to supply energy that starts the engine. Once the engine is started, the dynamo supplies power to the car's electrical systems.

Typically, the boot discharges less than 3% of battery range. That is why automatic batteries are conceive to deliver maximum current for a short duration of time. It is shown in Fig 4.

2.4. Micro-controller

The microcontroller like Arduino is used to control the system. A microcontroller is a small computer in a single unsegregated circuit. In contemporary phraseology, it is similar but less trailblazing than a system on a chip or SOC; An SOC can include a microcontroller as one of its parts. A microcontroller contains one or more CPUs (processor cores) along with memory and configurable input / output circumferential. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included in the chip, as well as a small amount of RAM. Microcontrollers are fabricated for unsegregated applications, in contrast to the microprocessors used in personal computers or other general-purpose applications consisting of several different chips.

Microcontrollers are used in instinctually controlled products and devices, such as car engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other unsegregated systems. By decreasing the size and cost compared to a prototype that uses a microprocessor, memory and discrete input / output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components necessary to control non-digital electronic systems. It is typically shown in Fig 5.

2.5. Relay

A relay is a galvanizing functional switch. Many relays use an electromagnet to self-propelled functional switch, but other operating principles, such as solid-state relays, are also used. The relays are used where it is ineluctable to control a circuit by means of a different low power signal, or where other circuits must be modulated by a signal. The first relays were used in the long-distance telegraph circuits as amplifiers: they continue signals from one circuit and impart it in another circuit. The relays were widely used in telephone exchanges and early computers to perform logical operations. It is typically shown in Fig 6.

3. Proposed Mechanism

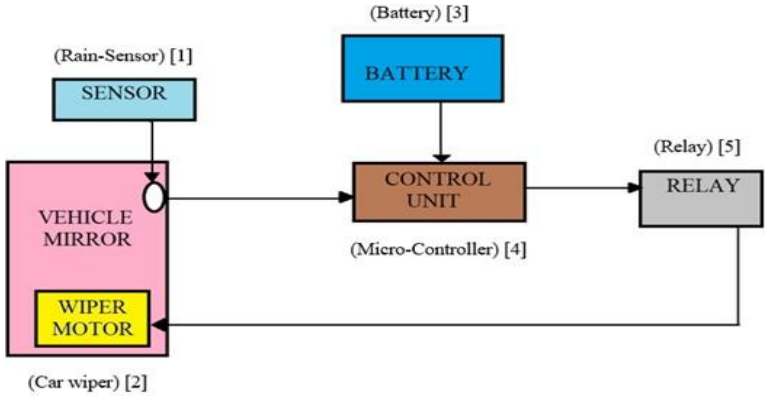


Fig 6: Working of self-executing rain sensing wiper controller.

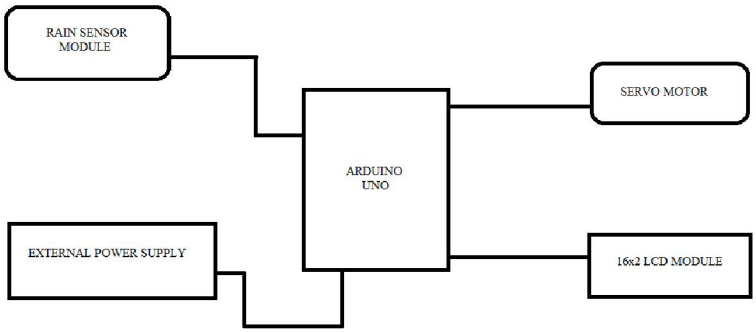


Fig 7: Architecture of self-executing rain sensing wiper controller system.

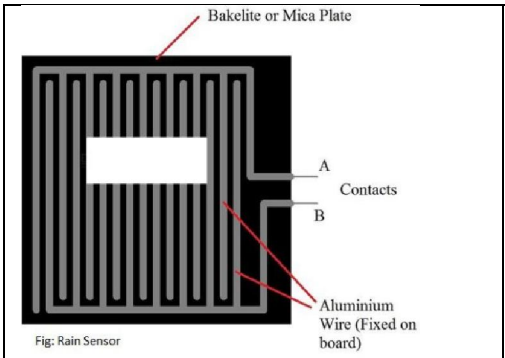


Fig 8: Architecture of rain detector.

Fig 9: Rain detector on the windshield.

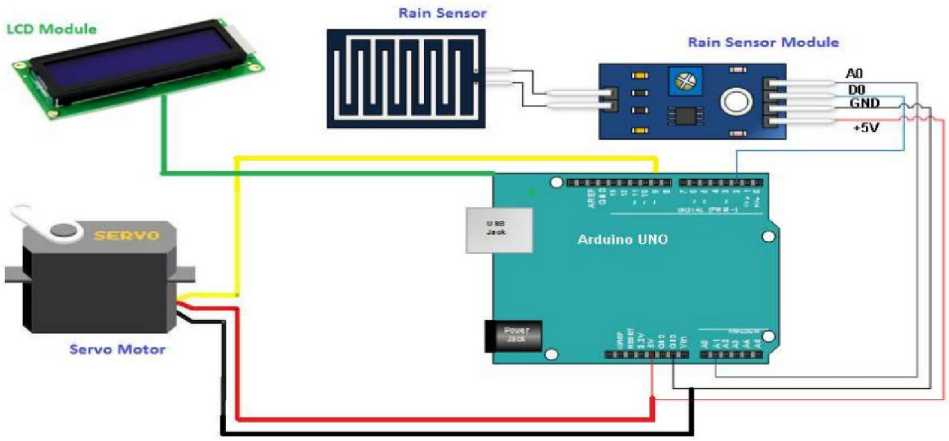


Fig 10: Arduino implemented circuit diagram.

4. Components required for implementation

The various components that are required for the implementation of the above proposed model are discussed as below:

- **Small Rain Detector**: A rain sensor or rain switch is a switching device activated by rainfall. There are two main applications for rain sensors. The first is a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall.
- **Timer IC**: The timer IC is an integrated circuit used in a variety of timer, pulse

generation, and oscillator applications.

- **Transistors**: A transistor is a miniature electronic component that can do two different jobs. It can work either as an amplifier or a switch: When it works as an amplifier, it takes in a tiny electric current at one end (an input current) and produces a much bigger electric current (an output current) at the other.
- **PN Junction Diode**: A p-n junction diode is two-terminal or two-electrode semiconductor device, which allows the electric current in only one direction while blocks the electric current in opposite or reverse direction. ... When the n-type semiconductor is joined with the p-type semiconductor, a p-n junction is formed.
- **Resistor**: Resistor is an electrical component that reduces the electric current. The resistor's ability to reduce the current is called resistance and is measured in units of ohms (symbol: Ω). If we make an analogy to water flow through pipes, the resistor is a thin pipe that reduces the water flow.
- **Capacitor (Polarized):** 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.
- **Ceramic Capacitor**: Ceramic capacitors are majorly used in the resonant circuit in transmitter stations. Class 2 high-power capacitors are used in high voltage laser power supplies, power circuit breakers, induction furnaces etc. Surface mount capacitors are often used in printed circuit boards and high-density applications
- **Buzzer (or Speaker)**: The buzzer consists of an outside case with two pins to attach it to power and ground. ... When current is applied to the buzzer it causes the ceramic disk to contract or expand. Changing the This then causes the surrounding disc to vibrate. That's the sound that you hear.
- **Breadboard**: A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

5. Viscosity

A Fluid is a matter that can flow ultimately and determines the shape of the containing vessel because it can-not oppose shearing pressure so, both liquid and gaseous are fluid.

It is the patrimony of fluid by efficacy of which an internal force of friction comes into play when a fluid is in kinesics and which oppose the relative kinesics between its separate layers. The backward streeling force called viscous drag or viscous force acts tangentially on the layers of the fluid in kinesics and tends to destroy its kinesics.

The atoms or molecules in a fluid are sorted in a random manner. A fluid cannot oppose tangential or shearing stress. It begins to flow when a shearing stress is applied. A fluid has no precise shape. It ultimately assumes the shape of the containing vessel. So, a fluid has no modulus of rigidity. A fluid can endeavor a force in a direction perpendicular to its surface so, a fluid has a vast modulus of rigidity.

5.1. Coefficient of Viscosity

Suppose a liquid is flaccid in the form of parallel layers on a stable horizontal surface. Examine two layers P and Q at distance x and X+ DX from the solid veneer and moving with velocities V and V+DV respectively. Then DV/DX is the ratio of change of velocities with distance

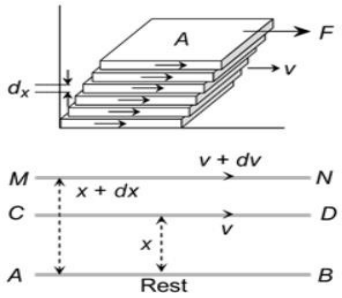
in the direction of extending distance and is called velocity gradient.

5.2. Factors Affecting Viscosity

Viscosity is initial and premier function of the material. The viscosity of water at 21℃ is 1.0020 milli-pascal seconds. Most prevalent liquids have viscosities on the sequence of 1 to 01,000 mPas, other gases have viscosities in the sequence of 1 to 10 µPa s. Pastes, gels, emulsions, and other different liquids are harder to condense.

5.2.1. Temperature

The viscosity of a water goes down with the increase in temperature. The increase in temperature results in the brisk increase of the standard molecules movement and the total amount of time molecules spend "in contact" with their near neighbors decreases. Thus, as temperature increases, the average intermolecular strength decreases.



5.2.2. Pressure

Viscosity is basically individualistic of coercion unless liquids are under enormous pressure often experience anincrease in viscosity. Since liquids are regularly incompressible, an increase in pressure doesn't really bring the molecules substantially closer together.

$$F \propto A \text{ and } F \propto \frac{dv}{dx}$$

$$\therefore F \propto A\frac{dv}{dx}$$

$$\text{or } F = -\eta A\frac{dv}{dx}$$

Table of Viscosities

SIMPLE LIQUIDS	T(°C) η (mPa s) gases	T(°C) η (µPa s)
Oil, machine, light	20	102
Oil, machine, heavy	20	233
Oil, motor, SAE 20	20	125
Oil, motor, SAE 30	20	200
Oil, motor, SAE 40	20	319
Propylene Glycol	25	40.4
Propylene Glycol	100	2.75
Water	0	1.79
Water	20	1.00

6. Advantages of Using Self-Executing Car Wipers Over Manual Controlling Wipers Ease of Operation

The Operating principle of self-executing wiper mechanism will be very easy because there is no need of operating the switch manually.

Power Consumption

As the manual wipers were also operated on the battery power. This wiper also consumes the negligible amount of battery power for operating in an automation mode.

Simple Installation

Installation of rain detector-based system is very much simple.

Cost

The rain detector device is used for detection of water droplets on the windscreen. When the water droplets are being identified by the rain detector device so it switches the wiper automatically on.

There is a very minimal cost being involved in installing the individual rain detector. But it can reduce the headache of the driver a lot by not operating the wipers in manual mode.

Self-Execution made possible

Rain detectors help to perform operations self-executing ally without making efforts thereby reducing the driver effort for manual operation of the same. The driver can fully focus on driving during the rain also.

Driver Safety & Comfort

In manual wiper mode, the driver needs to operate (Switch On/off) the wipers as and when the rain droplets are being poured on the windscreen of the car. This hampers the safety and security of the driver a lot as this leads to mind distraction. But, with the wiper automation the driver will remain tension free as he need not to operate the same manually. The driver safety as well as the comfort will also be high with this technology.

High operation accuracy

Since the rain detector sensors and automatic wiper control mechanism is installed with n number of testing. So, the accuracy of the same will be quite high

7. Conclusion

In the present automobiles the number of facilities is much higher. The driver has to concentrate on road while driving, and with increased traffic, things get frustrating. The features in the car like GPRS to trace the route, music system, air condition system etc. may drive away the attention of the driver. Thus, an effort has been made to reduce the effort put by driver in controlling the wiper during the rainy season and put more focus on his driving. As, a motivation of the same we have tried to propose a real time-based model for reducing the cumbersome task of wiper operation by the driver manually. Thereby, a self-executing operation of the car wipers will work on the windshield. By the use of Rain detector, Relay, Wiper, Water detecting sensor, Arduino board the operations of the entire system are going to be operated, as it also saves the electricity. Controlling of system on user's virtue can also be achieved through device like GSM (Global System for Mobile communication is an architecture used for mobile communication). hardware implementation is reliable and cheap of this project. In order to avoid false detection of rain, it requires rain detectors to take decision after few minutes. This system works only in the case if water falling on the glass only.

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References

Lee, Mark (2010). Cypress Semiconductor Corp The Art of Capacitive Touch Sensing, PlanetAnalog.com, 06

Hashim N.M.Z, Husin S.H, Ja'afar A.S & Hamid N.A.A, (2013), International Journal of Application Smart Wiper Control System"or Innovation in Engineering & Management, 2(3) Pp. 409-415.

Park, J.-H., Kim, M.-H., Im, H.-J., Lee, K.-C., and Lee, S. (2006). Development of vision-based control smart windshield wiper system for intelligent vehicle' in SICE-ICASE, 2006, International Joint Conference. IEEE, 2006, pp. 4398–4403.

Khan I.A. and Gupta K. (2015). Design of RainDetection System for Power Windows International Journal ofAdvanced Research in Computer Science and Software Engineering5(4), pp. 1523-1527.

Netzer, Y. (2000). A differential windshield capacitive moisture sen- sor', eP Patent 0,753,438, May 17 2000.

Mishchenko, M.I., Hovenier J.W. and Travis L.D. (2000). Light scattering by nonspherical particles: theory, measurements, and applications." 1827.

Veerasamy and Vijayen S. (2009). Rain sensor with capacitive-inclusive circuit, U.S. Patent No. 7,561,055.

Reddy P.A. and Prudhvi G.S. (2018). Self-executing rain sensing car wiper, International Journal of Advance Research, Ideas and Innovations in Technology,5(5), pp 657-661.

Kurihata, H., Takahashi, T., Ide, I., Mekada, Y., Murase, H., Tamatsu, Y., & Miyahara, T. (2005). Rainy weather recognition from in-vehicle camera images for driver assistance, In IEEE Proceedings, Intelligent Vehicles Symposium, (pp. 205-210).

Yan, X., Luo, Y., & Zheng, X. (2009). Weather recognition based on images captured by vision system in vehicle. In International Symposium on Neural Networks. Springer, Berlin, Heidelberg.pp. 390-398.

Broggi A., (2000). Intelligent Vehicle Applications Worldwide, IEEE Intelligent Systems, 15(1), pp. 78–81.

Cheok, K. C., Kobayashi,K., Scaccia, S. and Scaccia, G., (1996), A Fuzzy Logic-Based Smart Self-Executing Windshield Wiper, IEEE Control Systems, 16(6), pp. 28–34.

Figueiredo, L., Jesus, I., Machado, J.A.T., Rerreira, J.R. and Carvalho, J.L., (2001). Towards the Development of Intelligent Transportation Systems, 2001 IEEE Intelligent Transportation Systems Conference Proceedings, pp. 1206–1211.

Foo, S.Y., (2000). A Fuzzy Logic Approach to Fire Detection in Aircraft dry Bays and Engine Compartments, IEEE Transactions on Industrial Electronics, Vol. 47, No. 5, pp. 1161–1171.

Lee, C.C., (1990a), Fuzzy Logic in Control Systems: Fuzzy Logic Controller—Part I, IEEE Transactions on Systems, Man, and Cybernetics, Vol. 20, No. 2, pp. 404–418.

Lee, C.C., (1990). Fuzzy Logic in Control Systems: Fuzzy Logic Controller—Part II, IEEE Transactions on Systems, Man, and Cybernetics, Vol. 20, No. 2, pp. 419–435.

Lee, H.C. and Tomizuka, M. (2003). Adaptive Vehicle Traction Force Control for Intelligent Vehicle Highway Systems (IVHSs), IEEE Transactions on Industrial Electronics, 50(1), pp. 37–47.

Dogra, M., Singh, Y., Bhateja, N., & Singh, M. (2017). Mobile Application for Vehicular Auto Locking System, International Journal of Advanced Research in Computer Science, 8(7), pp 857-859.

Kulkarni T.S., Holalad H.S. (2012). Semi-Automatic Rain Wiper System, International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, 2(7), pp.2250-2459.

Madankar, S.B., & Khanapurkar, D.M.M. (2011). Intelligent Rain Sensing using Automatic Wiper System. In 2nd National Conference on Information and Communication Technology (NCICT). pp. 27-29.