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# Determine and Overcome Challenges that Cause Failure in the Automatic Braking System in Driverless Cars

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## ABSTRACT

The automatic braking system of cars relies on remote infrared ray object detection, this research focuses on the applied results of a hand-made infrared remote sensing device and obtains practical results of the efficiency of the remote infrared sensing device that is used now on the self-braking systems, in different weather conditions and the position of the Sun in the sky (intensity of Sunray) as well as various variable such as the colour and temperature of the obstacle to improving this device to be able to do its function properly without car accidents, in the meantime the electronic system of the automatic braking system must be connected to the speedometer device of the car to make the car brake at high speeds for obstacle objects from greater distances, and reduce that distance at lower speeds. If the car was moving at high speed, even braking the vehicle a few meters away from the obstacle objects may not help to prevent the accident because the vehicle will keep moving and collide with the obstacle objects due to the momentum generated in the material of the car at high speed, adding a camera and computer and an artificial intelligence program to diagnose objects in the used system could reduce errors and malfunctions and avoid accidents. Considering the light polarization features in the used infrared ray of the automatic braking system via an added polarization filter in the emitter and the same sort of filter in the receiver (infrared sensor), to receive the same angle of the polarized infrared ray, to identify the used infrared ray of the same car strictly, and to separate the rest of the received infrared rays either from the artificial or natural sources in the infrared ray sensor.

**Purpose:** Determine the factors that cause failure in the automatic braking system to improve this device to be able to do its function properly without car accidents.

**Method:** Collect data concerning the remote infrared ray object detection device in different weather conditions to improve this system's recently used technique to function properly without car accidents.

**Results:** The used frequencies in the remote infrared sensing device are greatly affected by the surrounding circumstances because the used frequencies are very close to visible ray frequencies. Therefore, changing the frequencies of the used infrared rays of this system to the longer wavelength could reduce the effects of the surrounding circumstances, and reducing the rates of absorption and refraction rates through different density media could increase the efficiency of the remote infrared ray and improve the efficiency of this device in the automatic braking system, preventing car accidents caused by a failure in the remote infrared ray object detection device.

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**Keywords:** Failure in the Automatic Braking System, Infrared Remote Sensor, Automatic Braking System in Driverless Cars

## Introduction

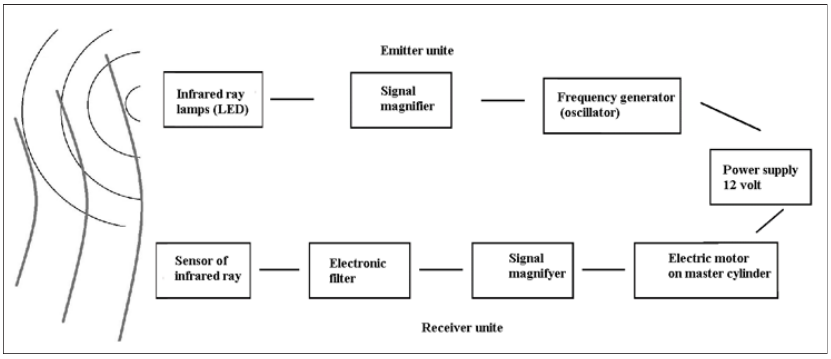
Driverless cars operate independently with little or no human supervision, where they can determine their locations and move independently, completing tasks based on artificial intelligence. There are many companies working in this field, and the expected volume of investment in the global market of autonomous cars will reach 2.3 trillion US dollars by 2030 [1]. For instance, the robot taxis where the start-up Cruise [2] is offering taxi services for people in the United States and deploying a fleet of cars, rigged with sensors and programmed with various navigation algorithms. There are several applications used in driverless cars, such as LiDAR, RADAR, Infrared (IR), Sonar, and ultrasonic applications: in this study, we shall focus on Infrared (IR) that is often used in the automatic braking system to investigate its mechanisms, challenges and solutions [3]. I this research we shall focus upon the infrared sensors where it represents the best sensors in driverless cars [4]. In order to develop the recently used system for the autonomous braking system, we have to identify the factors that reduce the efficiency of the remote sensing system by the infrared rays, taking into account weather conditions, natural and artificial resources of the infrared rays, physic characteristics of electromagnetic waves for each frequency and wavelength, and physic characteristics of the material at different temperatures. To identify the factors that undermine the operation of the automatic braking system for vehicles. We must know the electronic circuits used in this system, identify their weak points, and improve them by adding the required accessories that support the operation of these electronic circuits.

We must also know the properties of the electromagnetic waves used (infrared rays) and their spectra, frequencies, and how they are affected by their surrounding conditions to choose the most appropriate frequencies for this system so that the automatic braking system performs its function in the best way possible. Because the way these circuits work is one of the examples of the interaction between electromagnetic waves with the materials in the electronic circuits as well as in the materials of the environment surrounding the electronic system, in this research, we find laboratory experiments and results as well as solutions to avoid any failure in the automatic braking system in driverless cars to prevent car accidents caused by malfunction of parts of this system. Designing a system of automatic braking should consider the speed of the car, where the higher the speed, creates a greater the momentum in the car, when the car at high speed, the car will remain in motion for a long distance even though the tires stop as a result of braking. In this case, the electronic system of the automatic braking system must be connected to the speedometer of the car to make the braking from greater distances of the obstacles at high speed, and reduce that distance at lower speeds. In the meantime, the existence of other sources of infrared radiation interference occurs with the radiation used for the self-braking system, and when it enters the receiver sensor, it leads to distorted currents in the sensor outputs that are not proportional to the frequency of the electronic filter designed to allow them to pass. Therefore, adding the features of polarization light to the used infrared ray of the automatic braking system, for the emitter and the receiver for the same angle of polarization could help strongly identify the used infrared ray of the same car and prevent the infrared ray from reaching the sensor.

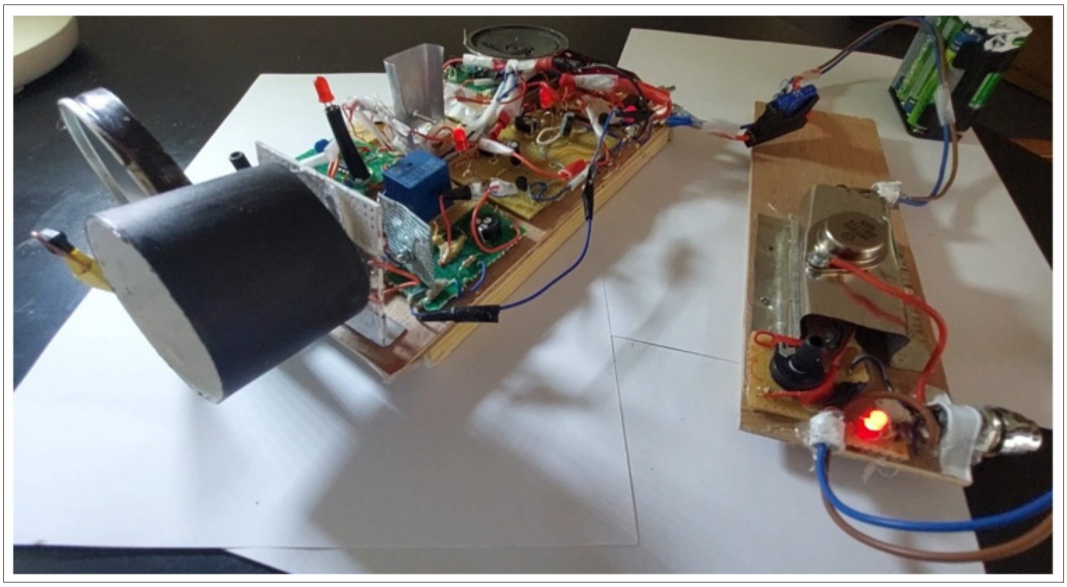
This will reduce the distortion that occurs in the electronic system of the automatic braking system and reduce the probability of failure. It is important to install sensors to measure the rates of infrared ray in the environment around the car to notify the driver that the automatic braking system of the car is stopped, and he should depend upon himself in braking when it needs, this will also protect car producer companies of prosecutions if any accidents occur due to the failure in their systems, to prevent car accident and protect life of people, also protect car producer companies of prosecutions if any accidents occur due to the failure in their systems.

The Electronic Parts in the Automatic Braking System are: An automatic braking system is an important part of safety technology for automobiles, it is an advanced system, specifically designed to either prevent a possible collision or reduce the speed of moving vehicle, before a collision with another vehicle, pedestrian or an obstacle of some sort. These systems combine sensors, such as radar, video, infrared, or ultrasonic to scan for possible objects in front of the vehicle, and then use brake control to prevent collision if the object is in fact detected. Where the automatic brakes are one of many car safety features and are often integrated with other technology, such as pre-collision systems and adaptive cruise control, in order to activate the brakes in time if the driver fails [5]. The general idea of parts of automatic braking system [6]: The automatic braking system is composed of the following parts: ABS control module, brake booster, disc brakes, drum brakes, emergency brake, master cylinder, brake pedal, and wheel speed sensors, but here we shall focus on the electronic parts that cause failure in the self-braking system in the wheels and result in car accidents [7,8]. It`s the issue of running the electric motor automatically (via the cruise control) via the accessory electronic circuits [9] pushing the piston in the master cylinder the brake fluid sending the pressurized brake fluid to the wheel cylinder located inside the brake drum. This pressure causes the pistons in the cylinder to expand and press the brake shoes against the inner surface of the brake drum, which creates friction to help slow the spinning of the wheels or stop the vehicle.

1. Infrared emitters, consisting of LEDs with a specific frequency infrared ray [10], emit certain pulses per second (with a specific frequency of about 10 to 100 hertz or even more), which value the specified identity of the car on the road among the rest of the cars that use the same self-braking system.
2. The infrared sensor [11] is used on the receiver circuits for infrared rays.
3. An electronic filter [12] allows passing only the infrared ray with the specific frequency used by emitters of the same car (to identify the frequency used for that car when it has been reflected from the surface of the obstacle in the road and not passing only the infrared for the rest of other cars in the road).
4. Electronic signal magnifying circuit to magnify the output signal from the infrared ray sensors to run electric motor connected to the hydraulic system of the car's braking system. Parts of the automatic braking system as shown in illustration (1) show how this system works to detect the obstacle via detecting the reflected infrared ray, where the emitter consists of the infrared ray projector (LED lamps), an electrical power source of 12 volts, a frequency-generating unit (the oscillator), and an amplifier unites the magnifying the signal from the output of the oscillator to a high electrical current equal to the amount required to operate the infrared projectors and lenses to focus rays in the desired direction. The receiver consists of an infrared sensor, an electronic filter, a signal magnifier, and an electric motor circuit to run the master cylinder to push the hydraulic fluid into the vehicle's braking system.




The illustration (1) the emitter and receiver parts of the infrared ray object detection in the automatic braking system.



The image (1) shows the laboratory model of the infrared remote sensing device.

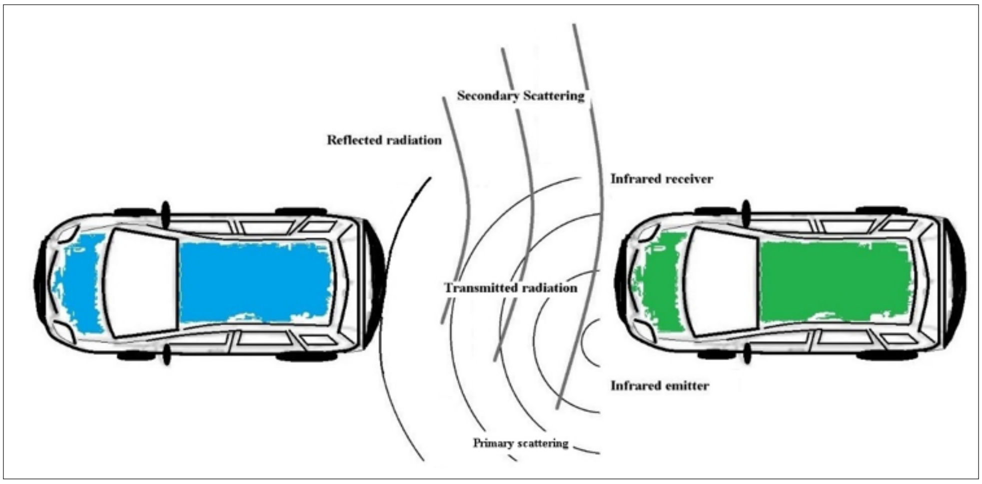
How the Automatic Braking System works: When an obstacle obstructs the path of the car the used infrared radiation from the emitter of the car will collide with the obstacle object, and some of that reflected radiation will arrive at the receiver of the car (the infrared sensor), an electrical signal emerges from the sensor towards the electronic filter to identify the used frequency signal of the car. If the electronic filter passes the signal, that means it`s the correct signal used at the frequency of the same car, then the electronic signal will be magnified by the amplification circuit that is connected directly to an electric motor to perform its function of injecting the hydraulic fluid of the hydraulic system of braking system, thus the car stops automatically before making a car accident, as depicted in the illustration (2), several stages of scattering occur for the used infrared rays, where a very small rate is received by the sensor. The reflected part suffers from a second scattering during reflection, where the presence of fog or raindrops will lead to extra scattering of the rays that pass through these raindrops because infrared rays have the same properties as visible radiation [13], where the process of transmitting and receiving infrared rays in the automatic braking system, as the transmitted radiation suffers from scattering, and a small percentage reaches the obstructing object. Note that the existence of another car that is coming from the opposite direction is also using the automatic braking system, which couldn't affect the braking process of the first car because the filter used for the first car allows passing the frequency emitted from the infrared lamp pulses but not the frequency emitted from the infrared lamp pulses of the second car due to the different pulse frequencies of the second that may only pass through the infrared lamp pulses of the first car that may be reflected from the obstacles or the presence of an obstruction in front of the first car. But receiving two different frequencies at the same time results in mixing them in the sensors and generating confusing electric frequencies from the output of the sensor that may not be able to pass through the electronic filters, and this causes confusion in the automatic braking system of the car because the generated electronic frequency from the output the sensor (the current pulses) of the out-put of the sensor will not be at the same value as the cut-off electronic filter used to recognize the radiation pulses used for the first car, and no signals will come out from the filter to the first car to the magnifying circuits nor the electric motor of the hydraulic system of the car's braking system, therefore the accident will occur even though the entire automatic braking system of the first car is working properly.

General reasons cause the Failure in the Automatic Braking System

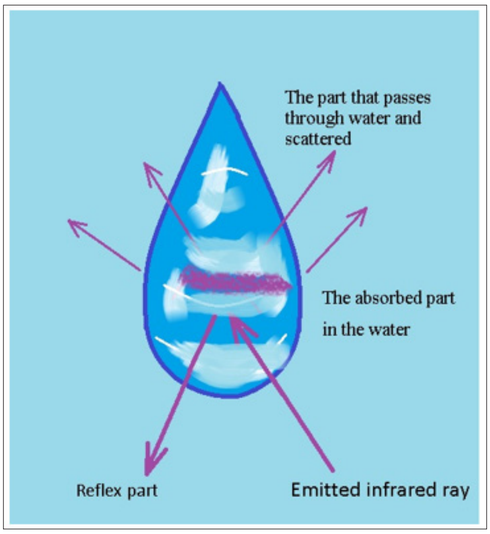
During the times of sunset, when the percentage of infrared radiation in the sun's rays increases, a high rate of infrared radiation in the sun's rays leads the interference receiver to be mixed with the infrared rays used in the automatic braking system, so that the infrared sensor receives two radiations of infrared radiation, one from the sun and the second from the car's infrared ray emitters that are reflected from the object interfering in the direction of the car. This leads to the generation of an almost distorted electrical current from the sensor, and this is not able to pass through the electronic filter that is designated to determine the frequency (emitter pulses) that is used for the system, so the car does not break and an accident occurs.

Many sorts of scattering occur for the used infrared ray and cause a decrease in the rate of radiation received by the sensor:

1. Scattering of radiation caused during the refraction.
2. Scattering is caused by passing the radiation through different media densities.
3. The absorbed rate of infrared rays (thermal rays) by low energy obstacles.
4. Scattering is one of the basic physical properties of radiation during its release.



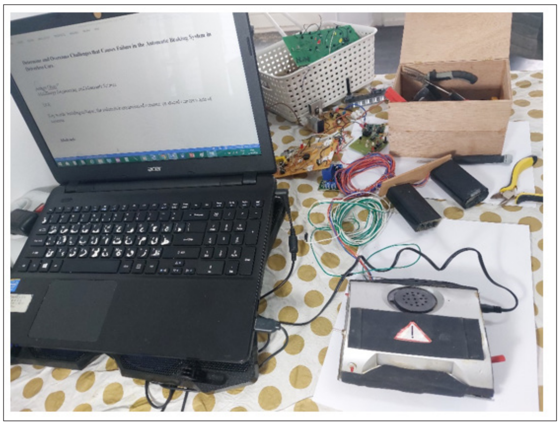

*The illustration (2) shows the process of transmitting and receiving infrared rays in automatic braking system, which suffers from many sorts of scattering radiation, such as that caused during refraction, passing the radiation through different media densities, and the absorbed part of infrared rays (thermal rays) by low energy medias and obstacles, as well as the scattering represents one of the basic physical properties of radiation during its release.*



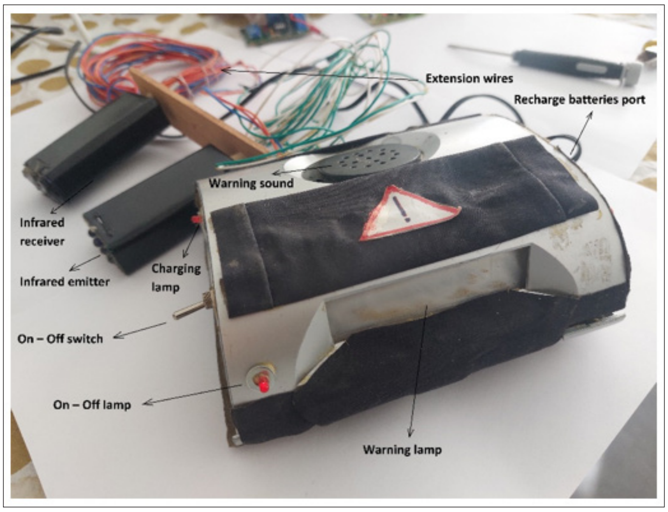

*The illustration (3) shows the scattering of the emitted infrared ray during the raining as a reflex part, the part that passes through water and scatters, and the absorbed part in the water.*

The handmade device for the infrared remote sensor consists of the following items:

1. Infrared emitting circuit.
2. Infrared sensing circuit.
3. A light and sound alarm circuit.

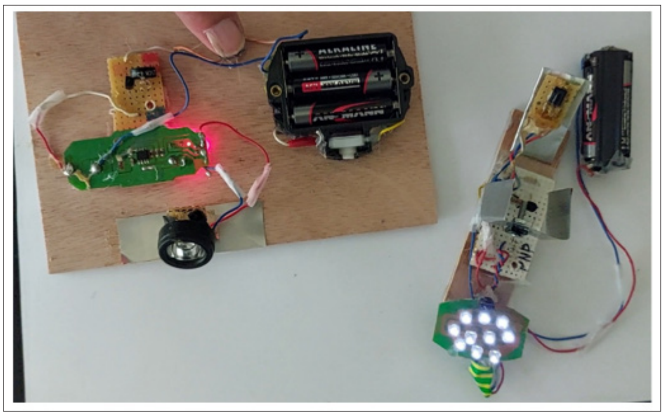


The image (2) the handmade infrared ray object detector.



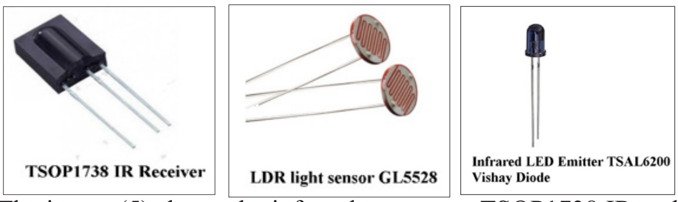

*The image (3) is for the remote sensor that sends and receives infrared rays, the device is made by remote control devices and a handmade infrared detector circuit.*

The image (4) shows what happens inside this device, where the emitter consists of the remote-control circuit, which pivots to keep running to emit an infrared beam, whereas the receiver consists of an infrared sensor. The signal gets transmitted to the signal magnifier circuit via a first transistor (BD 557), then to the second transistor (BD 140), to be able to run the light and sound alarms circuit. The purpose of organizing this device is to identify the physical properties of infrared rays in different conditions and the extent of the effects of environmental conditions such as temperatures and the rate of infrared rays in sun rays, as well as the colour of the obstacles that may affect the efficiency of the remote sensing system in sensing objects.



*The image (4) is forming circuits inside the remote sensor device that sends and receives infrared rays.*

A very important note was identified during our electronic circuit applications of the infrared emitters and receivers, where the infrared sensor such as the TSOP1738 IR type does not react like the normal light sensor such as the LDR light sensor GL5528 type. In the normal light sensor such as the LED light sensor GL5528 type, the signal continues to transmit the signal to the installed magnifying circuit as long as light is exposed on the sensor. But when infrared rays are directed at the infrared sensor, such as the TSOP1738 IR type, the signal gets created and transmitted to the magnifying circuit for just the first moment only, and then it stops creating and transmitting the signal despite the continued directing of infrared rays at it. Here it was important to connect electronic circuits that convert direct current to pulsed current supplies the infrared LED emitter such as the TSAL6200 Vishay diode of the infrared emitter in order to generate infrared rays from the intermittently as pulses, thus the infrared sensor such as the (TSOP1738 IR) type will keep transmitting the signal and converting it to the installed magnifying signal circuit, and what greatly increases the efficiency of this system is the use of a digital system in the emitter, which consists of a microprocessor using an ADC (analog to digital converter), that converts the analog function into digital, as shown in the illustration 9 at the page 20, therefore, when designing an infrared emitter for the remote sensing devices, it is important to ensure that there is a microprocessor that converts the analog function into digital frequencies to obtain the best results at the emitter and receiver in the device.




The image (5) shows the infrared ray sensor TSOP1738 IR and the light sensor LDR light sensor GL5528 as well as the Infrared LED Emitter TSAL6200 Vishay Diode.

The efficiency of the remote sensor can be increased in several ways, such as increasing the sensitivity of the magnifying circuits installed for the infrared sensor, an example of this is replacing an amplification circuit (IC 741) instead of the transistor (BC 557) as shown in the image (6), where the (IC 741) has a very high sensitivity, in operational amplifier (IC 741), also called an op-amp is an integrated circuit primarily designed for performing analog computations and has a very high voltage gain typically of the order of 105 (100dB) [14] in the meantime, the used circuit has a low-frequency filter that reduces the possibility of preventing many frequencies from interference and affecting upon the receiver circuit. Here the transistor (BD 140) is used to amplify the signal coming from the (IC 741) circuit to operate the light and sound alarm of the device. Note that concave mirrors or lenses with the sensor could increase the device's efficiency by collecting the largest possible number of infrared rays reflected from the obstacle towards the sensor.

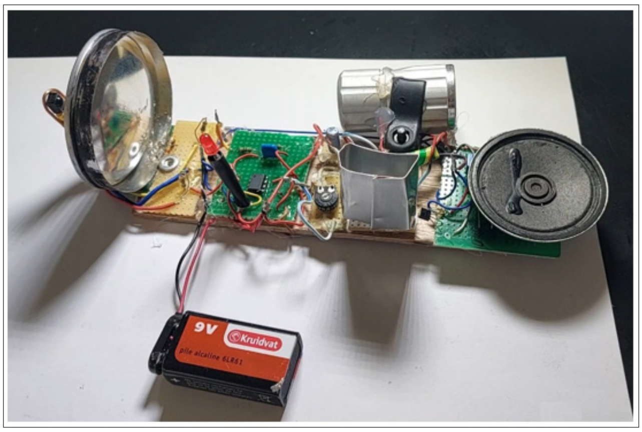



Image (6) shows the receiver circuit is replacing a magnifying circuit of (IC 741) instead of the transistor (BC 557) where the (IC 741) has a very high sensitivity with the low-frequency filter and the concave mirrors with the sensor to increase the device's efficiency via collecting the largest amount possible of infrared rays reflected from the obstacle towards the sensor.

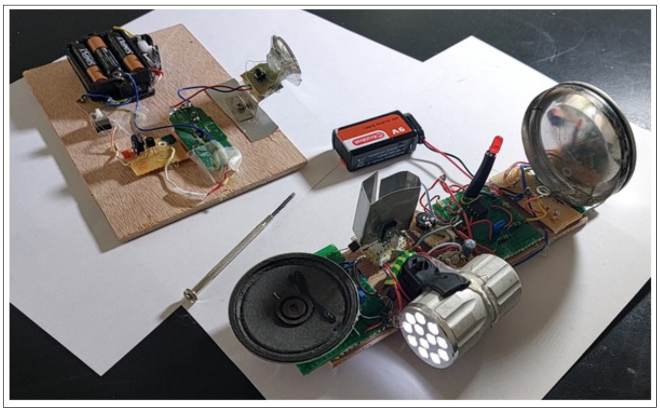
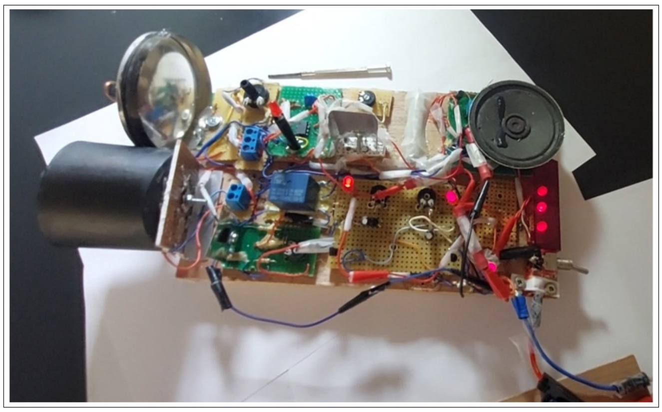


*Image (7) shows the receiver in operation receiving the infrared ray reflected from the obstacle.*

Laboratory model of the advanced version of the remote sensing device: The image (8) shows a laboratory model of the advanced version of the remote sensing device on page (15), where all parts of this device are hand-made and no part is pivoted from another circuit. The emitter part consists of a flip-flop circuit of two transistors (BC 547), a pulses signal is the output of one of the transistors to the magnification circuit composed of transistors (BD 139) in order to operate the relay, which it runs to cut the electric current from the power supply to the three infrared LEDs, thus the infrared ray LEDs generate regular intermittent infrared rays at the frequency which is equal to the frequency of the signal coming out of the flip-flop circuit. When the infrared sensor of the receiver part of the device receives the reflected infrared ray from the obstacle, the electrical signal gets generated and sent to the magnifier circuit composed of IC 741 and then to the second magnify circuit composed of transistors (BD 139) to operate the optical and audio alarm circuits. This version is distinguished by a greater advantage than its predecessor in the higher intensity of the infrared rays generated in the emitter circuit and the high sensitivity of the receiver circuit, so it performs its function over greater ranges and distances than in the previous version. After several tests of this modified device (on the roads), we got the same results as the previous version but with clearer results.



*The image (8) shows a laboratory model of high intensity infrared ray and high sensitivity of the remote sensing device.*

If the option is to modify the electronic circuits to save time and effort and make them suitable for a remote-sensing device, the best option is to use the 2-channel IR remote receiver with relay (24VA/DC 1A max) as shown in the image (9), where the channel and reception indication through LEDs, toggle / pulse for each channel, with most Velleman Kit IR remotes: MK 162, K6710, K805, K8049.

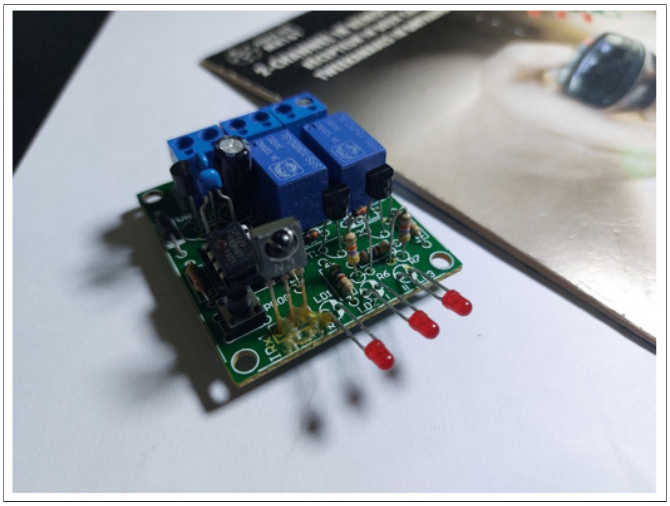
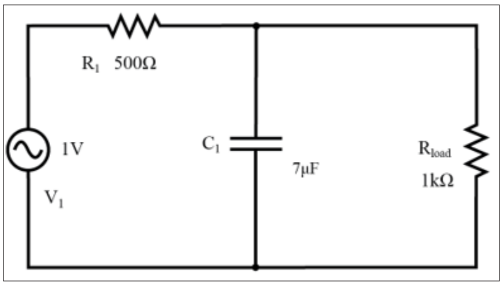


*Image (9) is for the 2-channel IR remote receiver with relay (24VA/DC 1A max), Channel and reception indication through LEDs, toggle / pulse for each channel, with most Velleman Kit IR remotes: MK 162, K6710, K805, and K8049, [15].*

Note that we found through practical applications that this circuit carries a microprocessor in the remote control emitter and the receiver so that it encodes the emitted and received signal, therefore it couldn't be affected at all by other remote control signals, consequently, this is more suitable in the automatic braking applications after connecting one of the relays with the electric motor of the master cylinder so that it operates it as soon as the sensor receives the signal reflected from the obstacle object. But this modification can happen for educational or experimental purposes, on the application level, the difference in frequencies of the installed devices must be considered in order not to affect each other on the road, and this is possible by manufacturing such a circuit with the participation of the producing company and adding the feature of controlling the frequency or encryption of this circuit by computer, in the meantime improving the intensity of the infrared ray of the emitter and the sensitivity of the receiver is also important to expand the active zone of this circuit.

**Low-pass Filters [16,17]**

This circuit of the components of the device is used to cut-off frequencies that do not belong to the installed the device on the car, and in order not to be affected by the rest of the frequencies used by the rest of the devices on the rest of the cars using the same system on the road, where all low-pass filters are rated at a certain cut-off frequency. That is the frequency above which the output voltage falls is 70.7% of the input voltage. This cut-off percentage of 70.7 is not really arbitrary, although it may seem so at first glance, in a simple capacitive/resistive low pass filter, it is the frequency at which capacitive reactance in ohms equals resistance in ohms. In a simple capacitive low-pass filter (one resistor, one capacitor), inserting the values of R and C from the last spice simulation into this formula, we arrive at a cut-off frequency of 45.473 Hz. When we look at the plot generated by the spice simulation, we see the load voltage well below 70.7% of the source voltage (1 volt) even at a frequency as low as 30 Hz, below the calculated cut-off point, but when the load resistance of 1 kΩ affects the frequency response of the filter, skewing it down from what the formula told us it would be without that load resistance in place, produces a bode plot whose numbers make more sense, as shown in the illustration (4).

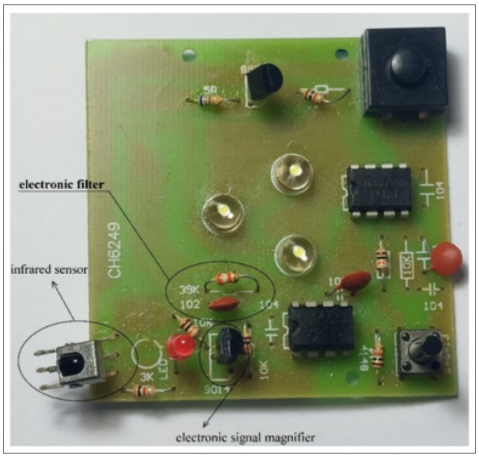



*The illustration (4) of the low-pass filters, which determines the frequency that operates in the range of the device, should be equal to the frequency of the emitter pulses used in the same device.*

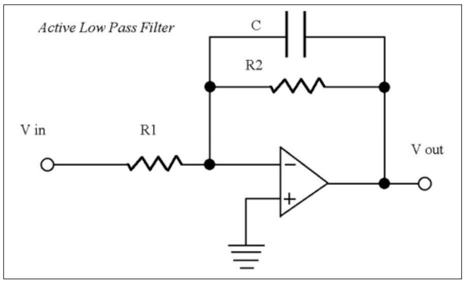
**Cut-off Frequency:** All low-pass filters are rated at a certain cut-off frequency, the frequency above which the output voltage falls below 70.7% of the input voltage. This cut-off percentage of 70.7 is not really arbitrary, although it may seem so at first glance. In a simple capacitive/resistive low-pass filter, it is the frequency at which capacitive reactance in ohms equals resistance in ohms. In a simple capacitive low-pass filter (one resistor, one capacitor) the cut-off frequency is given as:

$$f_{cutoff} = \frac{1}{2\pi RC} \qquad (1)$$

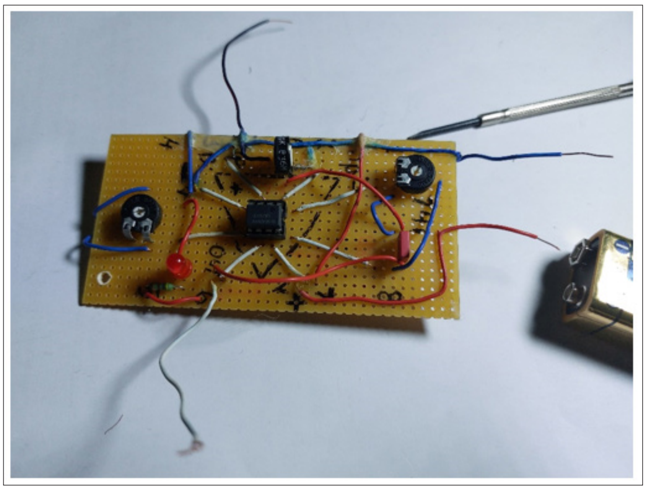
Inserting the values of R and C into this formula, we arrive at a cut-off frequency of 45.473 Hz. We see the load voltage well below 70.7% of the source voltage (1 volt) even at a frequency as low as 30 Hz.




*The image (10) shows the receiver circuit, which consists of an infrared sensor, low-pass filters, and an electronic signal magnifier.*

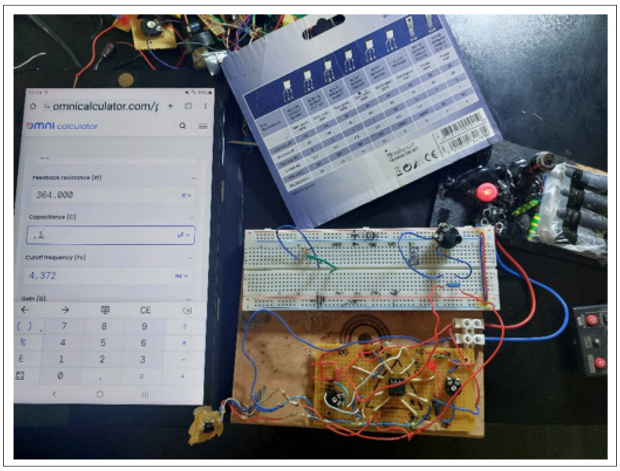



*The illustration (5) shows an example of an active low pass filter Inverting 0p low-pass filter diagram, the IC used is 741 op-amp.*



*The image (11) for example of low pass filter use IC 471 and variable resistor to change the value of the frequency required in our device.*

This is a practical example to calculate the frequency value of inverting op-amp low-pass filter when the value of resistor (Rf) is 364 Ω and the value of capacitor (C) is 0.1 uF, the value of frequency calculated via the formula (1) allows to pass is 4.772 Hz as seen the image (12) with the details if the circuit and the online calculator.




*The image (12) for example of low pass filter use IC 471 and variable resistor is an example to calculate the frequency value of inverting op-amp low-pass filter when the value of resistor (Rf) is 364 ohms and the value of capacitor (C) is 0.1, the value of frequency calculated via the formula (1) allows to pass is 4.772 Hz with the details of op-amp low-pass filter, the circuit and the online calculator.*

An active low-pass filter is a filter that passes signals with a frequency lower than a certain cut-off frequency and attenuates signals with frequencies higher than the cut-off frequency.

It must be acknowledged that the automatic braking system for cars relies on a remote sensing system that depending on sending and receiving infrared rays, collects all data about the automatic braking system of cars, the materials used are not manufactured to construct the remote sensing device, but the device works normally, when the device detect an object, a specific sound is generated and a lamp runs on the front of the device.

Important Information has been collected about the Remote Sensing System
During checking this device, and this is the collected data from our experiments on the remote sensing system that relies on sending and receiving infrared rays:

- The best working condition for this device is in cold weather, at night when the complete absence of sunlight for sensing cold objects with white colour in temperature limits lower than 20 degrees Celsius and being able to sense them through a distance of around ten meters.
- The efficiency of the device drops to 50% during the day when Sun's ray are at high intensity.
- The efficiency of the device and the sensitivity (the distance of detection) increase for cold objects and light colours especially after sunset when the Sun's rays are absent, and that increases much more during the night.
- The device stops working completely, or a significant disturbance occurs during sunset hours, when the rates of infrared rays increase in the Sun's rays.
- The efficiency of the device decreases extremely by sensing hot objects by (30-40) degrees Celsius.
- The efficiency of the device and the sensitivity (the distance of detection) decreases for the dark colour objects.
- The device's ability stopped completely for hot black colour objects even from a very short distance.
- Confusion occurs during rain, the device continues to warn when there is nothing in front of it.

**These are some footages of the experiment of infrared rays sensing objects:**
1. The scene is during sunset, where the devise stopped working completely and is unable to detect for any object.

*Image 13*

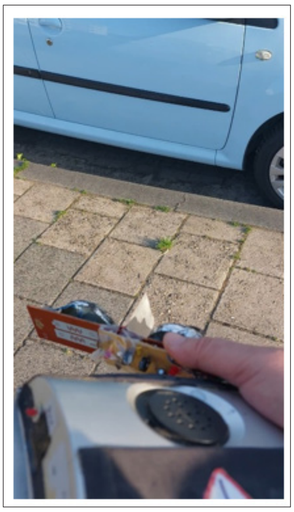


*Image 14*

In images 13 and 14, the device cannot detect any objects, even in white car during the sunset.

2. After sunset and the absence of sunlight, the device's ability to detect objects is restored.

*Image 15*

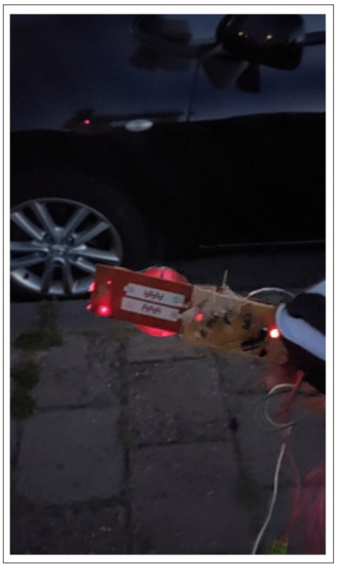


*Image 16*

In images 15 and 16, the device is able to detect white objects with high efficiency and the rest of the colours with less efficiency, while being unable to sense black objects at all.

The second infrared ray remote sensing device with the high intensity of infrared ray of the emitter and high sensitivity of the receiver, the results are identical to the previous test, as we see that the device is able to sense the white car from a greater distance (around 15 meters) than the distance it senses rest of colours (around 8 to 5 meters) and it is also unable to detect the black colour car.

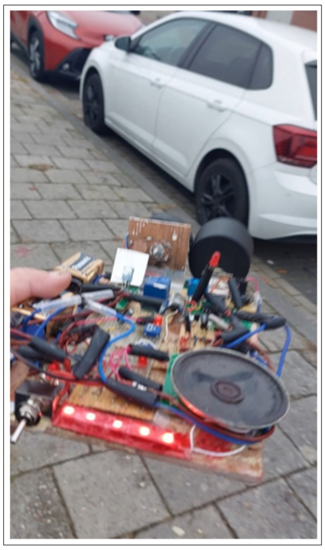


*Image 17*

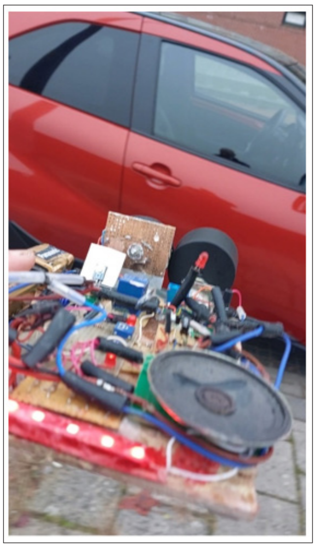


*Image 18*

In images 17 device is able to detect the white car from distance 15 meters and in images 18 the device is able to detect red colour from 8 meters.

*Image 19*

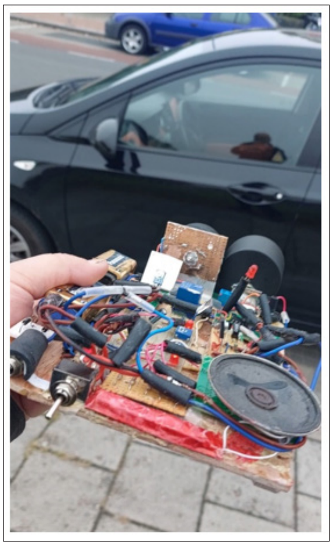
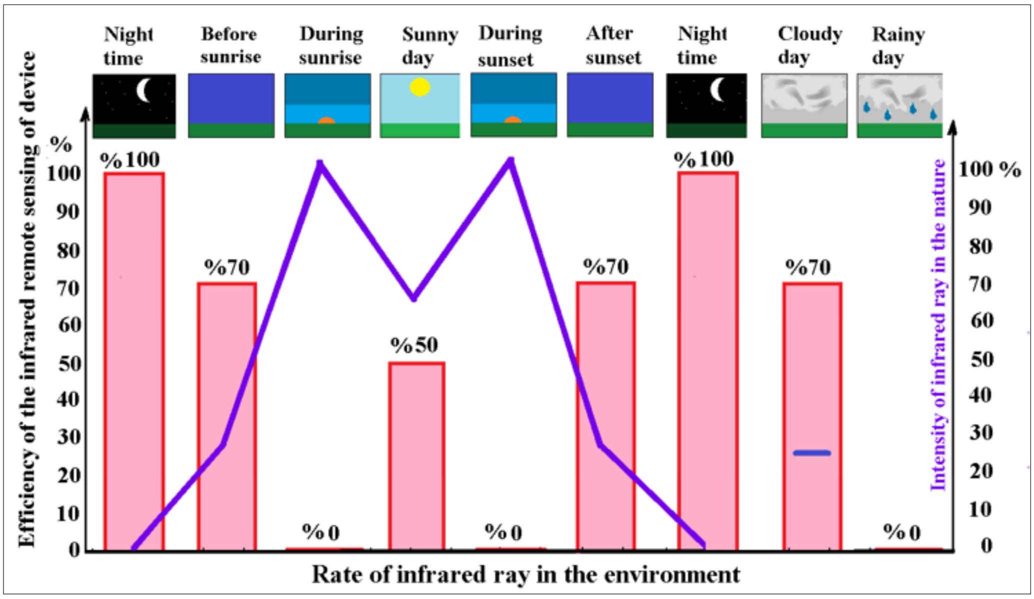


*Image 20*

In images 19 device is able to detect the grey colour car from distance 7 meters and in images 20 the device is unable to detect black colour car completely.

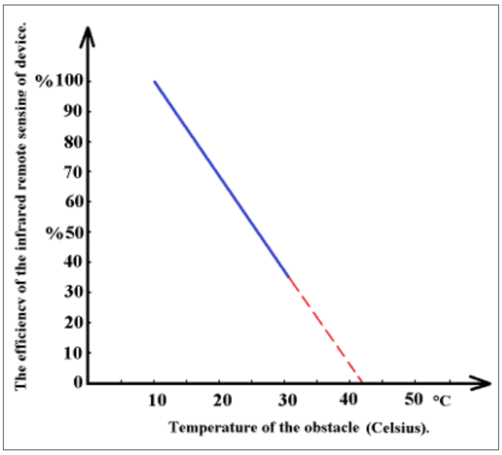
Critical point: during our work to increase the intensity of the generated infrared ray of the emitter, we found the high rates of intensity distort the device because some of this generated infrared ray will be reflected by the dust or fog in the air; therefore, the maximum intensity of the generated infrared ray shouldn't reach the level to be affected by the dust or fog to keep the device running properly. Briefly, an infrared remote sensing device is susceptible to weather conditions, as we sometimes find it works precisely and senses objects from long distances, but the next day we found it not working at all and unable to detect any object, so we even suspected the existence of a technical fault in the device until it became clear that this device is greatly affected by the surrounding atmospheric conditions between the device and the obstructing object. The illustrations (6, 7, and 8) show the efficiency of the infrared remote sensing device during a different environment circumstance, temperature, and the colour of the obstacle.




*The illustration (6) shows the effect of the rate of infrared ray in the environment upon the efficiency of the infrared remote sensing of device.*

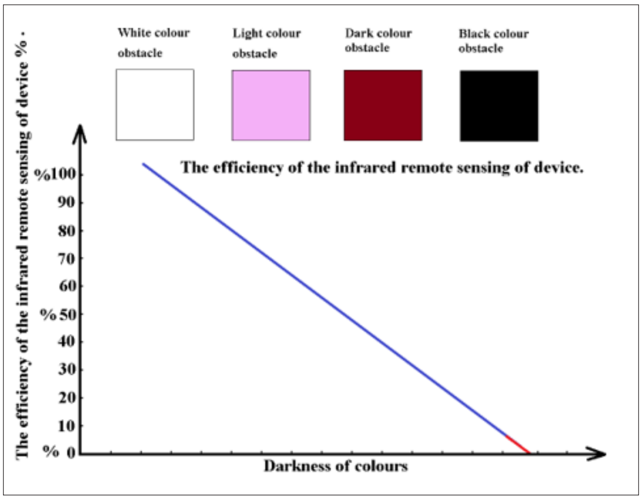
During the rain, fog, and dust, a high rate of infrared rays from the emitter reflects from drops and particles of rain, fog, or dust to the receiver as shown in the illustration (3), causing distortions and leads and halting the inferred ray remote sensing device temporarily and being unable to detect any object properly.

As known that the infrared rays are part of the thermal spectrum, as shown in illustration (9) therefore they are strongly affected by the temperature of the medium they pass through and also by the temperature of the obstacle being exposed, as shown in the illustration (8) the rates of reflected infrared rays from surfaces varies according to the degree of darkness of the surface from which they are reflected, as a result of a large percentage of them being absorbed by those surfaces.




*The illustration (7) shows the effect of the temperature of the obstacle upon the efficiency of the infrared remote sensing of device.*

The physical properties of infrared rays make them behave like visible rays, as they can be absorbed by the surfaces they collide with and reflected at different rates and percentages according to the colour of the surface, as visible rays are affected.



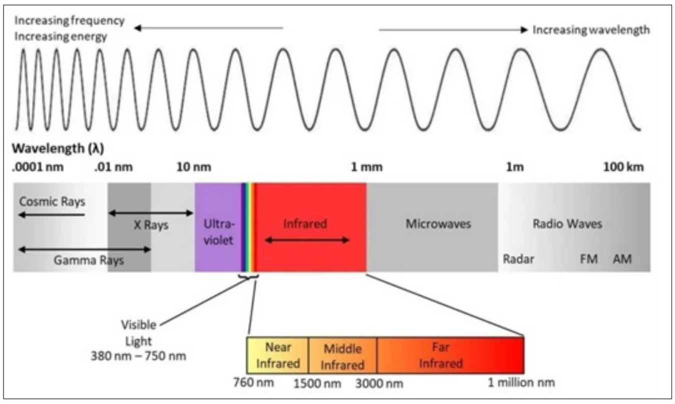

*The illustration (8) shows the effect of the colour of the obstacle upon the efficiency of the infrared remote sensing of device.*

Note that these results are approximate and preliminary and were recorded during ongoing experiments to test the efficiency of the infrared remote sensing device in different conditions depending on the ability of detecting, where the efficiency represents the distance that the device can detect the obstacle.

**Critical note:** Through our practical experiments, we knew that the LEDs of infrared rays run at specific values of voltage and amperage, where less than the determined values leads to stopping affecting the infrared ray sensor. Therefore, we have to avoid using any sort of transistor that supplies electric charge directly to the infrared ray LEDs, instead of using a relay. Therefore, once we design the emitter of the infrared ray for the remote sensing device, we have limited choices to make these LEDs work at specific rates of voltage and amperage, such as using a relay linked directly with the LEDs, and making the relay run to open and close electric circuit at a specific frequency according to the oscillator installed either the IC 555 or flip flop circuit, we may have another choice, as, running the LEDs with DC at its specific value of voltage and amperage, and in the meantime to run second electric circuit that creates pulses (oscillator and power transistors) to create negative charges to cancel the electric charge that supplies the infrared ray LEDs, thus these LEDs will run at it specific values of voltage and amperage and in particular frequency according to the value of the frequency generated via the installed oscillator. But this cancelling should not be done directly but to run another sort and colour of LEDs to prevent creating heat that may cause damage to the electric circuit. Otherwise, linking the transistor directly with the LEDs may fail to supply the specific value of voltage and amperage determined for the used LEDs. Where the second sort and colour of LEDs shouldn't be at the same place as the infrared ray of the ammeter to keep the generated rays invisible while running the automatic braking system. It will result in failure of running LEDs properly and failure in the entire system of the infrared ray remote sensing devices.

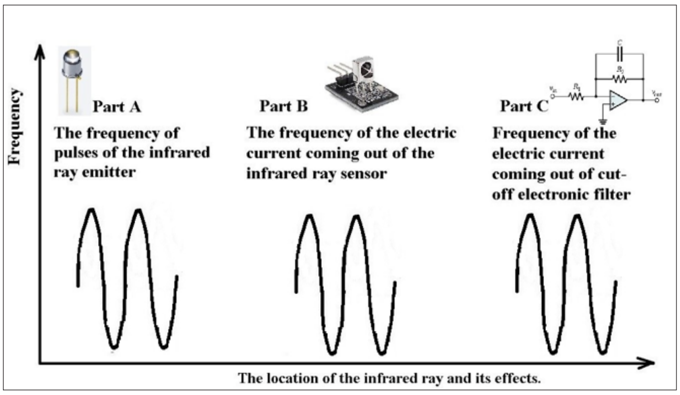
**Infrared Radiation [18]**

Infrared radiation usually goes unnoticed, but it's something you encounter every day. Toasters, incandescent bulbs, and remote controls use infrared energy, as do industrial heaters used in drying and curing materials and medical uses, Infrared radiation is a heating source in saunas as a sort of physiotherapy to treat high blood pressure and arthritis. It's important to note, though, that infrared saunas could be harmful for those with melisma or other skin pigmentation issues. They generally consist of 750 nm to 1,300 nm wavelengths, and this is what a remote control uses to change the channels. There are three general regions of the infrared frequency: the near-infrared frequency (nearest the visible spectrum), with wavelengths of 0.78 to about 2.5 micrometres, the middle infrared frequency, with wavelengths of 2.5 to about 50 micrometres, and the far infrared frequency, with wavelengths of 50 to 1,000 micrometres.

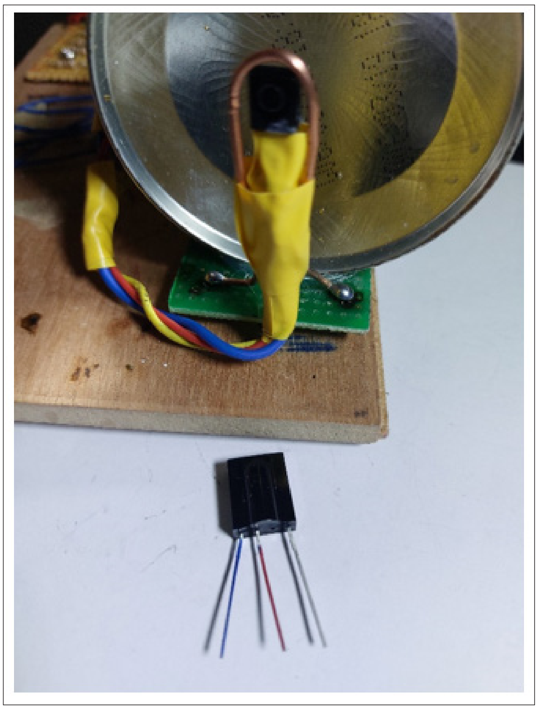



*The illustration (9) shows the infrared radiation categories in the electromagnetic spectrum.*

Briefly, the circumstances that undermine the efficiency of this system are the hot objects (which emit infrared rays) and the black objects (have the ability to absorb a high percentage of the infrared rays used by the device). Note that the backlights of cars light up in red, so if the front driver applies the brakes to stop his car and the red warning lights turn in the most highly intense, especially if the lamps are of the LED type, they may generate a high percentage of infrared rays capable of disrupting the automatic braking system of the car behind them. Because red radiation especially that generated by LED lamps, contains a high percentage of infrared rays able to confuse the receivers of the sensors and electronic filters of the car that use automatic braking system behind it via interference, the used infrared ray of the automatic braking system in the sensor creates confusion for the electronic filters of cars with the automatic braking. Whereas it has become common to use electronic circuits that convert direct current into a pulsed current that feeds LED lamps to increase the brilliance of their light or for decorative purposes, this will also create confusion for the automatic braking system.

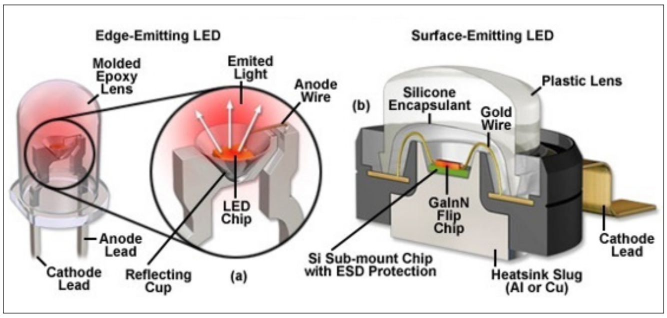



*The illustration (10) shows in part A the frequency of the emitter pulses, which is equal to the frequency of the current coming out of the infrared ray sensor in part B and equal to the frequency of the cut-off electronic filter, this case, the automatic braking system runs successfully.*



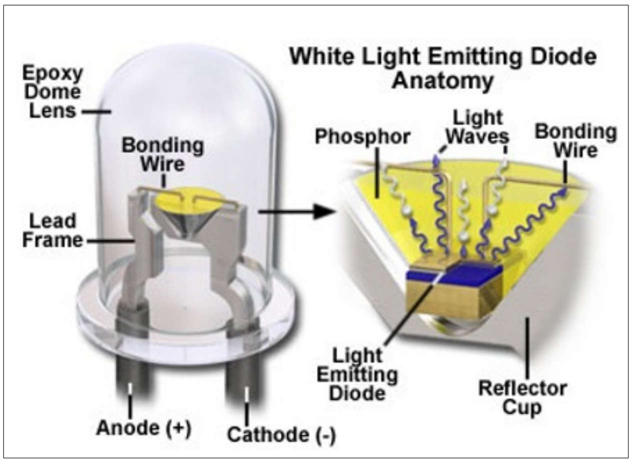
*The image (21) is an infrared sensor (TSOP1738 IR Receiver)[19].*

**LED architecture and design concepts:** Photon-emitting diode p-n junctions are typically based on a mixture of gallium, arsenic, phosphorous, indium, and aluminium. The relatively recent addition of silicon carbide and gallium nitride to this semiconductor palette has yielded blue-emitting diodes, which can be combined with other colours or secondary phosphors to produce LEDs that emit white light. The fundamental key to manipulating the properties of LEDs is the electronic nature of the p-n junction between two different semiconductor materials. When dissimilar doped semiconductors are fused, the flow of current into the junction and the wavelength characteristics of the emitted light are determined by the electronic character of each material. In general, current will readily flow in one direction across the junction but not in the other, constituting the basic diode configuration. This type of behaviour is best understood in terms of the transition of electrons and holes in the two materials and across the junction. Electrons from the n-type semiconductor move to the positively doped (p-type) semiconductor, which has vacant holes, allowing electrons to "jump" from hole to hole. The result of this migration is that holes appear to move in the opposite direction, or away from the positively charged semiconductor toward the negatively charged semiconductor. Electrons from the n-type region and holes from the p-type region recombine in the vicinity of the junction to form the depletion region, as shown in the illustration (11), in which no charge carriers remain. Thus, a static charge is established in the depletion region that inhibits current flow unless an external voltage is applied.




*The illustration (11) LED Architecture and Design.*

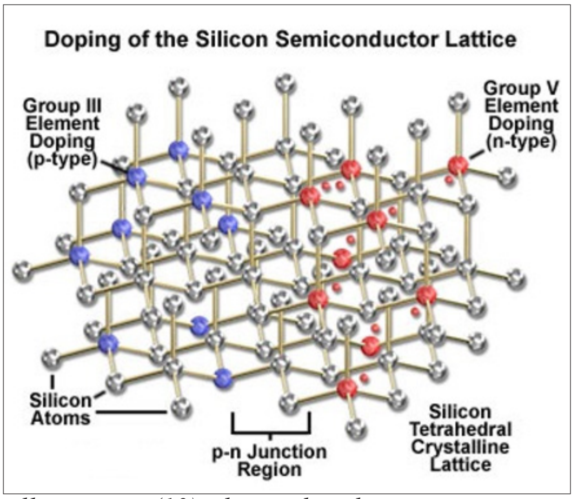
Photon-emitting diode p-n junctions are typically based on a mixture of elements, such as gallium, arsenic, phosphorous, indium, and aluminium; the relatively recent addition of silicon carbide and gallium nitride, the fundamental key to manipulating the properties of LEDs is the electronic nature of the p-n junction between the two different semiconductor materials. When dissimilar doped semiconductors are fused, the flow of current into the junction and the wavelength characteristics of the emitted light are determined by the electronic character of each material. Current will readily flow in one direction across the junction but not in the other, constituting the basic diode configuration [20]. We are focusing in this research on low frequency filters (circuits, calculations, and applications) because their frequency limits are the most suitable for LED applications, whether in infrared or other frequency limits are the most suitable for LED applications, whether in infrared or other frequencies, because the mechanism of how LED works consists of several elements and its specific design is more complex than traditional lamps, as shown in the illustration (12), therefore, it needs a longer period to reach peak performance from the off state; therefore, during the high frequency circuits, LEDs couldn't get sufficient time to reach peak performance due to the very short time interspersed pulses.




*The illustration (12) shows the specific design, parts and elements that consist LEDs*

The fundamental key to manipulating the properties of solid state electronic devices is the nature of the p-n junction. When dissimilar doped materials are placed in contact with each other, the flow of current in the region of the junction is different than it is in either of the two materials alone. Current will readily flow in one direction across the junction but not in the other, constituting the basic diode configuration. This behaviour can be understood in terms of the movement of electrons and holes in the two material types and across the junction. The extra-free electrons in the n-type material tend to move from the negatively charged area to a positively charged area, or toward the p-type material. In the p-type region, which has vacant electron sites (holes), lattice electrons can jump from hole to hole and will tend to move away from the negatively charged area. The result of this migration is that the holes appear to move in the opposite direction, or away from the positively charged region and toward the negatively charged area, as shown in the illustration (13). Electrons from the n-type region and holes from the p-type region recombine in the vicinity of the junction to form a depletion zone (or layer), in which no charge carriers remain. In the depletion zone, a static charge is established that inhibits any additional electron transfer, and no appreciable charge can flow across the junction unless assisted by an external bias voltage. For this reason, low-frequency circuits are best suited for operating LEDs, and in return, there will be a need to deal with low-frequency filters in the circuits of their receivers as well, To improve the performance of LEDs in identifying the identity of the vehicle on the roads, use the digital filters in addition to running beside the low-frequency filters, which can control the secondary details in the frequency functions during running LEDs in their emitter and receiver circuit [20] [21].

7.2 Simple conceptual description of the basic mechanism by which LEDs produce light: The fundamental processes underlying the function of light-emitting diodes and the materials utilized in their construction are presented in the ensuing discussion. The light-emitting diode employs a form of electroluminescence that results from the electronic excitation of a semiconductor material. The basic LED consists of a junction between two different semiconductor materials in which an applied voltage produces a current flow, accompanied by the emission of light when charge carriers injected across the junction are recombined.

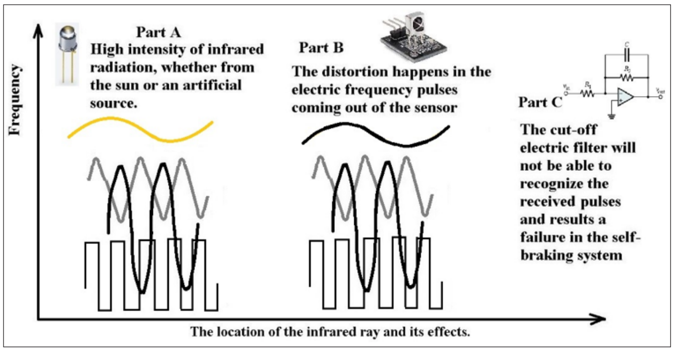



*The illustration (13) shows the electronic excitation of a semiconductor material that consists of a junction between two different semiconductor materials in which an applied voltage produces a current flow.*

Each combination of charges is associated with an energy level reduction that may release a quantum of electromagnetic energy in the form of a light photon. The frequency, and perceived colour, of emitted photons is characteristic of the semiconductor material, and consequently, different colours are achieved by making changes in the semiconductor composition of the chip [21].

**The Effects of the Presence of other Sources of Infrared**

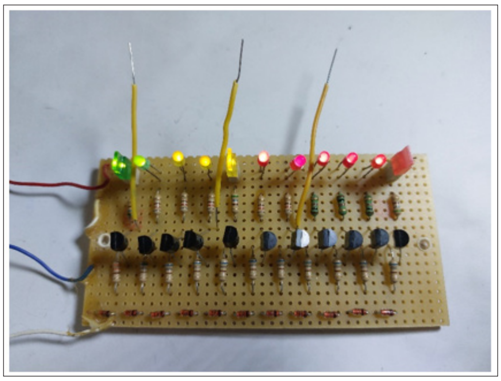
Presence of other sources of infrared radiation interference occurs with the radiation used for the automatic braking system, and when it enters the receiver sensor, it leads to distorted currents in the sensor outputs that are not proportional to the frequency of the electronic filter designed to allow them to pass as shown in Illustration (14), this prevents any signal passing towards the magnification circuits or the braking system, causing a traffic accident where the distortion does not include only low frequencies, but rather medium and high frequencies, as well as the electronic filter that uses digital codes such that used in remote control systems.




*The illustration (14) in the event of a high intensity of infrared radiation, whether it is from the sun or an artificial source (the same type of devices in other cars, or the lights of the red backlight, especially those using red LED lamps with a high percentage of infrared radiation), part B shows the distortion that happens in the electric frequency pulses coming out of the sensor, and the cut-off electric filters will not be able to recognize the received electric pulses, which will result in a failure in the automatic braking system and cause a traffic accident.*

Surrounding the sensor with a high intensity of infrared radiation from natural resources such as sunlight prevents the weak signal from passing toward the sensor this leads to generating a high-intensity DC from the sensor outlet preventing filters from doing their function properly and getting them out of function, where interfering several rays with the used received ray artificial resources either (the same type of devices in rest of cars, or the lights of the red backlight of vehicles in the road, especially those uses red LED lamps with a high percentage of infrared radiation) distort the received signal prevent them to pass through the electric frequency filter and our original signal will not be able recognized by our used filters causes failure in the automatic braking system a traffic accident. Other sources of infrared radiation interference occur when the radiation is used the automatic braking system, when it enters the receiver sensor it leads to the generating distorted currents in the sensor outputs that are not proportional to the frequency of the electronic filter designed to allow it to pass, this prevents any signal from passing towards the magnification circuits nor to the braking system this causes a traffic accident where the distortion does not include only low frequencies, but rather medium and high frequencies, as well as the electronic filter that uses digital codes such that used in remote control systems, as a result of the interference of the high-intensity infrared rays from the sun's ray with the low-intensity infrared rays assigned to the device, where the first antagonizes and cancels the function pulses of the second function pulses frequency, preventing the filter from sorting the used frequency of the remote control system device.

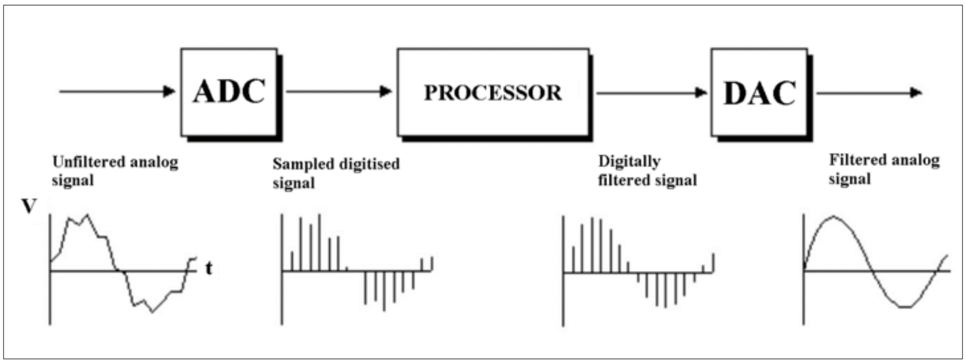
**Important note:** Through practical experiences, it has become clear that when the frequency of the infrared LED (pulses per second) is increased, the amount of glowing decreases, and the solution was increasing the voltage of current towards the LED of the emitter to raise the level of illumination. Note that infrared rays are not visible to human eyes, but we can see the glow by using the electronic camera of the mobile phone, while in the traditional case of continuous operation without pulses, the infrared LED emitter needs a certain value of voltage and amps, and the value should not exceed what is specified by the manufacturer to maintain the integrity of the lamp and prevent it from being damaged. Here, laboratory tests should be conducted to obtain data to know the range of voltage and current supplied to the infrared LED for each frequency and to operate the lamps optimally and effectively to do their functions properly.



*The image (22) the LED meter the used transistor in this circuit is BC 547 B).*

Also, through practical experiences the best way to determine the level of danger on the road is the light LED meter and translate it to the practical state is to connecting the input (base) of the first transistor with the output electric signal coming out of the infrared sensor of the infrared remote sensing device, activates the light diodes in sequence. Thus, the closer the car gets to the obstacle, the received signal becomes stronger, and it will run a larger number of light diodes, where connecting the output of each transistor (collector) as shown in the image (22) to a magnifying circuit and a secondary circuit for specific function. The first group of transistors in the light LED meter specified to driver light warning, the same way the second group of transistors in the light LED meter specified the audio warning, and the third group of transistors in the light LED meter specified to run the relay circuit and the electric motor (via the cruise control) pushing the piston in the master cylinder the brake fluid sending the pressurized brake fluid to the wheel cylinder located inside the brake drum. This pressure causes the pistons in the cylinder to expand and press the brake shoes against the inner surface of the brake drum, which creates friction to help slow the spinning of the wheels or stop the vehicle. As much as the obstacle is farther away, as much as the ray suffers from scattering, the received signal of the reflected infrared ray is weaker, and the electric signal from the output of the sensor will also be weaker and will run the first group of transistors of the LED meter, and vice versa, as the obstacle gets closer to the vehicle, the received infrared ray will be at higher intensity, and the electric signal from the output of the infrared sensor will be stronger, allowing it to run the second and third groups of transistors of the LED meter.

**Identifying a car`s identity on the roads:** It`s a very important issue identifying a car`s identity on the roads, where there are a big number of cars using the same auto braking system in order to prevent the influences of their infrared ray upon each other, it`s important to use a digital signal that uses a processor to change the analog signal to a digital signal and vice versa, here it appears the importance of using the digital filters in the circuits of remote infrared ray object detectors, as shown in the illustration 12 the digital filter uses a digital processor to perform numerical calculations on sampled values of the signal. The processor may be a general purpose computer, such as a PC, or a specialized DSP (Digital Signal Processor) chip [22], in these circuits, the signal must first be sampled and digitized using an ADC (analog to digital converter), the resulting binary numbers, representing successive sampled values of the input signal, are transferred to the processor, which carries out numerical calculations on them. These calculations typically involve multiplying the input values by constants and adding the products together. The results of these calculations, which now represent sampled values of the filtered signal, are output through a DAC (digital to analog converter) to convert the signal back to analog form, where in the digital filter the signal is represented by a sequence of numbers rather than a voltage or current. The analog input signal first be sampled and digitized using an ADC (analog to digital converter), where the resulting is as binary numbers that are transferred to the processor that carries out numerical calculations on them, and these calculations typically involve multiplying the input values by constants and adding the products together; thus, the results of these calculations to represent sampled values of the filtered signal of the output through a DAC (digital to analog converter) convert the signal back to analog form.




*The illustration (15) shows the process of transferring the analog signal to the digital signal transferred to the processor, which carries out numerical calculations.*

A digital filter is programmable, and its operation is determined by a program stored in the processor's memory. It is easily designed, tested, and implemented on a general-purpose computer and, in the meantime, can handle low-frequency signals accurately according to the speed of DSP and is also able to be applied to high-frequency. In the fast DSP, processors can handle complex combinations of filters in parallel or cascade (series), making the hardware requirements relatively simple and compact in comparison with the equivalent analog circuitry.
For the function
yn = xn
y1 = x1
y2 = x2
…. etc.

Simple gain filter: yn = K.xn …..2

This simply applies a gain factor K to each input value.

K > 1 makes the filter an amplifier, while 0 < K < 1 makes it an attenuator, K < 0 corresponds to an inverting amplifier.

Analog filters are cheap, fast, and have a large dynamic range in both amplitude and frequency. Digital filters are vastly superior in the level of performance that can be achieved. For example, a low-pass digital filter has a gain of 1 +/- 0.0002 from DC to 1000 hertz and a gain of less than 0.0002 for frequencies above.[22]

**The sources of the Infrared Rays which Distort the Function of the System**

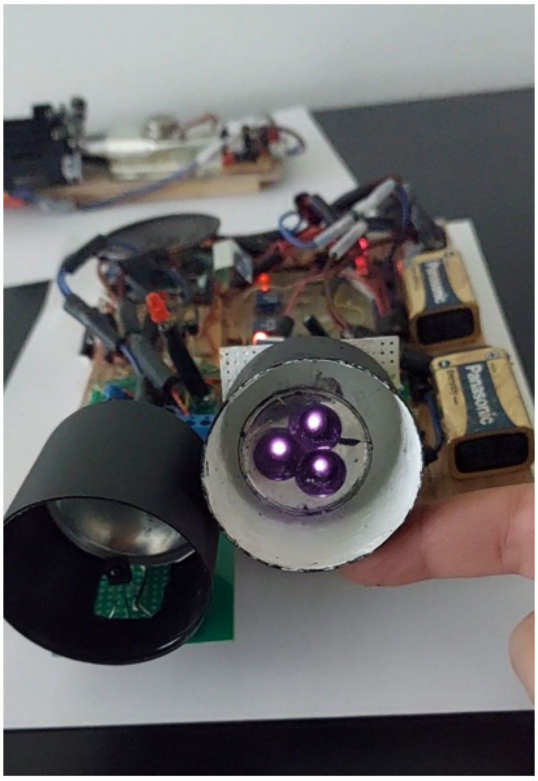
**1. Natural Resource of the Infrared Rays:** During the sunshine and sunset times a big ratio of the infrared rays of the sun rays will be scattered to the surface of the Earth due to the light diffraction phenomenon, where these big ratios of the infrared rays of the Sun rays will cover the sensors of the infrared rays for automatic braking system, because these scattered infrared rays of the Sun rays are at the same frequencies of the used infrared rays of these cars used by the radar of the driverless cars, that may distort and create a confusion in the functions of the driverless cars system and prevent of detecting objects properly on the roads and finally prevent the automatic braking of these driverless cars to run properly, note that the infrared rays are merely heat rays in the electromagnetic wave spectrum, therefore whenever the weather is cold, foggy, rainy, or snowy, these environmental circumstances of the weather around these driverless cars will absorb big rates of the heat rays (infrared rays) and this will also results failure to detectors of the emitted infrared rays and results failure in the automatically braking system of these driverless cars.

2. The infrared rays from artificial resources: The existence of several infrared radiation interferences either from the same sort of device used for the automatic braking system on the rest of cars or the lights of the red backlight of vehicles on the road, especially those use red LED lamps with a high percentage of infrared radiation), leads them interfering with the used ray in the receiver sensor of our device leads to the generating distorted currents in the sensor outputs that are not proportional to the value of the used frequency of the designed filter preventing signal passing towards the magnification circuits nor to the braking system, where the distortion does not include only the low frequencies, but rather medium and high frequencies, as well as the electronic filter that uses digital codes such that used in remote control systems, this will prevent the original signal to be recognized by used filters and causes failure in the automatic braking system and causes a traffic accident.

**The Effect of Speed on the Efficiency of the Automatic Braking System:** The higher the speed of the car, the greater the momentum generated in the car; therefore, when braking the car at high speed, the car will remain in motion for a long distance even though the tires stop as a result of braking. Therefore, the electronic system of the automatic braking system must be connected to the speedometer device of the car to make the car brake at higher speeds over greater distances from obstacles than distances at lower speeds. If the car is traveling at a high speed, even braking a few meters away from the obstacle objects may not help to prevent the accident because the car will keep moving and collide with the obstacle objects due to the momentum generated in the material of the car at high speed. The automatic braking system should consider the speed of the car and distance from the obstacle when deciding whether to brake. For example, when the vehicle moves at a speed of 30 km/h, it should consider the distance from the obstacle around 5 meters to brake, but when the car moves at a speed of 80 km/h, the remote detection system of the vehicle should be able to detect objects (through longer distances from the obstacle) and brake when the obstacle is in distance around 40 meters, considering the momentum of the car that rushes the car to a farther distance when it is at a higher speed to avoid a car accident. Momentum is one of the physical quantities known through classical physics as the product of a body's mass multiplied by speed [23]. One of the principles of conservation in classical physics applies to momentum, which is the principle of conservation of momentum or the law of conservation of momentum. The units of momentum are kilograms, meters per second kg.m/sec, or kg.m/h. or gram centimetres per second g.cm/sec. It is directly proportional to its mass and speed, as in the following relationship, because momentum is the producer of unit mass and velocity, we can express the momentum of a body with the letter **p**, and it has a proportional relationship to the amount of mass (**m**) and value of speed (**v**), as in the relationship:

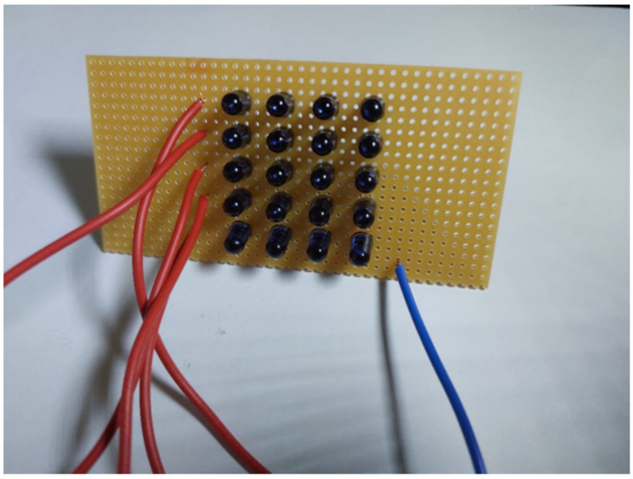
$$\mathbf{p = m.v} \quad .....3$$

Therefore, when a vehicle with a mass of 1,000 kg moves at a speed of 30 km/h, it will generate a momentum of 30,000 kg/h, but when the same vehicle with a mass of 1,000 kg moves at a speed of 80 km/h, the amount of momentum generated is 80,000 kg/h. Therefore, braking the vehicle at a speed of 80 kilometres per hour will let the vehicle continue to rush toward the incident body, and a collision will occur due to the high amount of momentum generated in the vehicle's body at the high speed. Here, the designer of the automatic braking system must consider the vehicle's speed and distance from the obstacle to decide whether to brake at suitable distances from the obstacle, and the remote infrared detection system must be able to detect objects for longer distances and brake when the obstacle is approximately 40 meters from the vehicle. The process should occur automatically by linking the sensor system with the vehicle's speedometer, so that at high speeds the intensity of the infrared radiation increases to reach a range of about 40 meters, and the braking process is performed within the limits of that range. Thus, the automatic braking system should consider the speed of the vehicle and the distance from the obstacle to decide when it should brake. For example, when the vehicle moves at a speed of 30 km/h, it should consider the distance of around 5 meters to brake, but when the car moves at a speed of 80 km/h, the remote detect system of the vehicle should be able to detect objects (through longer distances) and brake when the obstacle is around 40 meters, considering the momentum of the car that rushes the car to a farther distance when it is at a higher speed to avoid vehicle accidents.




*The image (23) is for the second handmade infrared ray remote sensing device with high intensity of emitter and high sensitivity of the receiver.*

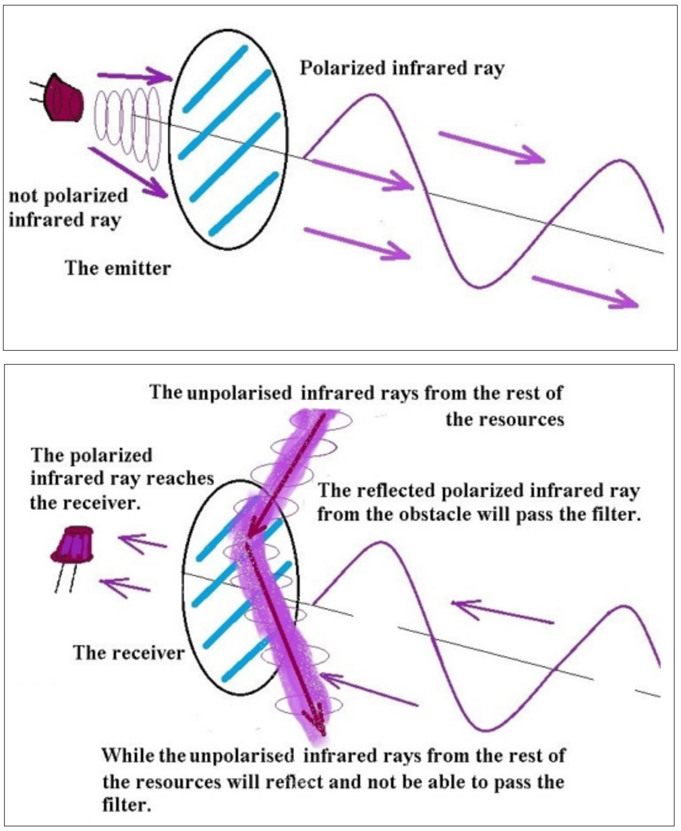
**Important note:** In case the decision is made to increase the glowing of the infrared LED emitter to reach the rays over longer ranges, the number of infrared LED running should be increased, but not the value of the supplied voltage and current to the infrared LED that was obtained from the producer of the infrared LED or our the results of our practical experiments.



*The image (23) shows the best way to control the intensity of radiation without changing the amount of voltage supplied to each infrared ray LED (TSAL6200 Vishay 940 Infrared Emitting Diode, 5mm), as the panel consists of a matrix of infrared ray LEDs, all of the cathodes of infrared ray LEDs of the matrix are connected, and the anodes of infrared ray LEDs are connected in each row. Thus, when the car moves at a faster speed, the electronic circuit in the speedometer connects a new row within the running rows to increase the intensity of the generated infrared ray, and vice-versa, when the speed of the car decreases, the electronic circuit separates electricity from some of the infrared ray LED rows, so the intensity of the radiation generated decreases.*

## Using the Feature of Light Polarisation in the Automatic Braking System

In the definition of light polarization [24] is a property of transverse waves that specifies the geometrical orientation of the oscillations. Polarized light can be produced by passing unpolarised light through a polarizer, which allows waves of only one polarization to pass through. Some materials have an optical activity that affects light differently depending on the polarization direction used in making polarizing filters. In the meantime, the light also becomes partially polarized when it reflects at an angle from a surface. In quantum mechanics, electromagnetic waves are viewed as streams of particles called photons. The polarization of an electromagnetic wave is determined by a quantum mechanical property of photons called their spin. Where a photon has one of two possible spins, it can either spin in the right or left direction, depending on the direction of its travel. The circularly polarized electromagnetic waves are composed of photons with only one type of spin, either right or left, but the linearly polarized waves consist of photons that are in a superposition of right and left circularly polarized states, with equal amplitude and phases synchronized. Material used in light polarisation [25]: A polarizer filter is an optical filter that lets light waves of a specific polarization pass through while blocking light waves of other polarizations [25] thus it can filter a beam of light of undefined or mixed polarization into a beam of well-defined polarization, known as polarized light. As shown in the illustration (10) effect of using polarization filter with the infrared remote sensing system, where the reflected polarized infrared ray from the obstacle will pass the filter to the receiver but unpolarised infrared ray from rest of resources will reflect and not be able to pass the filter toward the receiver. Polarizers are used in many optical techniques and instruments. Polarizers find applications in photography and LED technology, and in photography, a polarizing filter can be used to filter out reflections. The two most common types of polarizers are linear and circular polarizers. Polarizers can also be made for other types of electromagnetic waves besides visible light, such as radio waves, microwaves, and X-rays. Hence, infrared rays have the same physical characteristics as invisible light. The best method of useful polarization to polarize the emitter and receiver of the infrared ray in the automatic braking system is using a thin film polarizer, known as TFPN, such as glass substrates on which a special optical coating is applied. Either Brewster's angle reflections or interference effects in the film cause them to act as beam splitting polarizers.




*The illustration (16) shows the effect of using polarization filter with the infrared remote sensing system, the reflected polarized infrared ray from the obstacle will pass the filter to the receiver but unpolarised infrared ray from rest of resources will reflect and not be able to pass the filter toward the receiver.*

The substrate for the film can either be a plate, which is inserted into the beam at a particular angle, or a wedge of glass that is cemented to a second wedge to form a cube with the film cutting diagonally across the centre, the most common filter named Mac Neille cube [26]. Thin film polarizers are inexpensive and provide two beams that are about equally well polarized. Strongly recommended to use the features of polarisation of light in the used infrared ray of the automatic braking system, where if the emitted ray was polarised vertically or at a specific angle (via the added Thin film polarizers), the same sort of filter should be added to the receiver (infrared sensor) to receive the reflated infrared ray from the obstacle at the same angle of the polarization of the emitter, to identify the used infrared ray of the same car strictly, and to separate the rest of the received infrared rays either from the artificial or natural sources in the infrared ray sensor, may rise the efficiency of the used infrared remote sensing device and the automatic braking system to do its function properly.

**Discussion**

There are several remote detection systems, via ultrasonic or electromagnetic waves, but we focus this study on the infrared ray and its challenges and solutions to prevent accidents caused by the failure of this system, which causes loss of life, property, insurance companies, and automobile manufacturers. When verifying the components of this system, its components, and its mechanism of operation, its weak points can be known through applied experiments. They will be able to overcome the conditions that prevent this system from performing properly, and also after full knowledge of the physical properties of infrared radiation and the behaviour of materials in the environment surrounding the car towards this radiation, it became obvious through this research that the best efficiency of the infrared remote-sensing device is sensing objects in white, and its efficiency reduces for objects in other colours where it cannot detect black objects. It is strongly recommended that all car producers all car producers consider this issue and add accessories to their cars in white or metallic to be detected easily by the infrared ray remote-sensing detectors (even cars in black) to avoid car accidents due to the failure of this system to detect dark coloured objects, especially black ones on the road. Because we are dealing with infrared rays as a fundamental factor the device relies on mainly in the emitter and receiver, while temperature represents one of the infrared spectra, this confuses the efficiency of your system; therefore, we should develop it to be able to overcome these challenges. Considering the car's mechanics and the momentum generated during its speed, increasing the speed of the car leads to an increase in the value of the momentum in the material of the car, so when the car brakes at high speed, it remains in motion for a long distance toward the obstacle even though the tires stop during braking. Therefore, the electronic system of the automatic braking system should be linked to the car's speedometer so that the car can brake at the appropriate distance from the incident object at high speeds, which is greater than the distance that the car should brake at low speeds. For instance, if the car is traveling at a high speed, even braking a few meters away from the obstacle objects may not help to prevent the accident because the car will continue to rush and collide with the obstacle objects due to the high momentum generated in the material of the car at high speeds. Because at a speed of 30 km/h, the momentum generated in the body of the car is low, it may be sufficient to brake within five meters of the obstacle objects, but at a speed of 80 km/h, a high amount of momentum will be generated, pushing the car towards the obstacle objects a longer distance. Here, the infrared detection system of the car must be able to detect objects over longer distances to brake when the obstacle is about 40 meters away from the car, and the distance must be greater for higher speeds. This may greatly help in stopping the car at the right time to avoid accidents. Adding a camera, computer, and artificial intelligence software to diagnose things in the system being used in the can may reduce errors, malfunctions, and accidents. While there are many developments in self-driving car systems that even contain artificial intelligence software to diagnose objects such as the human faces of cars and the rest of objects, It`s very important to install sensors to measure the rates of infrared rays to notify the driver that the automatic braking system of the car is temporarily stopped and he should depend on himself to brake when it needs it. This will also protect car producer companies from prosecution if any accidents occur due to the failure of their systems.

## Conclusion

The reasons behind the failure of the automatic braking system in driverless cars are due to many reasons, including:

1. **Weather conditions:** Because these used rays should reflect to be received by the sensors of these automatic braking cars to send an electronic signal to the central computer of the car, then it should be understood that the car should brake or steer immediately, but if the weather was cold, rainy, fog, or snowy around these cars, that would absorb and scatter big rates of the used infrared rays from the front radar, thus there would not remain sufficient amounts of these emitted infrared rays to be reflected to return to the sensors, thus these cars would not be able to detect objects behind, and unfortunately, accidents would occur due to the failure in the automatic braking of the driverless cars.
2. **Resources of the infrared rays:** During the sunshine and sunset times a big ratio of the infrared rays of the sun rays will be scattered to the surface of the Earth due to the light diffraction phenomenon, where these big ratios of the infrared rays of the Sun rays will cover the sensors of the infrared rays for the system of the driverless cars, may distort and create a confusion in the functions of the system of driverless cars and prevent detecting objects, where the existence of several infrared radiation interferences either from the same sort of device used for the automatic braking system on the rest of cars or the lights of the red backlight of vehicles on the road, especially those use red LED lamps with a high percentage of infrared radiation), leads them interfering with the used ray in the receiver sensor of our device leads to the generating distorted currents in the sensor outputs that are not proportional to the value of the used frequency of the designed filter preventing signal passing towards the magnification circuits nor to the braking system, where the distortion does not include only the low frequencies,

The suggested solutions: The most important issue is to change the features of the used infrared of these cars to make it difficult to be absorbed and scattered by the weather circumstances around and to have different features than features of the infrared rays of the sun:

1. Using the long wavelengths of infrared rays (far infrared) used systems of these cars may prevent any confusion that could occur due to the existence of the infrared ray of the sunray during the sunshine or sunset, and this may also reduce the absorption rates due to the cold weather circumstances such fog or scattering via raindrop in the air between the car and the obstacles, such as the part far infrared in the 300 nm to 1 million nanometres in the electromagnetic spectrum, where the physics feature of visible light drops, because we should keep only the feature of reflection in the used ray and reduce the rest of features such as the absorption and fraction, to guarantee our used rays to transmit to the obstacle and get reflected with lowest rats of scattering to increase the rate of received red ray in the sensor. This will increase the rates at which the infrared rays are received by the sensors and, finally, will increase the efficiency of the automatic braking system for these cars because, as the wavelength used is longer, the physics characteristic of visible drop absorption will be affected by the mentioned circumstances.
2. Consider sunset and sunshine time in our schedule to prevent or reduce the use of automatic car braking systems during these times, while the rates of infrared rays increase externally with the sun during sunset and sunshine time.
3. Add the features of polarization of light in the used infrared ray of the automatic braking system, where if the emitted ray was polarized vertically or at a specific angle (via the added filter), the same sort of filter should be added to the receiver (infrared sensor) to receive the infrared ray at the same angle of the polarization, to identify the used infrared ray of the same car strictly, and to separate the rest of the received infrared rays either from the artificial or natural sources in the infrared ray sensor.
4. Use a high intensity of the infrared rays in these automatic braking systems of driverless cars to increase the rate of receiving infrared rays from obstacles.
5. Increase the sensitivity of the receiver's sensors and their electronic circuits in the system to detect any ratio of reflected rays from the object in their way on the roads, despite the large amounts of absorption and scattering due to the cold weather circumstances.
6. The automatic braking system should consider the speed of the car and distance from the obstacle when deciding whether to brake. For example, when the vehicle moves at a speed of 30 km/h, it should consider the distance of around 5 meters to brake, but when the car moves at a speed of 80 km/h, the remote detection system of the vehicle should be able to detect objects (through longer distances) and brake when the obstacle is around 40 meters, considering the momentum of the car that rushes the car to a farther distance when it is at a higher speed to avoid a car accident.
7. A second system for detecting objects should be used, such as the ultrasonic object detection [27] as an additional accessory to support the used infrared ray object detection, in order to increase the efficiency of the automatic braking system, this increases the probability of detecting objects and the prevents complete failure of the automatic braking system, but not to rely upon one of them and ignore the second, because there may be circumstances that cause failure in infrared ray object detection system that are not the same circumstances that cause failure in the ultrasonic object detection system, or there may be circumstances that cause failure in the second that are not the circumstances that cause failure in the first. Therefore, working on both detection systems at the same time may grant higher results for the automatic braking system and prevent car accidents due to the failure in their used object detection systems.
8. Adding a camera, computer, and artificial intelligence program to diagnose objects in the system could reduce errors, malfunctions, and accidents.
9. Considering these issues during design, the automatic braking system of cars may prevent any failure that may result in accidents by overcoming the challenges of the surrounding features that always change according to the weather and the rate of red rays in the environment.

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