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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 self-braking system of cars relies on a remote infrared sensing device. Hence, 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 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.

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

Method: Collect data in respect to the remote infrared sensing device in different weather conditions to improve the recently used technique of this system to do its 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 by reducing the rates of absorption and refraction rates through different density media to 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 this device.

Key words: failure in the automatic braking system, infrared remote sensor, automatic braking system in driverless cars.

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Introduction: To identify the factors that undermine the operation of the self-braking system for cars, first must know the electronic circuits used in this system, identify their weak points, and add how to improve them by adding the required accessories that support the operation of these electronic circuits, second knowing the properties of the electromagnetic waves used (infrared rays) and their spectra, frequencies and how it be effected of their surrounding conditions, to choose the most appropriate frequencies for this system so that the self-braking system performs its function at the best way possible. Because the way these circuits work is one of the examples of the interaction between electromagnetic waves with the materials of the electronic circuits and the materials surrounding the environment of the electronic system, and in this research we will find laboratory experiments and their results to confirm our conclusions.

General idea of parts of self-braking system [3]: The self-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 roods and results car accidents.

The electronic parts that cause failure in the self-braking system:
1. Infrared emitters (LD with a specific frequency infrared ray) emit certain pulses (specific frequency of about 10 to 100 hertz or even more), which value the specified identity of the car in the road among the rest of cars that use the same self-braking system.

2. The infrared sensor is used on the receiver circuits of infrared rays.

3. An electronic filter 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 an electric motor connected to the hydraulic system of the car's braking system.

General reasons causes the failure in the self-braking system: During the times of sunset, when the percentage of infrared radiation in the sun's rays increases, a big rate of infrared radiation in the sun's rays leads the interference receiver to be mixed with the infrared rays used in the self-braking system, so that the infrared sensor receives two radiations of infrared radiation, one from the Sun and the second is of the car`s infrared ray emitters that is 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 designated to determine the frequency (emitter pulses), that used for the system, so the car does not break in the presence of an accident, and accident occurs.
Note that the existence of another car that coming from the opposite direction is also using the self-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 may 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 self-braking system of the car because the generated electronic frequency from the output the sensor (the current pulses) of the output 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 self-braking system of the first car is working properly.

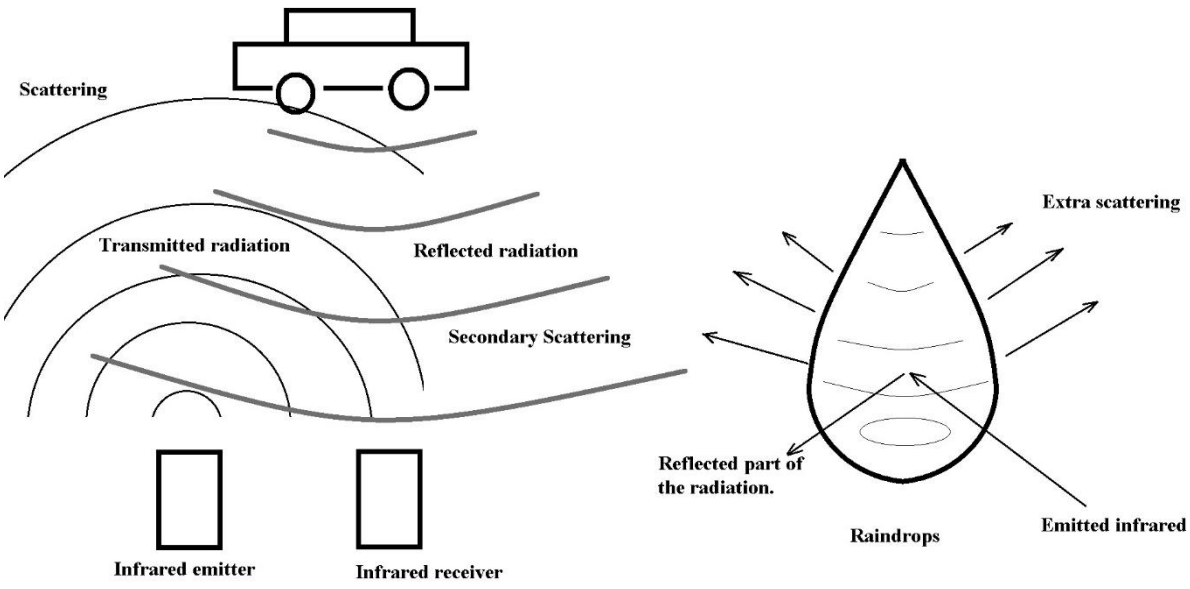
How the self-braking system works: When an obstacle obstructs the path of the car, the infrared radiation used from the front of the car collides with the obstructing object, and some of that radiation is reflected toward the receiver of the car (the infrared sensor). An electrical signal emerges from 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 the frequency of the same car then the electronic signal will be magnified by the amplification circuit that connected directly with an electric motor to perform its function of injecting the hydraulic fluid of the hydraulic system of the breaking system thus the car stops automatically before making a car accident, as shown in the illustration (1) there are a several stages of scattering occurs for the used infrared rays, where a very small rates got received by the sensor.

The illustration (1) shows the process of transmitting and receiving infrared rays in the self-braking system, as the transmitted radiation suffers from scattering, and a small percentage reaches the

obstructing object, where 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 passes through these raindrops because infrared rays have the same properties as visible radiation [5].

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

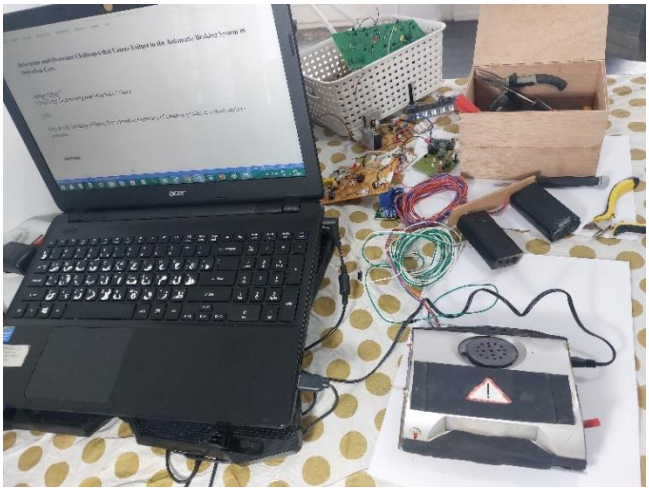
1. Scattering of radiation caused during the refraction.
2. Scattering is caused by passing the radiation through different media densities.
3. The absorbed part of infrared rays (thermal rays) by low energy obstacles.
4. Scattering is one of the basic physical properties of radiation during its release.



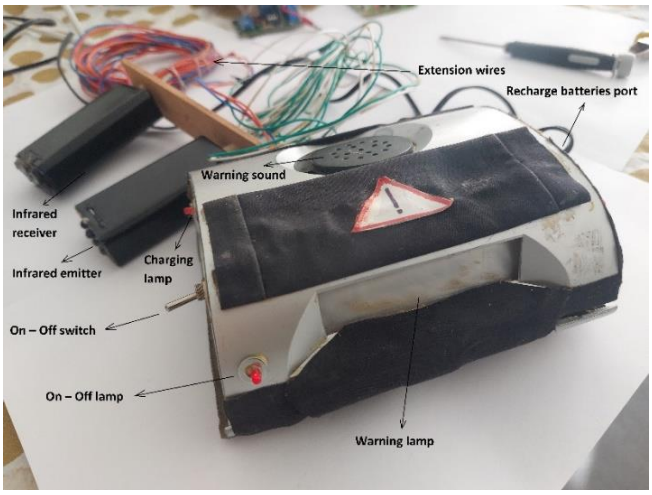
The illustration (1) shows the process of transmitting and receiving infrared rays in the self-braking system, which suffers of many sorts of scattering radiation such as caused during the refraction, passing the radiation through different media densities, and the absorbed part of infrared rays (thermal rays) by low energy midis and obstacles, as well as the scattering is one of the basic physical properties of radiation during its release.

The handmade device of the infrared remote sensor composes of the following items:

1. Infrared emitting circuit.
2. Infrared sensing circuit.
3. Light and sound alarm circuit [4].



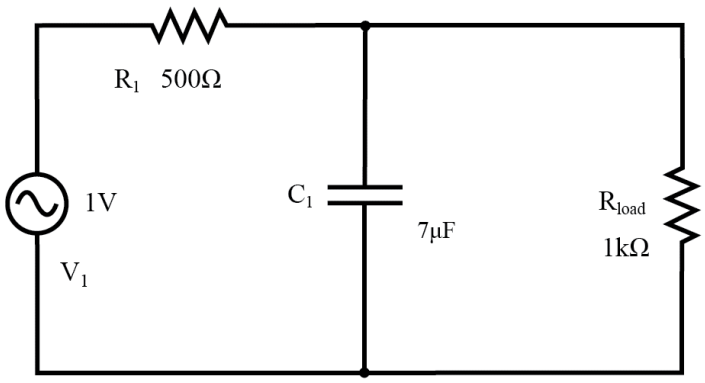
The image (1) the handmade infrared remote sensor.



The image (2) is for the remote sensor that sends and receives infrared rays where the device was made by remote control devices, and handmade infrared detector circuit.

Where the materials used were not manufactured to construct the remote sensing device, but the device works normally after a simple restoration and replacing the batteries with new ones.

Low-pass Filters [6]: This circuit of the components of the device is used to cut-off frequencies that are not belong to the installed the device on the car, and in order not to be affect by rest of frequencies used by rest of devices of rest of 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 below 70.7% of the input voltage. This cut off percentage of 70.7 is not really arbitrary, all though 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, spice produces a bode plot whose numbers make more sense as shown in the illustration (2).

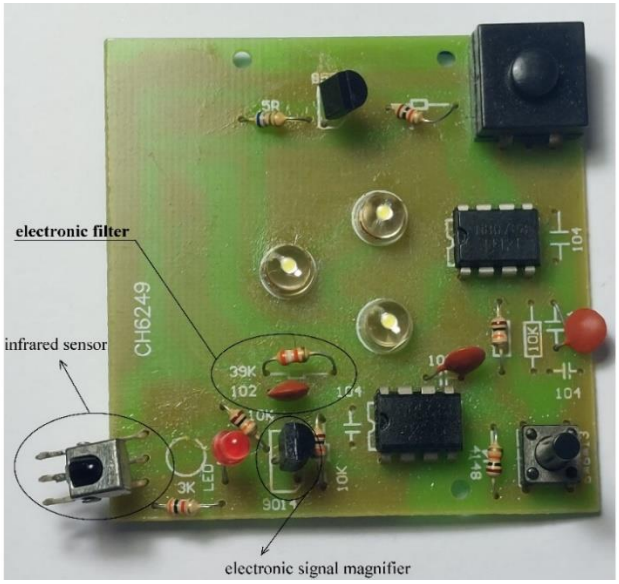


The illustration (2) of the low-pass filters which determines the frequency that operates in the range of the device and should be equal to the frequency of the emitter pulses used in the same device.

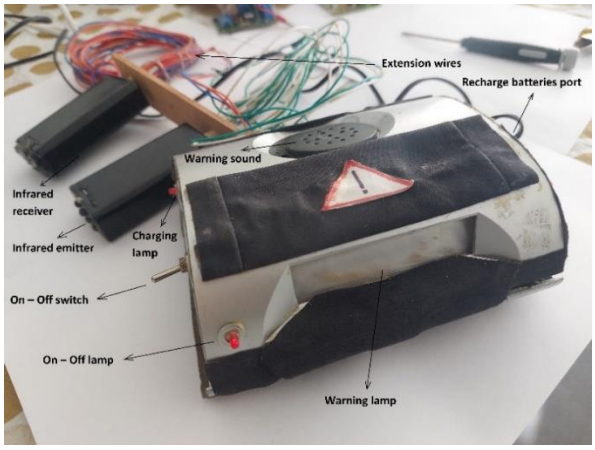
Cut-off Frequency: All low-pass filters are rated at a certain cut-off frequency, the frequency above which the output voltage falls below 70.7% of the input voltage. This cut-off percentage of 70.7 is not really arbitrary, all although it may seem so at first glance, in a simple capacitive/resistive 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:

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

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



The image (5) shows the parts of device which consists of On – Off switch, On – Off lamp, infrared emitter, infrared receiver, warning lamp, warning sound speaker, recharge batteries port, charging lamp, extension wires.

It must be acknowledged that the self-braking system for cars relies on a remote sensing system that depending on sending and receiving infrared rays, to collect all data about the self-braking system of cars, where the materials used are not manufactured to construct the remote sensing device, but the device works normally after a simple restoration and replacing the batteries with new ones. When the device senses an object, a specific sound is generated and a lamp is ignited on the front of the device, but important information has been collected about the remote sensing system by 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:

1. 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 able to sense them through the distance around ten meters.

2. The efficiency of the device drops to 50% during the day hours when Sun’s ray is at high intensity.

3. The efficiency of the device and the sensitivity (the distance of detection) increases for the cold objects and light colours especially after sunset when Sun’s rays get absent and that increase much more during the night.

4. 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.

5. The efficiency of the device decreases extremely by sensing hot objects by (30-40) degrees Celsius.

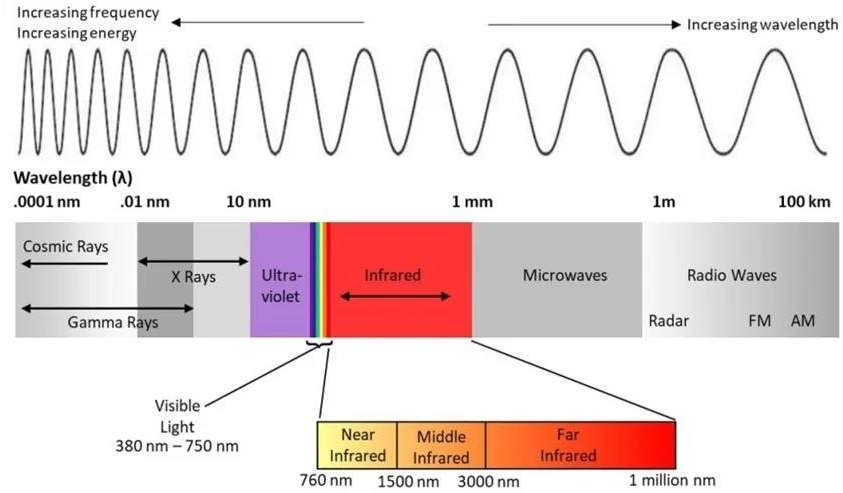
6. The efficiency of the device and the sensitivity (the distance of detection) decreases for the dark colour objects.

7. The device's ability stopped completely for hot black colour objects even from a very short distance.

8. Confusion occurs during rain, where the device continues to warning where there is nothing in front of it.

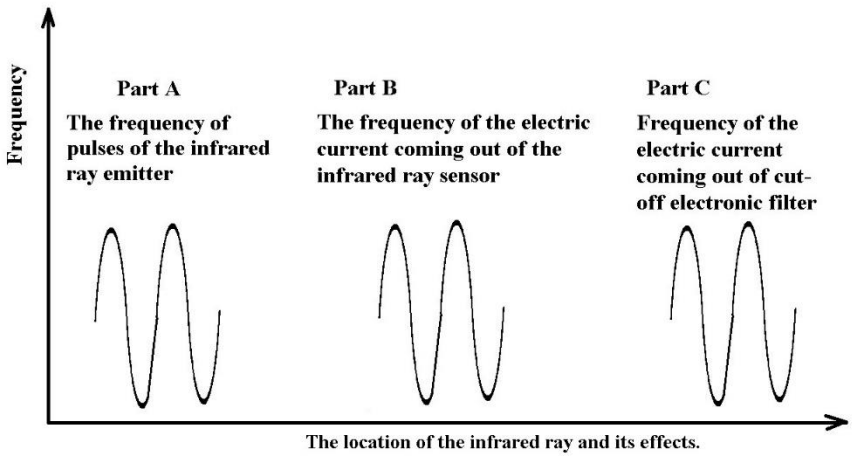
Infrared radiation [7]: Infrared radiation usually goes unnoticed but it’s something you encounter every day. Toasters, incandescent bulbs, and remote controls use infrared energy as well as industrial heaters used in drying and curing materials and medical uses, infrared radiation is a heating source 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 a 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, and the middle infrared frequency, with wavelengths of 2.5 to about 50 micrometres as well as the far infrared frequency, with wavelengths of 50 to 1,000 micrometres.



The illustration (3) the infrared radiation categories in the electromagnetic spectrum.

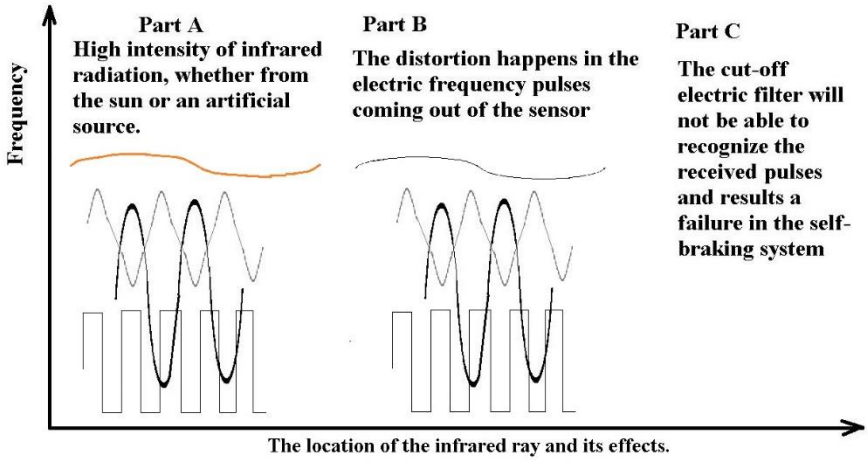
Briefly, the circumstances that undermine the efficiency of this system are the hot objects (emit infrared rays) and black objects (have the ability to absorb a high percentage of the infrared rays used by the device), note that the backlights of cars light up in red, so if the front driver applies the 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 self-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 which use a self-braking system behind it via interference the electronic filters of cars with a self-braking system, note that 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 the confession for the self-braking system.



The illustration (4) shows in part A shows 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 self-braking system runs successfully.

The effects of the presence of other sources of infrared: As it shown the illustration (5) the presence 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 the generating distorted currents in the sensor

outputs that are not proportional to the frequency of the electronic filter designed to allows to pass, this prevents any signal passing towards the magnification circuits nor to the braking system this cause 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 (5) 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 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, and this will results a failure in the self-braking system causes 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 completely 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 self-braking system a traffic accident. Other sources of infrared radiation interference occur when the radiation is used for the self-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, prevents the filter from sorting the used frequency of the remote control systems device.

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

A. Weather conditions: Because these used rays should reflect to be received by the sensors of these driverless cars to send an electronic signal to the central computer of the car, then to be understood that the car should brake or steer immediately, but if the weather was cold or rain or fog or snow around

these cars, that will absorb and scatter big rates of the used infrared rays of the front radar, thus there will not remain sufficient amounts of these emitted infrared rays to be reflected to return to the sensors, thus these cars will not be able to detect objects behind and unfortunately the accidents occur due to the failure in the automatic braking of the driverless cars.

B. 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 the system of the driverless cars, because these scattered infrared rays of the Sun rays are the same frequencies to the 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 system of driverless cars and prevent 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 results failure to detectors of the emitted infrared rays and finally results failure in the automatically braking system of these driverless cars.

C. The infrared rays from artificial resources: The existence of several infrared radiation interferences either from the same sort of device used for the self-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 our used filters causes failure in the self-braking system a traffic accident.

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 or scattered by the weather circumstances around and different features than features of the infrared rays of the sun rays:

A. Using the long wavelengths of infrared rays (far infrared) in used the 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 of the received infrared rays to the sensors and finally will increase the efficiency of the automatic braking system for these cars because as much as the used wavelength is longer the physics characteristic of visible drops reduce absorption by the mentioned circumstances the weather.

B. Add the features of polarisation of light [8] 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 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 separate the rest of received infrared rays either from the artificial or natural sources in the infrared ray sensor.

C. Use a high intensity of the infrared rays of these automatic braking systems of driverless cars to increase the rate of received after the reflection.

D. 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.

E. Adding a camera and computer and the artificial intelligence program to diagnose objects in the used system could reduce errors malfunctions and accidents.

Considering these issues during design the automatic braking system of cars may prevent any failure that may result in accidents via overcoming these challenges of the surrounding features that always get changed according to the weather and the rate of red rays in the environment.

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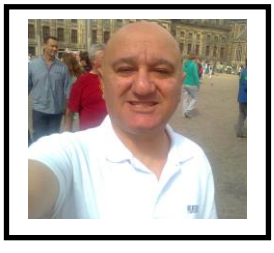
Sample Author Bio-sketch



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Research and Academic Experience:	Physics Researches: 1. Solving the Modern Cosmic Conundrum via Our Traditional Physics Concepts. 2. The Effect of the Different Cooling Rates of the Crust upon the Geological Activities and the Magnetic Field of Earth as well as Diverse Levels of the Water of the Seas and Oceans. 3. Qualifying Earth's Nature to be able to face the Latest Developments of the Climate Changes. 4. The Observation of the Dark Matter of the Universe through the Concept the Theory of Relativity. 5. Determine Material of the Gravity Particles and Understand the Mechanism of the Universe Gravity Fields. 6. The Effects of the Cosmic Rays upon Earth's Climate Changes to Generate Storms, Winds, Hurricanes and Tornadoes. 7. The Effects of Physics Properties of the Water in the Extreme Circumstances upon the Extraordinary Phenomena in the Nature. <u>Technical Researches:</u> 1. Technical Investigations of the Most Common Industrial Accidents. 2. Study to Make the Easiest Design of System able to extract Drinking Water from The Sea Water via Solar Energy and Earth's Gravity Force. 3. Study of using Microwaves Application to Search for Raw Materials Underground for Extraction and Industrial Purposes. 4. Converter of Hydrogen Bond Energy. 5. Using Laser Ray System to Measuring the Surface Tension Energy of Liquids inside Glass Tube. 6. Design Spherical Robot.
Research Area:	Physics, Materials Sciences and Engineering.
Number of Published papers:	7

Special Award (If any):	
Any other remarkable point(s)	