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Sudan University of Science and Technology
College of Graduated Studies
The Partial Research to Fulfillment the Degree of
MSC in Telecommunication Engineering

MOTION DETECTION SYSTEM
نظام لكشف الحركة

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CONTENTS:

MOTION DETECTION SYSTEM

- **Motion** in physics is the change in body location and it's typically described in terms of velocity, acceleration, displacement, and time [1].

- The **Motion Detector** is used to collect position, velocity and acceleration data of moving objects.

- Motion detector is a devices that **contains** physical mechanism or electronic sensor.

MOTION DETECTION TECHNIQUES

- The motion detection techniques can be divided to:

1. **Electrical motion technique.**
2. **Electronic motion technique.**
3. **Mechanical motion technique.**

MECHANICAL MOTION TECHNIQUE

- Mechanical motion technique based on taking reading from physical environment and turn it into an electrical message (signal) as:

1. **Tripwire.**
2. **Stress sensors.**
3. **Pressure mats.**
4. **Mechanical switches.**
5. **Magnetic reed switch.**
6. **Glass filled to the brim.**
7. **Taut wire fence systems.**

ELECTRICAL MOTION TECHNIQUE

- Electrical motion technique based on transmitting visible or infrared light beams across an area, and detect is these beams obstructed or not. Electrical motion technique as:

1. **Photoelectric beams.**

ELECTRONIC MOTION TECHNIQUE

- Electrical motion technique use principal methods by which motion can be electronically identified as:

1. **Optical detection:**

   which used infrared light or laser technology .

2. **Acoustical detection:**

   which used sound wave or ultrasonic wave or radio frequency wave technology.

CONT…

- Electronic motion technique such as:

1. **Infrared motion detectors (Passive , Active).**
2. **Ultrasonic motion detectors (Passive , Active).**
3. **Microwave motion detectors (Detectors,Barriers).**
4. **Radar motion detectors(Doppler, Traffic radar).**
5. **Sonar motion detectors (Passive , Active).**
6. **Laser motion detection.**
7. **Lidar motion detection.**

MOTION DETECTION PROBLEM

- The problem that usually face the motion detection system is **false alarm** and **how to avoid it**.
- False alarm(nuisance alarm)is the phony report of an emergency, causing unnecessary panic and or bringing resources (fire engines) to a place where they are not needed. Over time, repeated false alarms in a certain area may cause occupants to start to ignore all alarms, knowing that each time it will probably be a fake.

PROJECT ABSTRACT

- The project idea the monitoring system (Motion Detection Circuit) work look like that:
- The motion detection circuit will **generator ultrasonic wave** and the generated ultrasonic wave will be couple to the **transmitting antenna** which emit it (Radiate it) to a wide area, which represent the interrogation zone as it illustrate in figure (1) below.

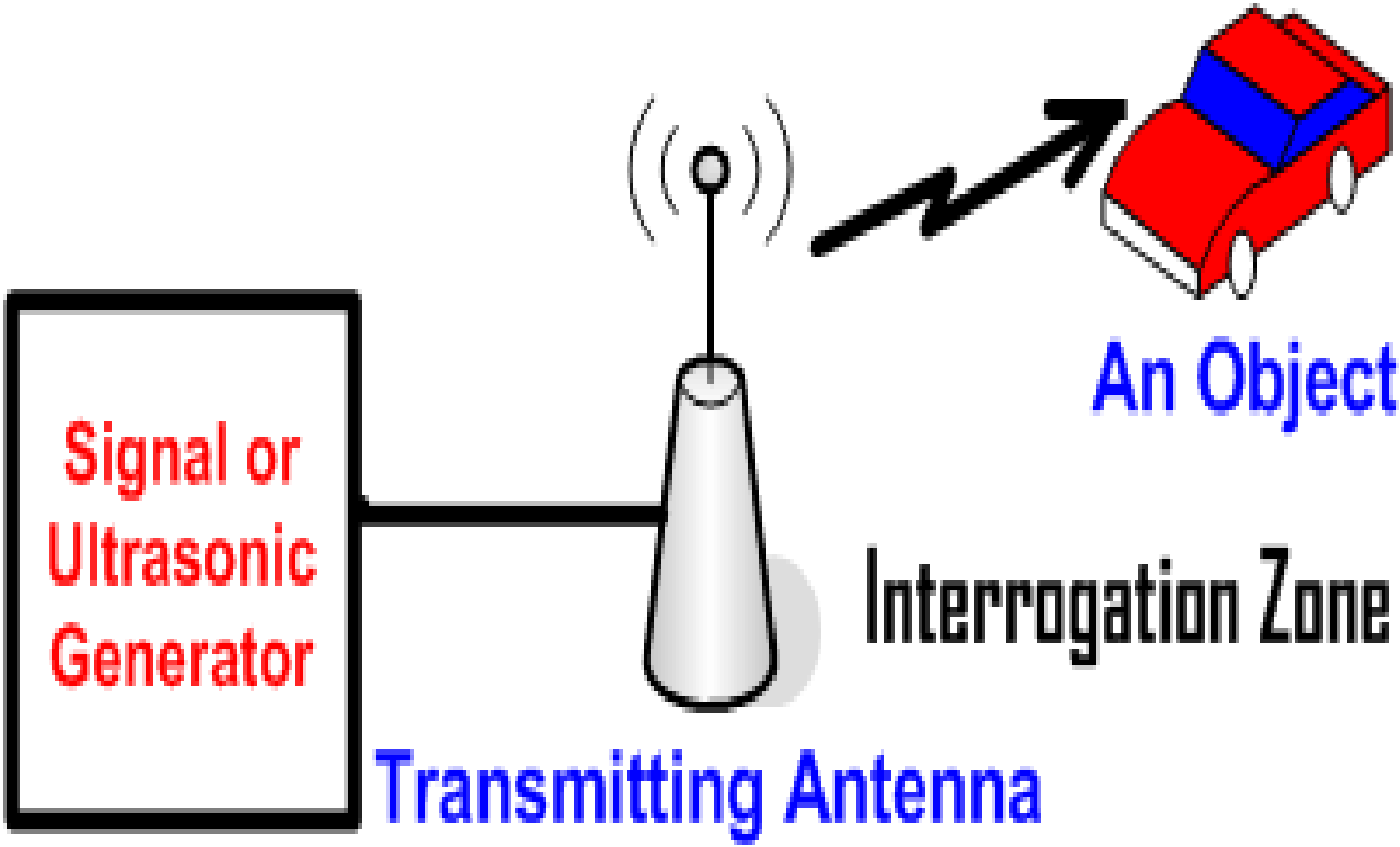


Figure (1): The ultrasonic generator and the transmitting antenna.

- Some of the ultrasonic wave will reflected back to the **receiving antenna** due to any object motion in the interrogation zone or any reflection as it illustrate in figure (2) below.

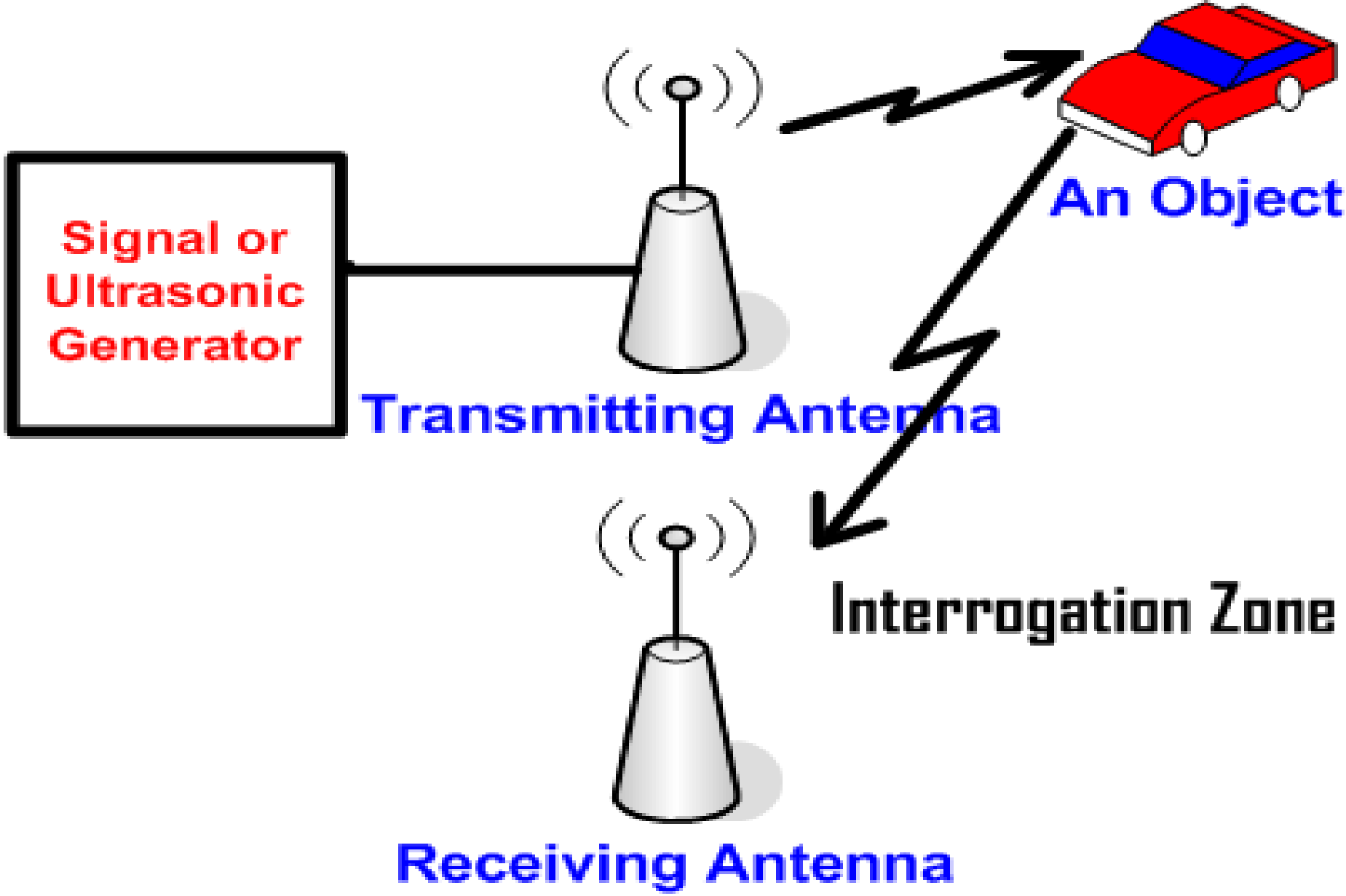


Figure (2): The ultrasonic generator and the transmitting antenna and receiving antenna.

- The reflected wave will be compared with the transmitted one in the **detection circuit** (extraction circuit) to determined is there is motion or not.
- If there is motion then the extraction circuit will generate an **electrical signal** and passes it to the **personal computer** as illustrate in figure (3) below.

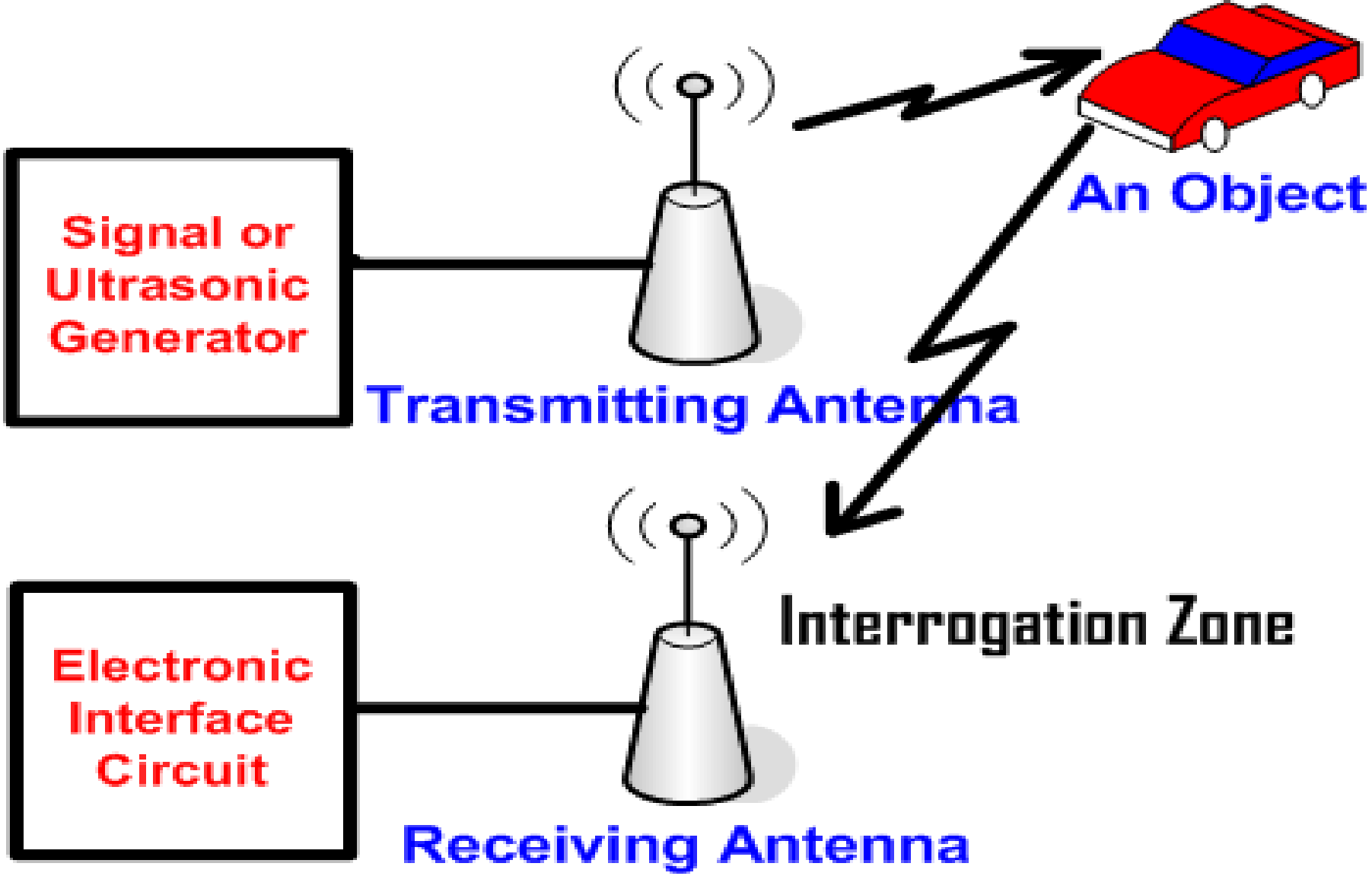


Figure (3): The ultrasonic generator, the transmitting ,receiving antenna and the extraction circuit.

- The electrical signal passes from the extraction circuit to the personal computer via parallel port as it illustrate in figure (4) below.

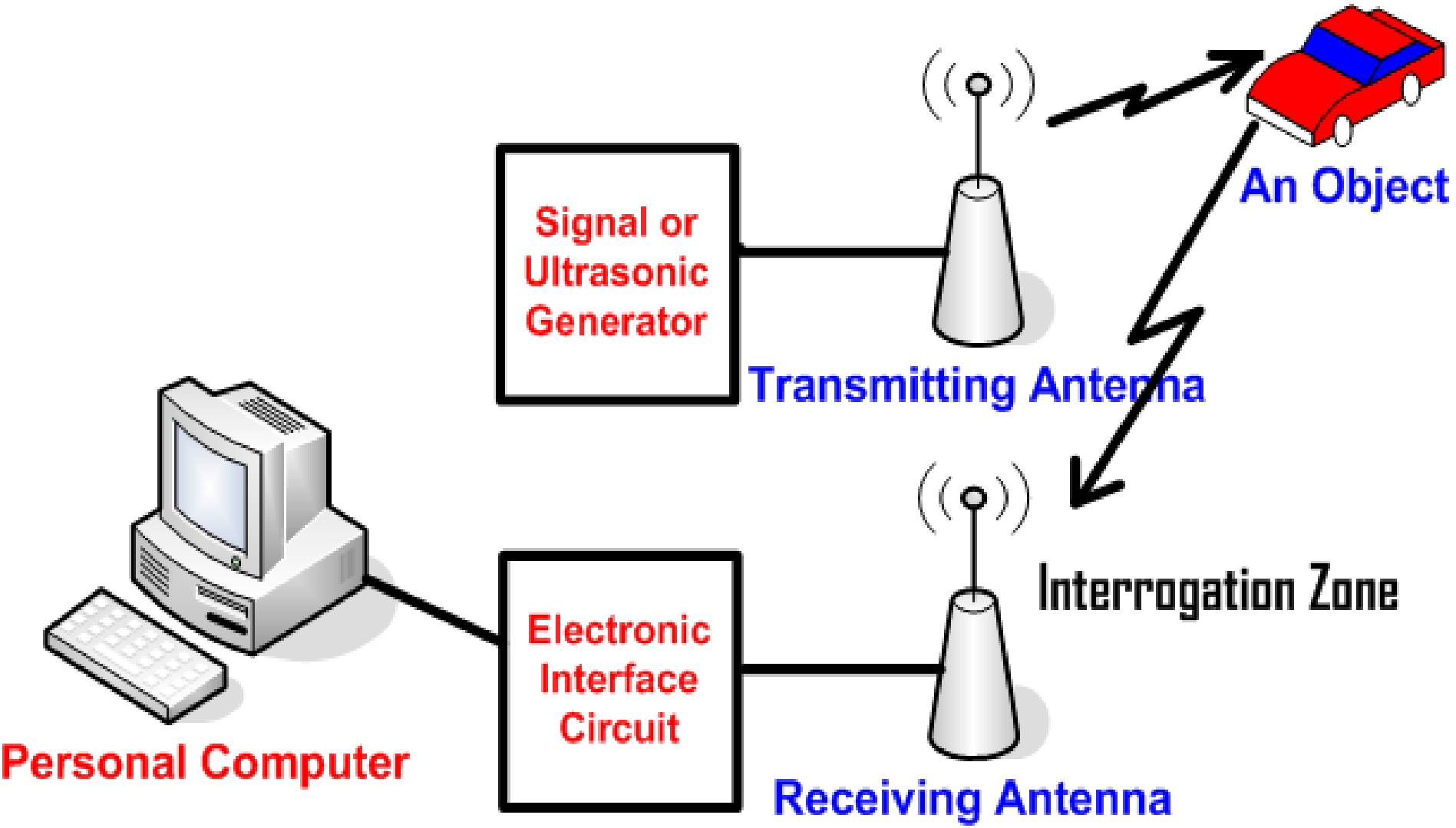


Figure (4): The ultrasonic generator, transmitting ,receiving antenna and extraction circuit pass electrical signal to the Personal Computer.

- PC contains a **programming language** which is used to test is there is an electrical signal or not. If there is electrical signal in the parallel port it will provide a control word and an **electrical signal** via the parallel port to the **interface circuit** as it illustrate in figure (5) below.

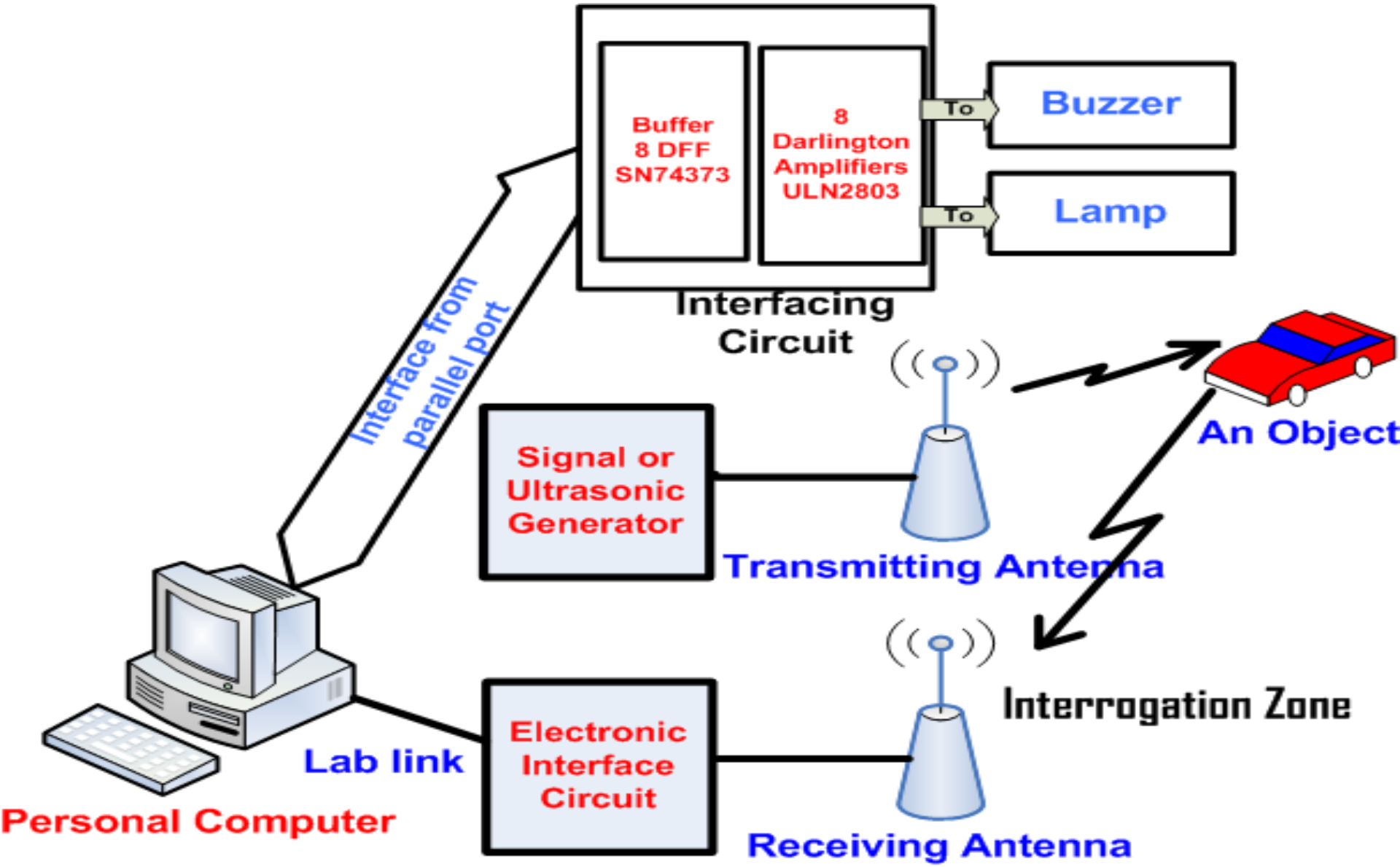


Figure (5): The Motion Detection full Design

- In the interface circuit the control word will store in the buffer and the electrical signal will be amplified to around 500mA (by using Darlington amplifiers) to activate the lamp and the buzzer.

THE MOTION DETECTION COMPONENTS

- The electronic circuit design of a motion detection system based on hardware such as:

1. Ultrasonic Wave Generator.
2. Transmitting and Receiving Antenna.
3. Detection Circuit (Frequency Comparator).
4. Personal Computer.
5. Buffer (HD74LS373 ICs, SN74373).
6. Amplifier (ULN2803A).
7. Board Panel.
8. Buzzer, and Lamp.

- Instead of using ultrasonic wave generator, transmitting, receiving antenna and detection Circuit (Frequency Comparator) the Ultrasonic radar modules (VM_125) was used.

ULTRASONIC RADAR MODULES (VM_125)

- It **generates ultrasonic wave** and coupled it to its **transmitting antenna** to emit it to a wide area (interrogation zone).
- It contain a **receiving antenna to receive** reflect wave from the interrogation zone.
- It contain a **comparator circuit** to compare the transmit and received wave frequency.
- it provide a **signal** if it detect different in the frequency (motion happened).

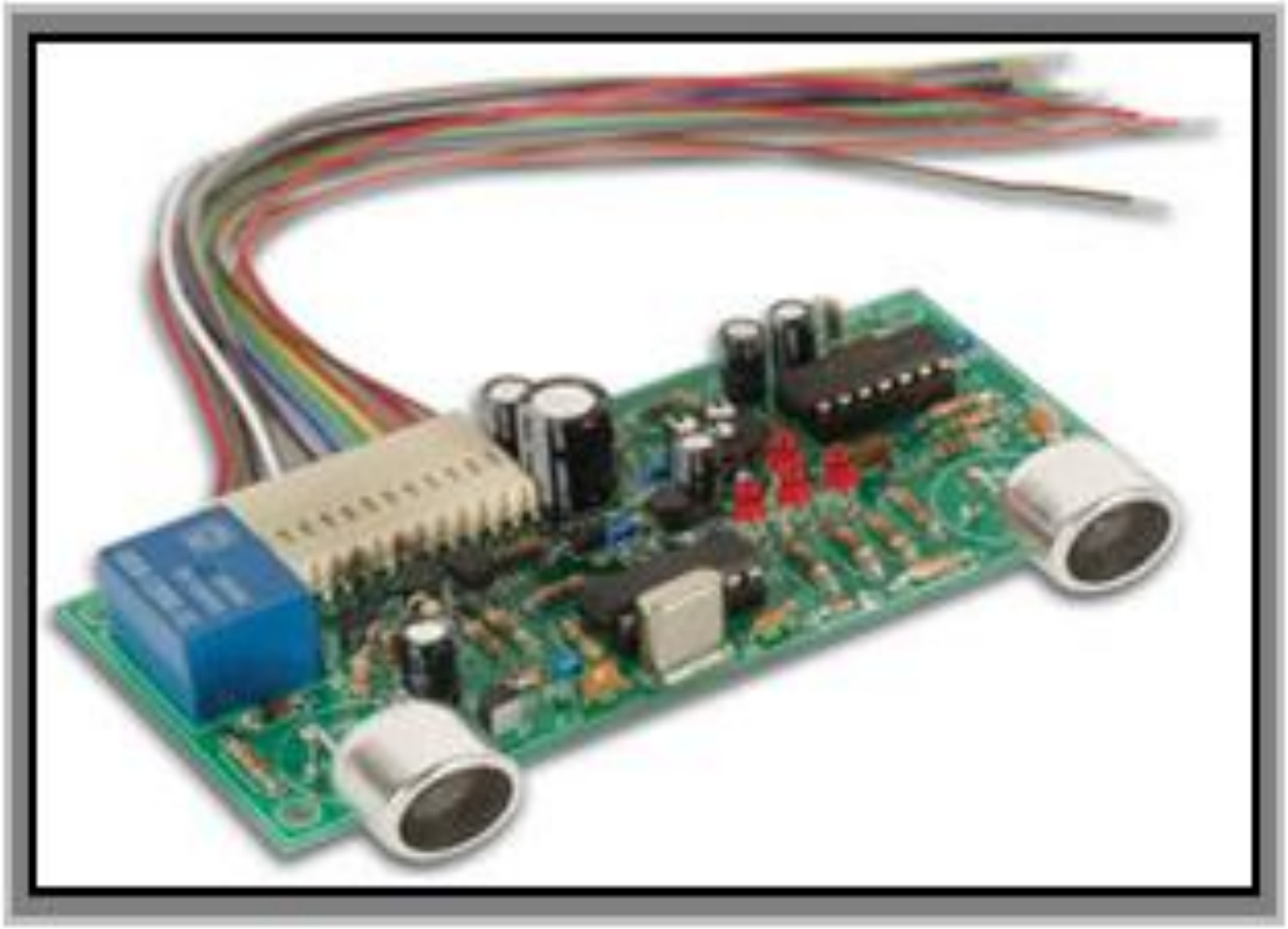


Figure (6): The Ultrasonic radar modules (VM-125)

ULTRASONIC RADAR MODULE FEATURES

- Buzzer output: fast / slow / continuous (Requires external speaker).
- Distance Indication with 3-LED-bar.
- LED alarm indicator.
- Adjustable alarm distance.
- Dry contact NO/NC relay.

ULTRASONIC RADAR MODULE SPECIFICATION

- It’s coverage range from 20cm to 250cm.
- Operate in frequency rang equal 40 kHz.
- The digital output=5V (50mA max).
- The analog output range from 0 to 5V (5mA max).
- Buzzer output: 12V (100mA max).
- Relay contacts: 1A low voltage NO/NC.
- Power supply=12VDC.
- The current consumption=200 mA max.
- Dimensions: 110 x 50 x 18mm / 4.3 x 2.0 x 0.7"[22].

- The motion detection in the Ultrasonic radar modules (VM_125) depend on its work on the Doppler effect.

DOPPLER EFFECT DETECTION TECHNIQUE

Doppler Effect means frequency shift (Wavelength).

Doppler effect causes:

1. When the **source moving** with respect to the medium.
2. When the **receiver moving** with respect to the medium.
3. When **medium moving**.

Doppler shift effect in:

1.Sound wave:

When the source and the receiver approaching to each other then the frequency will **increase**, but if they moving far away from each other then the frequency will **decrease**.

2. Light wave:

When the source and the receiver approaching to each other then **Blueshift** will happens, but if they moving far away from each other then **Redshift** will happens.

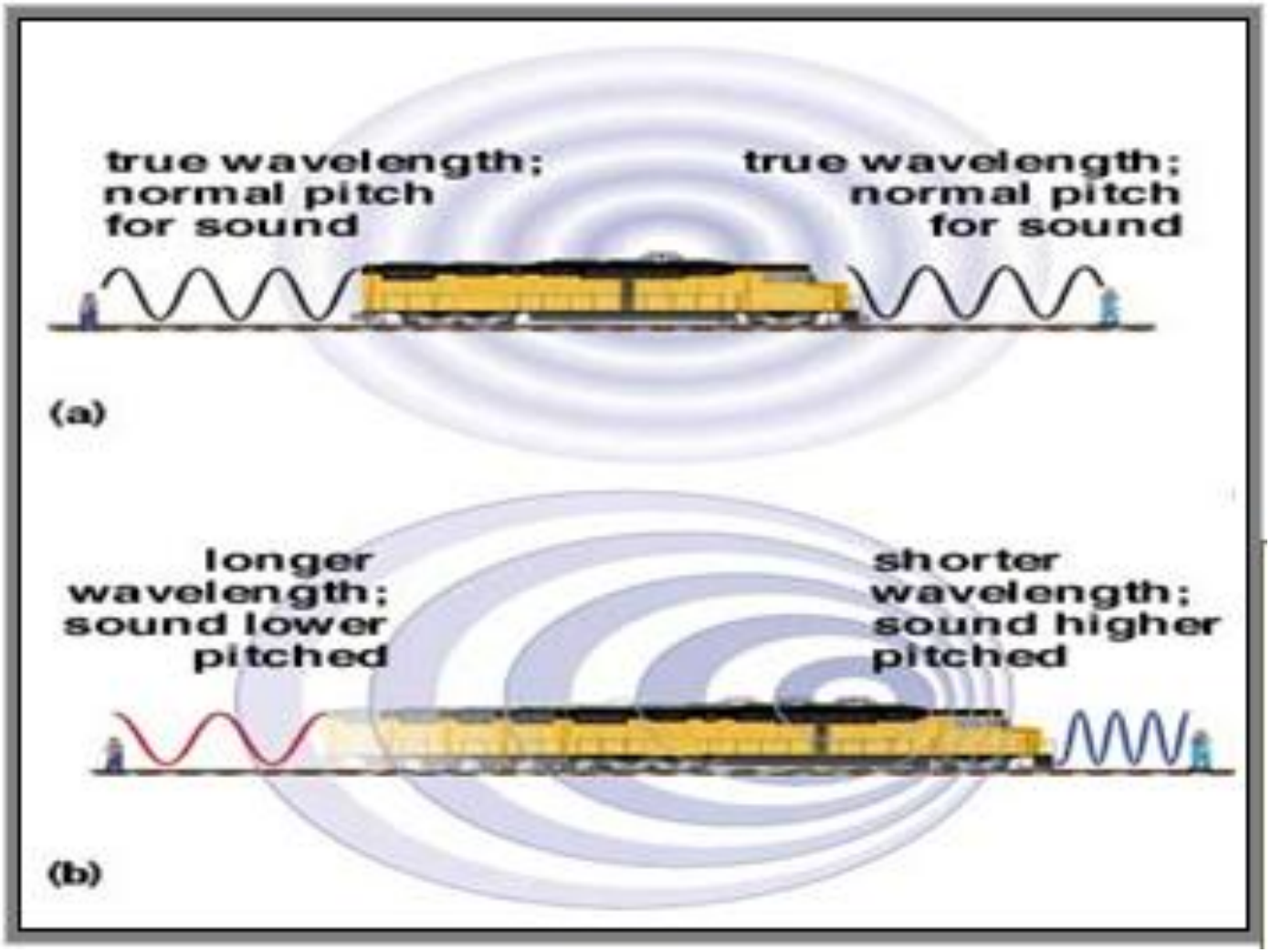


Figure (7): The Doppler Effect for Sound Wave.

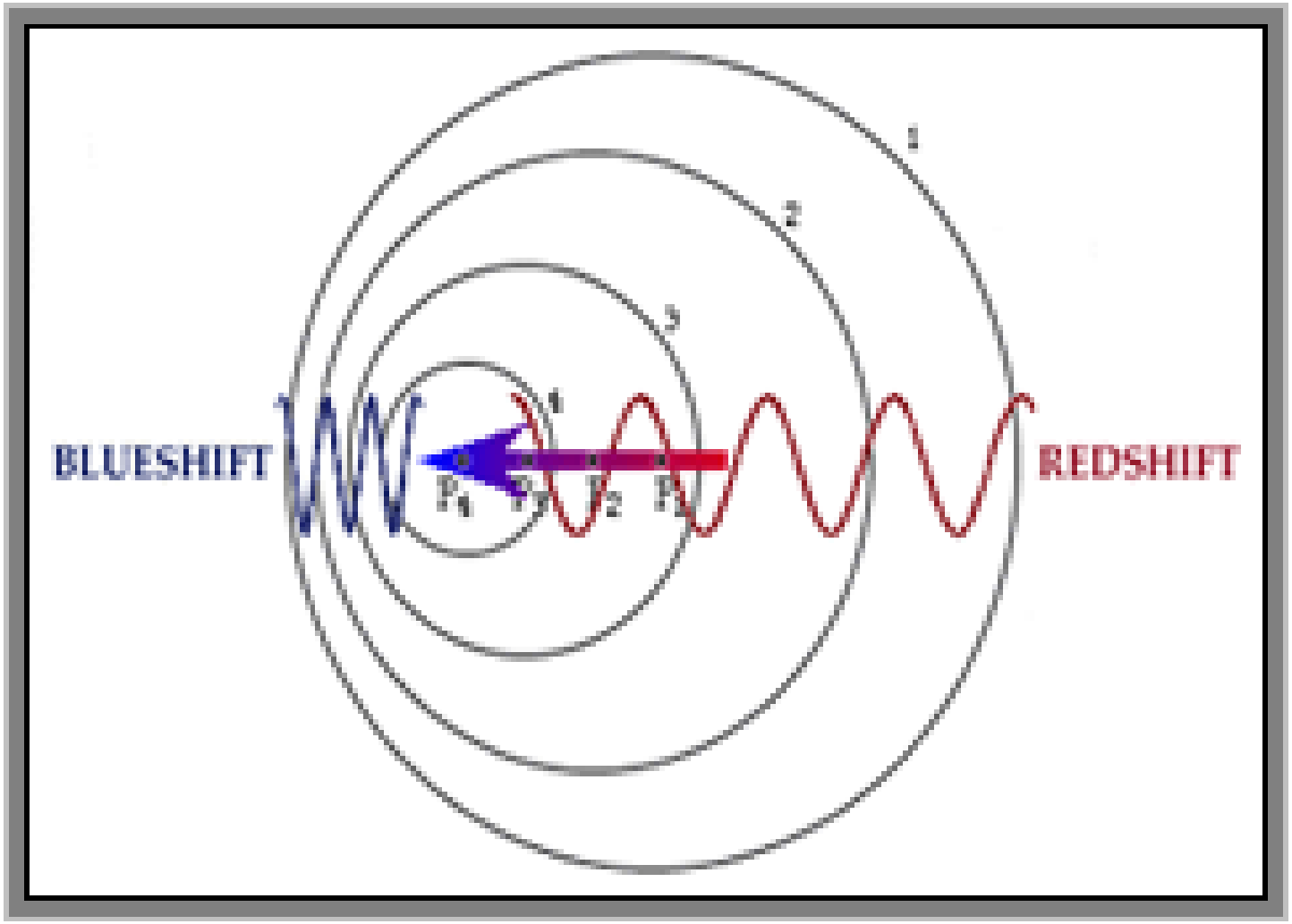


Figure (8): The Doppler Effect for Sound Wave.

- **Doppler shift can be calculated by the equation below:**

$$\text{Doppler shift} = \text{Doppler\_ factor} \times \text{Freq} \times \frac{(\text{Doppler Velocity} - \text{O. Velocity})}{(\text{Doppler\_ Velocity} + \text{S. Velocity})}$$

- **Where:**

  Doppler shift = Altered Frequency of the wave.

  Freq = Frequency of the emitting wave.

  O. Velocity = Object Velocity.

  S. Velocity = Source Velocity.

- After motion was detected their is an electrical signal will be transmitted from the ultrasonic radar module (VM_125) to the personal computer via the parallel port (Parallel Interfacing).

INTERFACING

- The interface is the physical and logical arrangement supporting the attachment of any device connector or other devices. It is the process of making two or more devices or systems operationally compatible with each other so that they function together as required without any external devices.
- There are two types of computer interfacing:

1. **Serial interfacing .**
2. **Parallel interfacing.**

SERIAL INTERFACING

- Serial interfacing is an interface on which data is transmitted or received in sequential manner one bit after another.

PARALLEL INTERFACING

- Parallel interfacing is an interface on which several bits, usually one byte (8 bits), are transmitted or received at a time .
- I use parallel interfacing due to:

1. Has high speed.
2. Number of data bits.
3. It is easy to interface than serial one (UART).
4. No need to convert signal from parallel to serial.

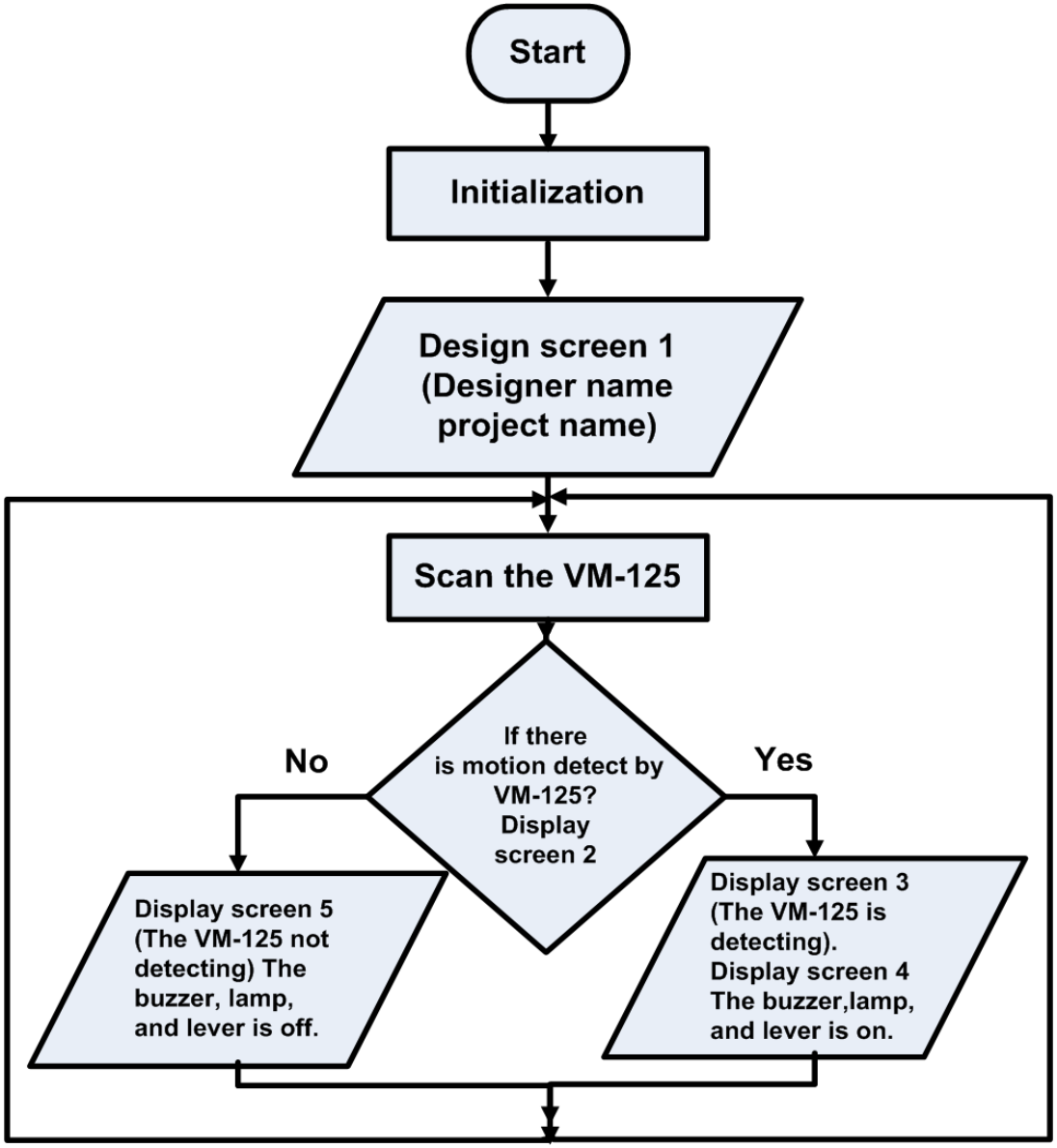
- When the electrical signal reach the personal computer parallel port the program (C language program) will detect it (electrical signal).

SOFTWARE DESIGN

- The program that was in the personal computer was wrote with C language.

- The software in the computer display on the monitor if there is a motion on interrogation zone or not.

THE SOFTWARE FLOW CHART



- When C language program detect the electrical signal that reach the parallel port it will send a control word via parallel port to the interface circuit which capture the control word in buffer and amplify the electrical signal to light the lamp and the buzzer.

CONTROL SYSTEM

- Controlling is a mechanism to manage, command, direct or regulate the behavior of the devices or systems.

CONTROL SYSTEMS
TYPES

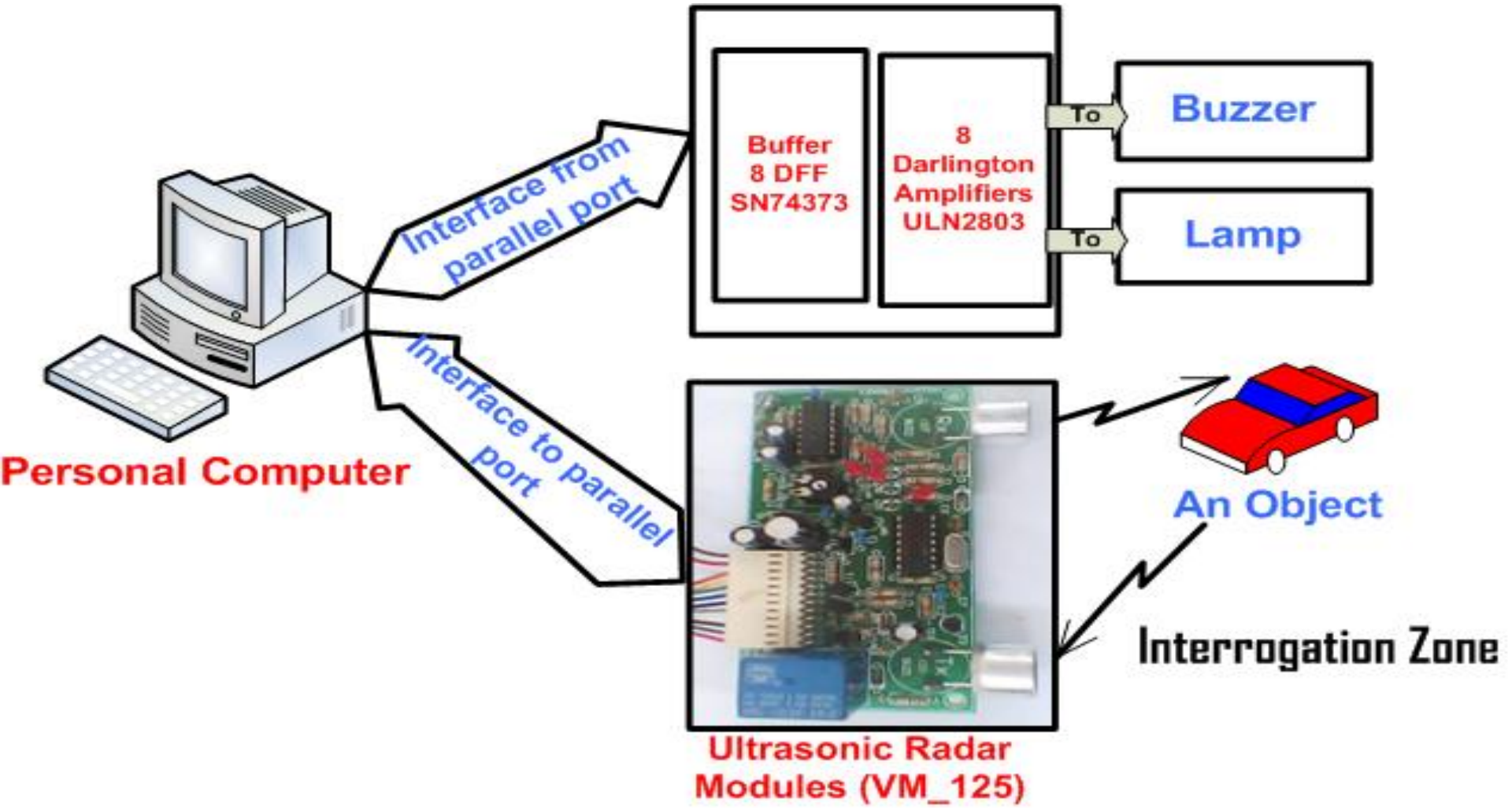
- The control system may be classified in a number of ways depending upon the existing of **feedback** to **open loop** and **close loop**.
- The feedback control system classified depending upon the **feedback type** to **positive feedback** and **negative feedback .**
- If the feedback controls system classified depending upon the method of **analysis and design** is classified to **logic or sequential control, feedback or linear** controls, **fuzzy logic** control system, and **digital** control system.

CONTROL SYSTEMS APPLICATION

- There are a lot of applications which can be divided to:

1. **General control systems** such as distributed control system.
2. **Specific control systems** such as Kite control systems and lighting control system.
3. **Computer control systems** such as Fire control system.
4. **Vehicle control systems** such as Aircraft flight control systems.
5. **Biological control systems**.

MOTION DETECTION SYSTEM CIRCUIT DESIGN



RESULT

- After the design of the motion detection system electronic circuit I find that the system will detect any object move far away from the transmitting antenna about 2.5 meters. The motion detection system is sensitive to any motion in front of it and it has a short delay time which it approximately equal to 400 m sec.
- The motion detection system electronic circuit has a simple construction and it can be built in any please but it prefers to cover it with plastic from the weather change.

DISCUSSION

- Any far away object (above 2.5 meter) will not detected by the motion detection system because the signal power will decrease below 3db so the reflected signal will not received by the receiving antenna. The motion detection system has a delay time due to the transition of the electrical signal from the VM_125 to D_25 connector to the c program then to the D_25 connector again then to the buffer and the amplifier and lastly to the devices.

CONCLUSIONS

Aims that was achieved in this project are:

1. **Built simple monitory system** (Surveillance system) that depend on Doppler effect.
2. **Detection of object** that move in front of motion detection system:

A. If (f1=f2) then there is no motion.

B. If (f1≠f2) then there is a motion.

3. **Alert the security system** that there is an intruder (Lamp and Buzzer).
4. There is no **false alarm**.

RECOMMENDATION

- I recommended to improve the motion detection system by:

1. **Send the ultrasonic wave** with high power to increase the area that the motion circuit can cover it (greater than 2.5 m).
2. Connect a **lot of VM_125 devices** to the personal computer to cover all direction which provide high level security system and expand the motion detection system to cover wide area.
3. **Add one dome camera** to the motion detection system so if one of the VM_125 devices detects motion that will feedback the dome camera to be directed to that direction to took a photo to the moving object.

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There are some aims that was **not achieved** as:

1. Determination is the object moving nearby or far away from the monitoring system? and that can achieved :

A. If **(f1>f2)** then there is a motion and the object move **far away**.

B. If **(f1<f2)** then there is a motion and the object move **toward.**

Where:

F1≡ Frequency of the **emitting** wave.

F2≡ Frequency of the **receiving** wave.

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2. Determination object speed as traffic Radar idea and using the equation below:

$$\text{Doppler shift} = \text{Doppler\_ factor} \times \text{Freq} \times \frac{(\text{Doppler Velocity} - \text{O. Velocity})}{(\text{Doppler\_ Velocity} + \text{S. Velocity})}$$

3. The motion detection system may be connected to camera to triggers it to record subsequent events.

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Thank you very much