**EchoGuard: My Beginnings of Evolution**

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EGN 1008: Intro to Engineering

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**Background**

Dr. Mohammed Dabbas’ Intro to Engineering (EGN 1008) course has been such an important course to attend as a student pursuing an Electrical Engineering (EE) degree. My focus is on applying foundational knowledge to advance technology, which is why I am actively researching and completing projects, building a strong technical skill set applicable in defense technology. I decided to concentrate on the foundational fields such as Telecommunications (RF), Autonomous Systems & Control, and Embedded Systems. My goal as an electrical engineering student is to become a Research & Development (R&D) Scientist in Defense Technology. With these concentrations, I can solve complex challenges and leverage Electrical Engineering principles in advanced defense systems.

**Introduction**

The project for this class I presented was “EchoGuard”, which is a non-kinetic system (programmed in C++) that uses mechanical energy, such as ultrasonic waves, to detect the presence, distance, and threat level of an object or person without any physical contact. This can be used in an Active Protection System (APS) such as a Trophy system. Real-world applications of ultrasonic technology is also used in Acoustic Hailing Devices (AHDs/Non-Kinetic): Uses ultrasonic technology to deliver long-range high-intensity sound to deter threats**,** Sonar Systems for underwater applications**,** Proximity Fuzes also use ultrasonic sensors which are embedded in missiles to detect proximity to a target and trigger detonation at the optimal distance, and as well as listening devices and imaging.

**Goal**

The overall project goal was to explore and evaluate the effectiveness of ultrasonic sensors in proximity detection, while investigating potential enhancements for faster response times and increased detection accuracy, reflecting real-world applications in security and defense systems.

**Components & Roles**

The microcontroller can be considered the “brain”. It acts as the central processing unit of the EchoGuard. It receives data from the ultrasonic sensor, processes it, and sends commands to the buzzer and LEDs. Depending on how it’s programmed, it can read and interpret an object based on the distance. Additionally, the ultrasonic sensor measures the distance between the sensor and a nearby object by sending out ultrasonic pulses. It measures the time it takes for the echo to return after hitting an object. As well as the buzzer emits a sound (indicator), signaled by the Arduino, when an object is detected within a specified distance. The LEDs are also an indicator, a visual indicator, which means they provide a visual alert to indicate an object is detected. Also, the resistors’ role is critical to the circuit as it provides protection, preventing too much current to the components, which can cause overheating. Lastly, the battery provides electrical energy to power the entire circuit.

**Demonstration Summary**

As part of the final presentation, a live video demonstration was conducted to showcase the functionality of the system, which was developed using an Arduino Uno, ultrasonic sensor, buzzer, and LEDs.

The demo visually demonstrated how the system responded to varying distances of an object:

* **LED Activation:**  
  A set of LEDs (green, yellow, red) were used to indicate proximity. As the object approached:
  + The green LED turned on at a safe distance.
  + The yellow LED indicated moderate proximity.
  + The red LED turned on when the object was very close.
* **Auditory Alert:**  
  When the object moved within a critical range (below 20 cm), the buzzer activated, providing an audible alert.
* **Real-Time Feedback:**  
  The system responded instantly and consistently across multiple trials, including displaying the distance, threat level, and time, proving the reliability of the code and circuit design.

This demonstration validated that the integration of software (C++ code using Arduino IDE) and hardware (sensor and output components) was successful.