

## 11.0 Results and Discussions

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### 11.1 General Project Outcomes

By no means is the MAIDS system perfect and further improvements are required. However, the project managed to accomplish the outcomes described below.

#### 11.1.1 Surveillance Capabilities

Motion and sound sensor devices within MAIDS cause the initiation of a local audible/visible alarms and notification events.

#### 11.1.2 Multi-channel Alerts

Transmission of alarm alerts to home/business owner, police department or central monitoring station via email (with picture), Android Push Notifications, SMS Messaging and phone calls.

#### 11.1.3 Sound Sensing Unit

A sound sensing device that has the ability to detect continuous attack noises in the audio frequency range up to 10 kHz.

#### 11.1.4 Motion Sensing Unit

A motion sensing device that has the ability to detect distinguish between object movement and human movement, cover a motion cone of 110°, distance of up to 7 meters within operating temperature from -20° to +80° Celsius and low power consumption of 65 mA.

#### 11.1.5 Signal Processing Circuitry

Provides separate signal processing circuitry for independent sensing microphone and PIR motion sensor.

#### **11.1.6 Intrusion Alarm System**

Intended for use in intrusion alarm systems to provide premise-protection (home/business) of spaces and other secure areas

#### **11.1.7 Visual Capabilities**

The camera takes a photographic record of the event and intruder when the alarm is activated providing a caption containing time of entry, place of entry and address of home/business. Photographic/video record is included in email message to the owner and can help law enforcement track down potential criminals or trespassers.

#### **11.1.8 EMI Resistance**

A sound sensing device that will not enter the alarm state when subjected to moderate levels of radiated electromagnetic fields and conducted interference.

#### **11.1.9 Reliability of the device**

MAIDS performed reliably in 50 out of 54 trial runs.

#### **11.1.10 Control Unit**

Raspberry Pi 4, Python Code and Sound/Motion sensing devices that provides the electronic circuitry to process the signal from the sensor and initiate an alarm signal when attack noises are detected.

#### **11.1.11 Secure Mode (All-Safe Mode)**

Sound/Motion sensing system where all sensors and control unit are active and ready to respond to attack sounds and motions.

#### **11.1.12 Strategic Placement of Components**

Electronic alarm sensors strategically placed so that they can monitor conditions that require security alerts.

#### **11.1.13 Enclosure Protection**

Designed MAIDS case to protect equipment from damage.

#### **11.1.14 Web-based Intrusion Database Log**

Designed and implemented a web-based intrusion database log developed with PHP and MySQL.

## **11.2 Project Issues/Challenges**

A few issues and challenges were encountered during the design and implementation of the MAIDS project which gave way to possible future improvements.

### **11.2.1 Project Issues**

1. Sensitivity Adjustments: Adjusting the sensitivity of the motion sensor can be tricky with the sensor's potentiometer.
2. False Alarms: Improper installation of the device (common traffic area/improper heights) can lead to a false detection caused by the movement of objects such as pets, blinds, and curtains within the range of a motion detector. The implementation of AI in MAIDS, as discussed below, can reduce false alarms considerably.
3. Overlapping Traces: PCB board design has to take into consideration short-circuits created between overlapping traces. Therefore, overlapping traces should be placed in different layers.
4. Sensor Threshold: Adjusting the sensor's threshold of allowed movement so that small movements in the room from events such as blind movement do not constantly set the alarm system off.

### 11.2.2 Project Challenges

1. **Environmental Impact:** New standards and regulations require electronics designers and manufacturers to consider the environmental impact of a product's entire life cycle. MAIDS tried to consider every aspect, from the manufacturing process, chemicals and tools used, to consumer energy use and disposal of the product.
2. **Stringent Quality Control Methods: For MAIDS,** it is important to produce good quality products. Consumers want electronic products that operate the way they should. Therefore, MAIDS implemented strict quality control measures to ensure the consistent quality of all the products produced.
3. **Lack of skills:** A lack of appropriate skills and an understanding of embedded technology can become an important issue in the design process. MAIDS strived to understand the embedded technology used (Raspberry Pi 4) and the associated GPIO pins, as well as, learn and apply the skills (i.e. CAD design, 3-D printing, soldering, etc.) required by the project.
4. **On-time Delivery of Project:** There is an inherent pressure to deliver projects quickly. Therefore, lead times become a primordial concern.

## **11.3 Project Lessons**

### **11.3.1 Design Lessons**

In order to minimize the design risk, MAIDS minimized the design complexity. Using electronic modules, as MAIDS has, for instance, was the common way to reduce the design complexity and risk.

### **11.3.2 Soldering Lessons**

The following are lessons learnt during the soldering process that are important to follow.

1. Set the tip temperature to the temperature appropriate to the solder alloy being used.
2. Use lead-free solder; healthier for the people working on the project and for the environment.
3. Place component and fix two opposing corner pins.
4. Clean the solder-well tip on a sponge.
5. Do not over tin the tip with solder
6. Remove flux residue if necessary.

### 11.3.3 Breadboard Building Process Lessons

The following are lessons learnt during the breadboard building process that are important to follow.

1. Breadboard circuits should only be used for designing and testing circuits outside of cases and housings, before you move on to a soldered version.
2. Tools are not needed most of the time, however, it is helpful to have a pair of tweezers or needle-nose pliers to handle some smaller components.
3. Component insertion into the breadboard must be done by pushing the component leads into the breadboard holes straight down and trimming them if they are not the right length.
4. Always pay attention to component and cable management in general, especially when it comes to arranging jumper wires. Otherwise, one will end up with a tangled, disorganized board.
5. Jump wire kits can provide the various lengths and color-coding options that will help organize a project as the project gets more intricate.
6. Do not wire individual components directly to power source. Instead, use the power rails.
7. A digital multimeter should be used often to check connections between holes and rails.

### **11.3.4 PCB Board Lessons**

The following are lessons learnt during the PCB board design process that are important to follow.

1. Draw an overview plan of where the different circuit components will be located.
2. Allow adequate board area for the circuit.
3. Do not place traces at right angle.
4. Ensure same orientation while placing components.
5. Keep power and control ground separate from each other.
6. Allow sufficient space for cooling around hot components.
7. Consider track size for lines carrying current.



### **11.3.5 Project Documentation Storage Lessons**

Perhaps the most important lesson of all regards the project's documentation storage. Storage and backup of the project's documentation should be paramount at any stage. These documents must be kept in a secured storage area and include availability redundancy.

While document storage might seem somewhat inconvenient, costly, and rather time-consuming, the loss of a project's documentation will cost a great deal more, not only to the project designers, but for the partners, clients and staff as well. Using a secure document storage facility is the safest, easiest and most cost effective way to ensure proper storage of documents. Therefore, MAIDS made use of OneDrive by Microsoft and GitHub to secure and store all documentation pertinent to the project. There is nothing more frustrating and catastrophic than losing all the documentation about a project due to human error, data loss or corruption, theft, sabotage or malware attack.

### **11.3.6 Technical Lessons**

During a project's life cycle, it is important to ensure consistent and timely progress reporting. Furthermore, the accuracy of the information and report data must be guaranteed. Finally, one needs to anticipate and exploit evolving technology.

### **11.3.7 Organizational Lessons**

Organizational lessons include the need to clarify project and functional roles and responsibilities and understand the skills required. Also, we need to heed and measure the capacity to develop the project successfully. Finally, it is important to establish a consistent reporting process that can be used to improve decision making.

### **11.3.8 Marketing and Sales Lesson**

Creating something great is not the path to success. Creating something great and being able to market and sell it is the key to success.

### **11.3.9 Final Lesson**

The key to business success is always to build, test, learn, and repeat.

## 11.4 MAIDS Project Proposed Improvements

In order to further improve the MAIDS system, the following subsequent improvements should be undertaken:

1. Tamper Proof: Provide some type of alert if the alarm device has been tampered with or opened.
2. Protective Covering: Provide protective covering for surface-mounted contact switches, wire connections, and wire distributions. These protective coverings must be strong enough to withstand damage due to collisions and bumps.
3. Power Supply/Batteries: Alarm sensors need a power supply that cannot be interrupted. Backups and/or batteries will be required.
4. 2-way calling: Configured to allow two-way calling with your alarm company. This will allow you to speak to your security system provider without picking up the phone.
5. Away Mode: Provide an automatic Away Mode - the system assumes that you are out of the house, and will therefore enable all sensors between certain daily hours.
6. Central Monitoring: Provide a central monitoring station connected to the home/business security system for action in times of emergency.
7. Keypad Authentication: Addition of a keypad for authentication, arming/disarming of MAIDS.
8. Add-ons and Integrations: Allow users to create custom zones using a combination of sensors and cameras.

9. Future Technology Implementation: Concerns about future technology developments, including component obsolescence, can render an entire product difficult to sell. The MAIDS project tried to mitigate component obsolescence by incorporating the latest available modules into its construction.
10. Future Programming Implementation: In order to thrive in there is an inherent need to keep on top of programming developments. MAIDS should be updated to use the Paramiko library which implements the SSH2 protocol as an alternative to SSL for making secure connections between python scripts. All major ciphers and hash methods are supported. SFTP is also supported by Paramiko.
11. Emerging Artificial Intelligence (AI): Emerging technologies like AI can disrupt industries as well as providing new opportunities. For example, MAIDS video camera should be updated with AI with facial recognition functionality to identify whether the moving object is an intruder or a home member. This will provide a new mechanisms that improves accuracy in detecting intrusion into the home while reducing the chance of false alarms.

## 11.5 Project Best Practices

In order to have MAIDS function properly, the following best practices should be implemented upon deployment of the system.

1. Optimal Placement: The optimal place to install MAIDS is in a corner, so the 90 degrees of coverage run along each wall, effectively covering the maximum amount of space.
2. Optimal Angle: Motion detectors take a longer time to react to someone walking in a straight line directly towards the motion detector's lens, therefore, motion detectors are best suited to detecting movement made across the room, parallel to the lens.
3. Minimum Height: Install motion sensors at a height between 7 and 8 feet above the ground pointing downwards at an angle to cover the room.
4. Pet Proofing: Pet-proof motion detectors require a minimum of six feet between the motion detector and the animal to be effective so base your height placement on the height of your cat/dog at his tallest point when standing or jumping, depending on temperament.
5. Designated Surveillance Areas: Confine pets to areas that are not covered by your motion sensors while you are away.