CAPSTONE PROJECT CENG355

Humber College Institute of Technology & Advanced Learning

MAIDS HOME/BUSINESS INTRUSION DETECTION SYSTEM REPORT

Submitted by: Claudio, Meis

Discipline: Computer Engineering Technology

**Date Submitted: January 14, 2020**

# Declaration Of Sole Authorship

I, Claudio F. Meis, confirm that this work submitted for assessment is my own and is expressed in my own words. Any uses made within it of the works of any other author, in any form (ideas, equations, figures, texts, tables, programs), are properly acknowledged at the point of use. A list of references is included {OAECTT, 2017, Technology Report Guidelines Revised March 2017}

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Date: January 8, 2020

# Proposal

MAIDS (Meis Alert Intrusion Detection System) is a real-world Internet of Things (IoT) project aims to satisfy the following requirements:

1. Provide an affordable (under $200) home or business intrusion detection system (IDS)
2. Provide a small and easily deployed DIY IDS for any space
3. Provide the user with a simple IDS Android-based application interface
4. Provide rapid-response and reliable multiple-channel intrusion alerts in real-time
5. Eliminate monthly monitoring fee (self-monitoring system) and no contract required
6. Provide database information for authorities use.

MAIDS is an IoT-based home/business security device built around a 3-tier model distributed computing model. It runs on a Raspberry Pi 4 Model B 1.5GHz quad-core 64-bit ARM Cortex-A72 CPU platform interfaced with a customized PCB board. The customized PCB board includes three main components:

1. a small size PCB board (34 mm x 16 mm x 15 mm) HC-SR501 Human Sensor Module Pyroelectric Infrared PIR Sensor Detector with as cone angle of less than 120º.
2. A small PCB board size (37mm x 25 mm x 20 mm) High Sensitivity Sound Microphone Digital Sensor Detection Module with an operating range between 16 to 20 kHz (1 kHz is the frequency equivalent to 1,000 cycles per second).
3. A small PCB board size (20 mm x 20 mm) SunFounder Dual Color LED Sensor Module for Arduino and Raspberry Pi capable of emitting light of two different colors (red and green); all main PCB components operate at DC 3.3V.

Remote Central access to MAIDS by a custom Android application displays an intrusion database developed with HTML, CSS, PHP and MySQL, via the Internet on a locally located Apache HTTP Server version 2.4.41 service. Furthermore, MAIDS has the capability to connect to an enterprise size wireless domain and store certificates to receive multi-channel alerts (e-mail w/ photo, SMS messages, push notification and a phone call). The prototype is surrounded by a custom 3-D and laser-cut/etched white acrylic enclosure designed for component protection.

The accompanying technical report conforms to OAECETT certification guidelines.

MAIDS’ further feature development requires continued skills development in the following areas:

1. SSH Android application development with Java
2. Static IP address network configuration for Raspberry Pi 4
3. Apache server security configuration
4. Configuring Iptables or Firewalld for Linux system internal security
5. Intranet network setup and router forwarding configuration
6. KVM installation and configuration
7. Samba server setup and configuration to exchange data and files with Windows systems
8. SCP and SFTP configuration and usage.

MAIDS’ project phases (specifications, design, development and status) are reviewed by Mrs. Marilyn MacGhee, M.A., owner and operator of several Canadian-based franchise outlets in the city of Etobicoke and potentially hiring me upon graduation as her business network administrator, database developer and technological advisor. Mrs. MacGhee’s franchises have been in business for over 20 years and employ over 150 employees. Depending upon availability, Mrs. MacGhee will attend the ICT Capstone Expo.

The small MAIDS’ physical prototypes built is “…small and safe enough to be brought to class every week as well as be worked on at home. In alignment with the space below the tray in the Humber North Campus Electronics Parts kit the overall project maximum dimensions are 12 13/16" x 6" x 2 7/8" = 32.5 cm x 15.25 cm x 7.25 cm.” {Medri, 2020, Course Modules: Welcome}

In order to maintain MAIDS within safety and Z462 guidelines, it will use a maximum DC voltage of +3.3V (a Volt is the force that causes charges to move in a wire or other electrical conductor), less than 50 mA (a milliamp is equal to one-thousandth of an ampere; an ampere is the unit used to measure electric current and is a count of the number of electrons flowing through a circuit)current and maximum power consumption of 20 Watts (a Watt is a unit of power). The MAIDS’ prototype is never left unattended during transport, manipulation, displaying and modification and/or testing.

# Executive Summary

Break-ins occur every 90 seconds in Canada. {King, 2019, The secret to stopping break-ins} According to research studies, homes and businesses with a monitored security system are 2.2 and 4.5 times less likely burglarized. (Woodall, 2019, Canadian Crime Rates Burglary & Home Invasion: A Real Threat) MAIDS intended use as an intrusion detection alarm systems provides premise-protection (home/business) of spaces and other secure areas. Strategically placed motion/sound sensor devices within MAIDS initiates and transmits local/remote audible/visible alerts to home/business and/or police department via email with picture, Android Push Notifications, SMS Messaging and phone calls using Internet services like Twilio and PushOver. Furthermore, MAIDS’ separate signal processing circuitry incorporates a sound sensing unit that detects continuous attack noises in the audio frequency range up to 20 kHz. In addition, the motion sensing unit discerns between object movement and human movement as it covers a motion cone of up to 120° and distances of up to 7 meters within operating temperature from -20° to +80° Celsius and with a low power consumption of 50 mA. The camera takes a photographic record of the intrusion event when the alarm activates attaching a caption containing time of entry, place of entry and address of home/business. Photographic/video record is then included in an email message to the owner and can help law enforcement track down potential criminals or trespassers. An Android-based phone/tablet application provides remote control capabilities. A database records intrusion information and is reachable via the Android application. Accordingly, MAIDS is capable of connecting to enterprise size networks and accept certificates. Finally, MAIDS, is enclosed in a tough acrylic enclosure designed to protect the internal sensing devices from damage.

MAIDS is an affordable, small, easily deployed and low-cost alternative that protects and secures your home or business through constant 24/7 remote monitoring using an indoor camera and motion and sound detection sensors. MAIDS provides peace of mind by providing a rapid-response and reliable multiple-channel intrusion alerts (email w/ photo, Android push notifications, phone call and SMS messaging) in real-time when you are not around. It is also capable of dispatching emergency personnel, if necessary. MAIDS also protects your pets from harm and lower Home Owner’s Insurance premiums. While other competitors charge you an extravagant monthly monitoring fee between $30 and $45 dollars per month on a 42 to 60 month contract (i.e. between $1300 and $2700 per year) (Woodall, 2019, Top 5 Best Home Security Systems in Canada 2020) MAIDS costs less than $200! Procuring MAIDS, keeps your home and business safe at an affordable price and reduces the stress when you are not home to protect your loved ones, property and valuables.

MAIDS is a record of a successful project that demonstrates expertise in agile development processes, a strong work ethic and experience that contributes to an organization daily. It also demonstrates the software and technical skills to design and develop projects from proof of concept to deliverables by carrying out complicated tasks and duties efficiently. Moreover, MAIDS reveals an enthusiastic worker that is passionate and driven to deliver high-quality work, every time. Finally, this technical report indicates an effective communicator with strong interpersonal skills that promote cooperation and group cohesiveness, and influences business cultures affecting job performance positively which in turn aids a company's success.

Table of Contents

[Declaration Of Sole Authorship 2](#_Toc33267612)

[Proposal 3](#_Toc33267613)

[Executive Summary 6](#_Toc33267614)

[1.0 Introduction 12](#_Toc33267615)

[1.1 Scope and Requirements 14](#_Toc33267616)

[2.0 Background 20](#_Toc33267617)

[3.0 Methodology 22](#_Toc33267618)

[3.1 Required Resources 22](#_Toc33267619)

[3.1.1 Parts, Components, Materials 22](#_Toc33267620)

[3.1.1.1 Parts 22](#_Toc33267621)

[3.1.1.2 Components 23](#_Toc33267622)

[3.1.1.3 Materials 24](#_Toc33267623)

[3.1.1.4 Bill of Materials (BOM) 26](#_Toc33267624)

[3.1.2 Manufacturing PCB and Enclosure 28](#_Toc33267625)

[3.1.2.1 PCB Board Manufacturing Process 28](#_Toc33267626)

[3.1.2.2 Enclosure Manufacturing Process 29](#_Toc33267627)

[3.1.2.3 3-D Printing: Camera Holder Bracket 30](#_Toc33267628)

[3.1.2.4 Assembly 32](#_Toc33267629)

[*3.1.2.4.1 PCB Board Assembly* 32](#_Toc33267630)

[*3.1.2.4.2 Base Plate Assembly* 32](#_Toc33267631)

[*3.1.2.4.3 Enclosure Assembly* 32](#_Toc33267632)

[*3.1.2.4.4 Final Deliverable Assembly* 33](#_Toc33267633)

[3.1.3 Tools and Facilities 34](#_Toc33267634)

[3.1.3.1 Fabrication and Research Facilities: Humber College 34](#_Toc33267635)

[3.1.3.2 PCB Board Cutting and Etching 34](#_Toc33267636)

[3.1.3.3 Laser Engraving 35](#_Toc33267637)

[3.1.3.4 3-D Printing 35](#_Toc33267638)

[3.1.3.5 Soldering 35](#_Toc33267639)

[3.1.4 Shipping, duties and taxes 36](#_Toc33267640)

[3.1.5 Working time versus lead time 38](#_Toc33267641)

[3.2 Development Platform 39](#_Toc33267642)

[3.2.1 Mobile Application 39](#_Toc33267643)

[3.2.2 Login Activity 41](#_Toc33267644)

[3.2.3 Data Visualization Activity 43](#_Toc33267645)

[3.2.4 Action control activity 44](#_Toc33267646)

[3.2.5 Testing Screen Shots of MAIDS Android Application 46](#_Toc33267647)

[3.2.6 Android Application Status Report 48](#_Toc33267648)

[3.2.7 Image/firmware 49](#_Toc33267649)

[*3.2.7.1 Image Creation Process for Raspbian OS on 32 GB SCHD Card* 49](#_Toc33267650)

[*3.2.7.2 Firmware General Description and Requirements* 49](#_Toc33267651)

[3.2.7.3 Firmware and Hardware Interaction Description 50](#_Toc33267652)

[*3.2.7.4 Firmware’s Functional Design* 54](#_Toc33267653)

[*3.2.8 Code runs via CLI or remote desktop* 57](#_Toc33267654)

[*3.2.9 Wireless connectivity* 58](#_Toc33267655)

[*3.2.10 Sensor/effector code on repository* 60](#_Toc33267656)

[3.2.11 Breadboard/Independent PCBs 61](#_Toc33267657)

[3.2.11.1 MAIDS Schematics 61](#_Toc33267658)

[3.2.11.2 MAIDS Breadboard 63](#_Toc33267659)

[3.2.11.3 MAIDS PCB Board 66](#_Toc33267660)

[3.2.11.4 Bill of Materials 69](#_Toc33267661)

[3.2.11.5 Time commitment 70](#_Toc33267662)

[3.2.11.6 Testing 71](#_Toc33267663)

[3.2.11.8 Final Status Report 72](#_Toc33267664)

[3.2.12 Printed Circuit Board 73](#_Toc33267665)

[3.2.12.1 PCB board Design Flow 73](#_Toc33267666)

[3.2.12.2 PCB Fabrication Specifications 74](#_Toc33267667)

[3.2.12.2.1 Machining 74](#_Toc33267668)

[3.2.12.2.2 Imaging 74](#_Toc33267669)

[3.2.12.2.3 Etching 74](#_Toc33267670)

[3.2.12.3 PCB Board Specifications 74](#_Toc33267671)

[3.2.12.4 PCB Board Component Placement 75](#_Toc33267672)

[3.2.12.5 PCB Board Copper Thickness 76](#_Toc33267673)

[3.2.12.6 PCB Board RoHS Compliance 76](#_Toc33267674)

[3.2.12.7 PCB Board Laminate 76](#_Toc33267675)

[3.2.12.8 PCB Board Trough-Hole Technology 77](#_Toc33267676)

[3.2.12.9 Routing Guidelines for PCB Layouts 78](#_Toc33267677)

[3.2.12.10 PCB Board Size and Shape 78](#_Toc33267678)

[3.2.12.11 PCB Board Trace Angles and Widths 79](#_Toc33267679)

[3.2.12.12 PCB Board Verification 80](#_Toc33267680)

[3.2.12.13 PCB Board Final Status Report 81](#_Toc33267681)

[3.2.13 Enclosure 82](#_Toc33267682)

[3.2.13.1 Enclosure Design Software 82](#_Toc33267683)

[3.2.13.2 Enclosure Design Software 82](#_Toc33267684)

[3.2.13.3 Enclosure Design Stroke Width and Line Colors 82](#_Toc33267685)

[3.2.13.4 Enclosure Design and Materials 82](#_Toc33267686)

[3.2.13.5 Enclosure Design Heat Dissipation Consideration 83](#_Toc33267687)

[3.2.13.6 Enclosure Design Physical Characteristics 83](#_Toc33267688)

[3.2.13.7 Enclosure Design Etched Icons 84](#_Toc33267689)

[3.2.13.8 Enclosure Final Deliverable 84](#_Toc33267690)

[3.2.13.9 Enclosure Final Report 86](#_Toc33267691)

[3.3 Integration 86](#_Toc33267692)

[3.3.1 Enterprise Wireless Connectivity 87](#_Toc33267693)

[3.3.2 Database Configuration 87](#_Toc33267694)

[3.3.3 Security 87](#_Toc33267695)

[3.3.4 Testing 87](#_Toc33267696)

[4.0 Results and Discussions 89](#_Toc33267697)

[5.0 Conclusions 90](#_Toc33267698)

[References 91](#_Toc33267699)

[Appendix I: MAIDS Python Source Code (maids\_final\_python\_code\_ceng355.py) 95](#_Toc33267700)

[Appendix II: MAIDS Wireless Connection Configuration - wpa\_supplicant.conf File 106](#_Toc33267701)

1. Introduction

A break-in is a very disturbing experience. Family, home and business are our most precious assets and their security is of great importance to all. A security system provides the peace of mind that comes from knowing that our loved ones and our possessions are protected. The consequences of a break-in can be deeply overwhelming emotionally and financially. One may recover from the financial loss but the trauma of the act perpetrated on the family and on oneself may linger for a lifetime.

Burglary is always a crime of opportunity and taking preventative measures reduces the likelihood of being affected by it. (SGI CANADA, 2020) For our families and businesses, taking a preventive measure, such as deploying MAIDS, can act as an effective deterrent against criminals from committing crimes against our family and our property. For example, when criminals see a sign informing them that security measures have been implemented, it reduces the likelihood of the crime happening. Moreover, homes and businesses with alarm systems are statistically less likely to be burglarized than homes or businesses with no security; burglars realize there is a greater chance of being caught, if activated. Finally, security alarms also reduce substantially vandalism and damage done to a person or property. An activated alarm system reduces the amount of time a thief has to commit a crime once inside the premises. In turn, the short time inside the home or business reduces harm to a person and the damage to the property and valuables, since once activated, thieves resort to fleeing the scene of the crime, promptly.

MAIDS is an affordable, reliable and simple self-monitoring home/business intruder detection alarm system based on the Raspberry Pi 4 platform, motion (Passive Infrared Sensor) and sound sensors, and connected to the internet (IoT) to deliver home/business intrusion alerts via email (with intrusion picture), Android push notifications, phone call and SMS messaging after detecting an authenticated intrusion. MAIDS hardware can be remotely controlled via an Android application. The software implements hardware-responsive (LED/motion/sound sensor) code that delivers human/animal intrusion detection system alerts in real-time and through a variety of communication channels.

Since most security events are initiated due to some sound that includes gunshots, aggressive behavior or breaking of glass, MAIDS includes a sound sensor. The sound sensor uses a microphone which detects the intensity of sound. The sound sensor captures the sound vibrations and changes them into signals (voltages). The output voltage then triggers the alarm system.

Moreover, a home or business intrusion involves movement on the part of the assailant, therefore, MAIDS also includes a motion sensor. A passive infrared (PIR) sensor device is used to detect a person moving in/out of the detection zone with high reliability. Positive or negative thermal radiation changes in contrast to a background are focused onto a lens that triggers the sensor element. The sensor produces an electrical output signal when the temperature of the incident radiation changes and triggers the alarm system.

Unarguably, by making your home more secure with MAIDS, you can save yourself inconvenience and money.

1.1 Scope and Requirements

MAIDS is an Internet of Things (IoT) capstone project undertaken at Humber College Institute of Technology and Advanced Learning in partial fulfillment of the requirements for the Computer Engineering Technology diploma. Its scope encompasses the design, development, modification and production of a home and/or business intruder alarm detection system.

The Meis Alarm Intrusion Detection System (MAIDS) implements a distributed computing model whose components include the following:

1. locally installed XAMPP server
2. MySQL/MariaDB database administered with phpMyAdmin, developed with HTML, CSS. PHP, and JavaScript, and accessible via the Internet
3. Capable of connecting to an enterprise wireless network and storing certificates
4. A Raspberry Pi 4 Model B 2019 embedded system with power supply and 32 GB SDHC card fitted with a custom PCB board containing a motion sensor, a sound sensor and a dual LED module
5. A custom acrylic, 3-D and laser cut/etched enclosure fitted with a small (3 mm x 3 mm) fan for cooling and an ON/OFF switch.

Furthermore, the project is documented by following and producing an acceptable OACETT technical report. Also, it is important to emphasize that the MAIDS project was not CSA tested.

The specifications for the MAIDS software-hardware components are as follows:

* **Raspberry Pi 4 Model B 2019:**
  + CPU: 1.5GHz quad-core 64-bit ARM Cortex-A72
  + RAM: 4GB of LPDDR4 SDRAM
  + Ethernet: Full-throughput Gigabit
  + Wireless: Dual-band 802.11ac wireless networking
  + Bluetooth: 5.0
  + USB ports: Two USB 3.0 and two USB 2.0 ports
  + GPU: Dual monitor support, at resolutions up to 4KVideoCore VI graphics supporting OpenGL ES 3.x4Kp60 hardware decode of HEVC video.
* **HC-SR501 Human Sensor Module Pyroelectric Infrared PIR Motion Sensor Detector:**
  + Product Type: HC--SR501 Body Sensor Module
  + Operating voltage range: DC 4.5-20V
  + Quiescent Current: <50uA
  + Trigger: L (Default repeated trigger)
  + Delay time: 5-200S (adjustable)
  + Block time: 2.5S (default)
  + Angle Sensor: les than 120⁰ cone angle
  + Lens size sensor Diameter: 23mm (Default)
  + PCB board size: 3.7 cm x 2.5 cm x 2cm (1.46x0.98x0.79inch)
  + Digital output pulse high (3.3V DC) when triggered (motion detected) and digital low (0V) when idle (no motion detected)
  + Sensitivity range between 7-20 feet (3-6 meters).
* **Sound sensor:**
  + Operating range between 3.3 V DC to 5.0 V DC
  + Operating current between 4-5 mA
  + Voltage gain of about 26 dB
  + Impedance of 2.2k Ohms
  + Frequency range between 16 to 20 kHz
  + Noise to signal ratio of 54 dB
  + Output model: digital switch outputs (0 (low) and 1(high))
  + PCB size: 3.4 cm x 1.6 cm.
* **Dual Color LED Module:**
  + Dual-color LED: red and green
  + Common cathode
  + PCB size: 2.0 cm x 2.0 cm
  + 3-Pin anti-reverse cable
  + Working voltage: 3-5V DC.
* **Rocker Switch - SPST (round):**
  + Rated up to 10 A at 125 VAC
  + Two-Pin switch
  + Size: 20 mm diameter.
* **Enclosure:** 
  + *Design:*
    - CorelDraw 2018landscape .pdf file
    - Stroke width: hairline (0.000 mm)
    - Outside laser cut: green
    - Inside laser cut: red
    - Etching color: black with stroke width thicker than hairline.
  + *Physical Characteristics:*
    - Small footprint (100 mm x 67 mm x 100 mm)
    - Hollow shell WT2447-1-8/1212 Acrylic White Sheet
    - Translucent: 10%
    - Thickness: 3 mm (1/8")
    - Glossy/shiny surface
    - Weatherproof/UV stable
    - Etched icons and lettering
    - 3-D printed camera holder bracket
    - Laser cutouts: Round rocker switch, SDHC card, fan (30 mm x 30 mm), USB2.0, USB3.0, Ethernet, 2 micro HDMI connectors and audio ports.
* **Raspberry Pi 4 Compatible Power Supply:**
  + ON/Off Switch
  + 5V 3A USB-C Charger Adapter for Raspberry Pi 4 Model B 2GB Version.
* **Storage:**
  + Sandisk Extreme Pro: 32GB SDHC UHS-I Card (SDSDXXG-032G-GN4IN)
* **Android Device:**
  + Display: 9.60 inch (800 x 1280 resolution)
  + Processor: 1.3 GHz quad-core or higher
  + Front Camera: 2 MP
  + RAM: 1.5 GB
  + OS: Android
  + Storage: minimum 8 GB
  + Rear Camera: 5 MP
  + Battery Capacity: 5000 mAh.
* **MySQL/MariaDB Database:** 
  + *Hardware:*
    - CPU: Intel Core or Xeon 3GHz (or Dual Core 2GHz) or equal AMD CPU
    - Cores: Single (Dual/Quad Core is recommended)
    - RAM: 4 GB (6 GB recommended)
    - Graphic Accelerators: nVidia or ATI with support of OpenGL 1.5 or higher
    - Display Resolution: 1280 × 1024 is recommended, 1024×768 is minimum.
  + *Software:*
    - Windows 7 (64-bit, Professional level or higher)
    - Mac OS X 10.6.1+
    - Ubuntu 9.10 (64bit)
    - Ubuntu 8.04 (32bit/64bit)
    - Fedora 11 (i386/x64)
    - Microsoft .NET 3.5 Framework
    - Cairo 1.6.0 or later
    - glib-2.10, libxml-2.6, libsigc++ 2.0, pcre, libzip.
* **XAMPP Stack** 7.4.1-1:
  + - PHP 7.1.1
    - Apache2.4.25
    - OpenSSL 1.0.2j
    - MariaDB 10.1.21
    - Perl 5.16.3
    - OpenSSL 1.1.1d (UNIX only)
    - phpMyAdmin 5.0.1.
* **Languages:**
  + HTML 5.0
  + CSS 3.0
  + JavaScript ECMAScript 2019.

2.0 Background

Break-ins occur every 90 seconds in Canada and more than 80 percent of break-ins occur during daylight hours. (SGI Canada, 2020) Statistics from 2018, showed that there were 159,812 burglaries across Canada and all types of properties. That is 431.24 reported burglaries per 100,000 persons. In other words, 4 percent of all Canadian households were burglarized; that is to say 1 out of 28 households were burglarized across the country. (Statistics Canada, 2018) Furthermore, once burglarized, a home or business is 12timesmore likely to be burglarized again! {Woodall, 2019, Canadian Crime Rates Burglary & Home Invasion: A Real Threat}

Closer to home, in the City of Toronto, Statistics Canada reported that in 2018 there were 14,265 Break and entering cases reports; that is 227.36 reported burglaries per 100,000 persons, an increase of 3.81 percent from 2017. According to the report, 1,723 persons were charged with the offence; 145 youths between the ages of 12 and 17 years of age were charged. {Woodall, 2019, Canadian Crime Rates Burglary & Home Invasion: A Real Threat}

More disturbing, according to the Canadian Centre for Justice Statistics, a typical home/business invasion robbery in Canada is carried out by strangers 68 percent of the time in which a weapon is present 62 percent of the time (firearms 33 percent, Knives or cutting instruments 30 percent other weapons 42 percent) during the home/business invasion and victims sustain injuries in 50 percent of the cases. (Statistics Canada, 2002)

Taking into account the abovementioned statistics, it is not surprising that home/business owners are looking for a home intrusion detection system to safeguard their families and property. However, they are finding it more difficult to protect their families, homes and businesses with the skyrocketing pricing of commercial alarm systems. For example, Vivint will charge around $700 just for the basic starter equipment package and a monthly monitoring fee between $30 and $45 dollars per month on a 42 to 60 month contract; that is between $1300 and $2700 per year! {Safety.com, 2020, The Best Home Security Systems of 2020}

According to research studies, homes with a monitored security system are 2.2 times less likely to be burglarized and business with a monitored security system are 4.5 times less likely to be burglarized. (Canadian Centre for Justice Statistics, 2019) In addition, 85 percent of police chiefs recommend the installation of monitored security systems. Furthermore, in its criminology study, the University of North Carolina at Chapel Hill found that thieves check for alarms in a home or business 83 percent of the time and if one is found more than 50 percent of them are deterred from committing the break-in. (Canadian Living, 2019)

3.0 Methodology

3.1 Required Resources

The MAIDS project was guided by the following resource management principles:

1. The use of fewer components, parts and materials, as possible
2. To use tools, methods and materials to reduce material and energy consumption during the lifecycle of the project and, in particular, to remove, as much as possible, hazardous substances from the production process.

3.1.1 Parts, Components, Materials

3.1.1.1 Parts

Parts are the distinct pieces comprising the MAIDS project which are manufactured separately and used to build or repair said project, and when combined with other pieces makes up the whole. This section provides information about the parts that make up the MAIDS assembly.

1. It includes multicolored Dupont Wire Female to Female Breadboard Jumper Wires Ribbon Cables Kit for Arduino which serve to internally connect all the various MAIDS components.
2. A 5 volts, 3 ampere power supply version compatible with the Raspberry Pi 4 Model B 2 GB (gigabyte) module with an ON/Off Switch and a USB-C Charger Adapter to provide the power needed for the Pi module.
3. A brushless cup Raspberry Pi 4 Cooling Fan with dimensions of 30 mm x 30 mm x 7 mm, with output voltage of 5 volts DC (direct current) and four rectangular aluminum heatsinks used to dissipate heat from running component (thermal control) and maintain moderate operating temperatures.
4. A SanDisk Ultra 32 GB, micro Secure Digital High Capacity (SDHC) flash memory card based on the SDA 2.00 specification, Ultra-High-speed (UHS-I) Card running at approximately 104 Mb/s with Adapter in order to hold Raspbian operating system (OS) and serve as an storage device for produced data.
5. A Panel Mount, round, Snap-In, double pole single throw (DPST) (a switch that has two inputs and two outputs; each input has one corresponding output) rocker switch with maximum alternating current (AC) of 16 amperes and maximum operating voltage of 125 volts used to turn MAIDS on or off.
6. A white acrylic, laser-cut joints used to hold the enclosure together
7. A custom 3-D printed, resin-based camera holder bracket used to attach and hold the MAIDS USB camera in place.
8. A set of four M2-M3 thread, Male-Female connectors, nylon, hexagonal shapes, standoffs with plastic thread that serve to attach and separate modules, isolate circuit components and prevent short circuits.

3.1.1.2 Components

The MAIDS alarm system is comprised of a few components, most modular in nature. Modular components are combined to work together and form a single functioning unit. Since each module is separate, it is often possible to upgrade, change or repair one component while leaving the main system operational. The main components of MAIDS include the following:

1. A white acrylic base and laser-cut and etched enclosure used to protect the internal components and designed specifically to provide good aesthetics.
2. A high sensitivity, high reliability, low voltage and low power consumption HC-SR501 Human Sensor Module comprised of a pyroelectric infrared (PIR) Sensor used to detect changing levels in infrared radiation, like the radiation changes of a moving (human) body.
3. A high sensitivity Microphone Audio Amplifier Module with an operating output of 20 decibels (dB) gain, low noise and running at 3.3 volts to 5 volts DC and used to detect sound and changing sound intensities.
4. A SunFounder, dual color light emitting diode (LED) sensor module for Arduino and Raspberry Pi used to provides visual intrusion information; green=safe and red=intrusion).
5. A Raspberry Pi 4 Model B 2019 module, equipped with a Quad-Core, 64 Bit central processing unit (CPU), with WiFi and Bluetooth capabilities and four GB of RAM. The Raspberry Pi module is used to process and control all sensor I/O signals.

3.1.1.3 Materials

Proper materials selection insures that the right material is used for the right job. Usually, materials are divided into four key groups: metals, polymers, ceramics, and composites. To complete the MAIDS project, metal and polymer components were the main materials used as inputs to the manufacturing process.

1. The project made use of MG Chemicals, 5" x 3" Copper Clad Board, Double Sided (both the top surface and the bottom surface are coated with a conductive material), one ounce Copper with a board thickness of 1/16" and FR4 designation (NEMA grade designation for glass-reinforced epoxy laminate material) used in the fabrication of the custom-made project circuit PCB board.
2. Lead Free Solder Wire with a Rosin Core of 0.6 mm in diameter used to provide safe soldering conditions of parts and components.
3. A [Falken Design WT2447-1-8/1212 Acrylic White Sheet with a translucence of 55 percent, board size of 12" x 12", thickness of 1/8"](https://www.amazon.ca/gp/product/B01DYSVPCQ/ref=ppx_od_dt_b_asin_title_s03?ie=UTF8&psc=1) and used as the main material for the enclosure, joints and base plates.

3.1.1.4 Bill of Materials (BOM)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Designator | MPN | Qty | Link |
| 1 | HC-SR501 Human Sensor Module Pyroelectric Infrared PIR Sensor Detector PIR Sensor | 4260474030781 | 1 | https://www.amazon.ca/Motion-Detector-Sensor-Switch-Arduino/dp/B075CNDXTB |
| 2 | High Sensitivity Microphone Audio Amplifier Module Output 20dB Gain Low Noise DC 3.3V/5V | STK0114016717 | 1 | https://www.amazon.ca/Microphone-Controller-Detection-Sensor-Arduino/dp/B01DBGZ2K2 |
| 3 | SunFounder Dual Color LED Sensor Module for Arduino and Raspberry Pi | 2SSR | 1 | https://www.amazon.ca/SunFounder-Sensor-Module-Arduino-Raspberry/dp/B014KR6VBA |
| 4 | MG Chemicals 5" x 3" Copper Clad Board, Double Sided, 1 oz Copper, 1/16" Thick, FR4 | 587 | 1 | https://www.amazon.ca/MG-Chemicals-Prototyping-1-Ounce-16-Inch/dp/B008OAFOUO/ref=pd\_sbs\_328\_2/132-5081513-4200133?\_encoding=UTF8&pd\_rd\_i=B008OAFOUO&pd\_rd\_r=95480a50-419b-47d5-91b4-3b88102fc136&pd\_rd\_w=zfGQl&pd\_rd\_wg=FhDkE&pf\_rd\_p=dbebb38c-0e3d-4a67-ac15-432d7c7a2789&pf\_rd\_r=A5QQ0YC5SPEYDWN36ZA7&psc=1&refRID=A5QQ0YC5SPEYDWN36ZA7 |
| 5 | Elegoo 120pcs Multicolored Dupont Wire 40pin Male to Female, 40pin Male to Male, 40pin Female to Female Breadboard Jumper Wires Ribbon Cables Kit for Arduino | EL-CP-004 | 1 | https://www.amazon.ca/Elegoo-120pcs-Multicolored-Breadboard-arduino/dp/B01EV70C78/ref=sr\_1\_1\_sspa?keywords=jumper+cables&qid=1579928593&s=industrial&sr=1-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyVkZXSjU0U1RGSjFQJmVuY3J5cHRlZElkPUEwMDcxMTkxM0tSVVU5WVBKQVhKMiZlbmNyeXB0ZWRBZElkPUEwMzg1ODgyMUwxRTJBRE0zR1dIWCZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU= |
| 6 | AUSTOR Lead Free Solder Wire with Rosin Core 0.6mm | AMA-17-532 | 1 | https://www.amazon.ca/dp/B071XVPJVX/ref=sspa\_dk\_detail\_0?psc=1&pd\_rd\_i=B071XVPJVX&pd\_rd\_w=apWS0&pf\_rd\_p=4b7c8c1c-293f-4b1e-a49a-8787dff31bcb&pd\_rd\_wg=s5ddm&pf\_rd\_r=Y6RJTAX1MR0X3E50MH9X&pd\_rd\_r=b093f5a4-5e04-4c4a-bf07-683669f8db02&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExWUMwVUFXVTBTMzUmZW5jcnlwdGVkSWQ9QTA0Nzk5MzAzSENLOTZDTEhKOTBBJmVuY3J5cHRlZEFkSWQ9QTAyMTk5NjJJTDlaVjVBQUtLRksmd2lkZ2V0TmFtZT1zcF9kZXRhaWwmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG9Ob3RMb2dDbGljaz10cnVl |
| 7 | Rocker Switch DPST 16A (AC) 125V Panel Mount, Snap-In | RR812C1121 | 1 | https://www.digikey.ca/product-detail/en/e-switch/RR812C1121/EG4779-ND/2116258?utm\_adgroup=Rocker%20Switches&utm\_source=google&utm\_medium=cpc&utm\_campaign=Shopping\_Switches\_NEW&utm\_term=&productid=2116258&gclid=Cj0KCQiAsbrxBRDpARIsAAnnz\_MoJhLf6plqc9U7ZpBJv8AWE22h3Xss7RSx12FQA\_XYb0KoUbjW\_LYaAo6NEALw\_wcB |
| 8 | M2 M3 Male-Female Nylon Hex Standoff Plastic Thread Motherboard Spacer | XHHD17041 | 1 | https://www.amazon.ca/Male-Female-Motherboard-Prototyping-Accessories-Quadcopter/dp/B06Y4LNDH9 |
| 9 | Raspberry Pi 4 Model B 2019 Quad Core 64 Bit WiFi Bluetooth (4GB) | 2GB-9003 | 1 | https://www.buyapi.ca/product/raspberry-pi-4-model-b-2gb/ |

3.1.2 Manufacturing PCB and Enclosure

Manufacturing refers to the process (ranger of human activities) for producing products for consumption or sale using machines, materials and tools. In essence, the raw materials are transformed into a finished good. This section of the report will outline the manufacturing process of the MAIDS project.

3.1.2.1 PCB Board Manufacturing Process

The PCB board is first designed using Fritzing software version 6.0.3. Once designed, the PCB board circuit rendition is exported for production as a RS-274X Gerber file and sent to the Humber College Prototyping Lab resulting in a professional quality DIY PCB manufactured board. The MAIDS project PCB board’s design is based on a two-layer approach; separates the input and output (I/O) layer from the ground layer. While the I/O layer is located at on the top surface of the PCB board, the ground layer is located on the bottom layer. It is important to emphasize that Design Rules Check (DRC) tests are performed during the design process to ensure proper board function and reliability before the manufacturing process.

Once the design is received at the Humber College Prototyping Lab, the manufacturing process of the PCB board is subject to a few phases. To begin, the PCB board 274X Extended Gerber format file is loaded into the ProtoMat S103 LPKF plotter and router using LPKF CircuitPro software. The software converts the design from the common layout program into control data for the structuring systems, and allows for the optimization of the layout elements, and verifies design using design verification rules. Once data from the file is imported, the ProtoMat S103 circuit board plotters uses a mechanical fiducial systems (cameras for automatic position detection) {Electronics, 2020, Manual Version 0.9`, English} to assist in drilling and milling the double-sided PCB board. In the case of the MAIDS PCB board, it drills four fiducial holes using the Optical Fiducial Recognition Systems (OFRS) on the un-etched sides. This ensures that the structures on both sides of the board are matching so that they remain aligned during transfer between processes. The holes themselves use Through-hole technology; holes that go completely through the boards. In addition, the holes are non-plated (NPTH). With non-plated through holes there is no conductive path from one side of the board to the other. Connections have to be made by applying a thin wire through the hole and soldering it in place to connect the upper and bottom portions of the circuit.

Once positioning holes are drilled, the blank PCB board is transferred to the ProtoLaser S machine. The laser first creates the contours of the circuit and the proceeds to delaminate and evaporate the copper layer. The ProtoLaser S uses a laser low energy source emitting light in the green range (532 nm) {Electronics, 2008, ProtoLaser S: Operation manual 2.0`, English.}Of the visible spectrum, to systematically delaminates and evaporates the conductive copper layer from both sides of the double-sided copper clad PCB board to prevent damage to the substrate. Laser etching makes the process cost effective, fast, and robust. The result is a professional quality PCB circuit board.

Finally, the PCB board is once again transferred to the ProtoMat S103 LPKF plotter and router to cut away the laser etched PCB board from the stock board. The PCB board is then ready for the component placement and the soldering phase.

3.1.2.2 Enclosure Manufacturing Process

The enclosure is designed using CorelDraw 2018 for fast and precise laser cutting. CorelDraw 2018 can export either a .svg or .pdf landscape file which are the preferred file formats for laser cutting. The enclosure rendition document ensures that the object size is constrained within the maximum of 12″ by 24″ object size allowed on the laser cutter bed. The laser cutter uses vector lines to cut with the stroke width set to hairline (0.000 mm wide). Outside laser cuts are colored green while inside cuts are colored red. Etching of words or logos require any other color and lines thicker than 0.000 mm (hairline) which result in the burning a light layer off of the top of the material.

Once designed, the .svg or .pdf file is imported into the Trotec Speedy 100 Laser Engraver which uses JobControl laser software. It is important to emphasize that the .svg file contains not only the designed acrylic walls for the enclosure but also the acrylic joint and base designs; the Speedy 100 cuts and etches the enclosure, as well as, cut the joints to hold it together and the base board on which it rests. The laser cutter and engraver uses a 50 W CO2 laser (Iradion tube) {Trotec, 2020, Operation Manual Trotec Job Control. Basic`, Advanced`, Expert} to cut away the enclosure and joint designs from the acrylic stock material. A fast engraving speed (4.3 m/s) {Trotec, 2020, Operation Manual Trotec Job Control. Basic`, Advanced`, Expert} creates a minimal distortion in the engraving image. Finally, separate parts are then joined together by means of acrylic joints and acrylic glue to produce the final MAIDS project enclosure.

3.1.2.3 3-D Printing: Camera Holder Bracket

The camera holder bracket manufacturing process requires 3-D printing. The design requires a SketchUp (software) produced .stl design file. The file is loaded into the Object 30 3-D printer. The Object 30 is a resin-based, ultraviolet light cured, 3-D printer. The 3-D building process begins by depositing a layer of resin 28 microns (0.0011”) thick {Geometries, 2010, Objet30 3-D Printer System: User Guide`, English. Page 6.}, and cures it (hardens it) by passing an ultraviolet light over the newly deposited resin. The 3-D printer continues the deposition process in layers with great accuracy (0.1 mm) (Geometries, 2010, Objet30 3-D Printer System: User Guide`, English. Page 6) To produce the resulting 3-D model of the camera holder bracket.

3.1.2.4 Assembly

The MAIDS project is assembled in the following stages:

1. PCB board component placement and soldering
2. Base plate assembly
3. Enclosure assembly
4. Deliverable assembly.

*3.1.2.4.1 PCB Board Assembly*

The assembly process begins with the PCB board. First, the connecting pins are placed onto and soldered (using safe and lead-free solder) to the laser-etched PCB board taking care that pins connectors are soldered on the appropriate layers. On the one hand, all pins connecting the main components (motion and sound sensors, and dual LED module) are soldered to the top layer of the PCB board. On the other hand, pins connected to the circuit’s ground connection are soldered on the bottom layer of the PCB board. At this point, the MAIDS hardware circuit is complete.

*3.1.2.4.2 Base Plate Assembly*

Once the circuit is completed, the base assembly process is started. Consequently, the laser-cut base boards are glued together with acrylic glue and left to cure for at least 24 hours to assure maximum the holding power of the glue; the base serves as the physical foundation of the final product.

*3.1.2.4.3 Enclosure Assembly*

After the MAIDS base is finished, the enclosure assembly is completed. The parts of the enclosure that serve as side walls for the project are placed in a vice-grip for support and correct alignment. Once aligned properly, laser-cut acrylic joint plates are glued onto the walls with acrylic glue; glued walls are set aside for curing for at least 24 hours for maximum hold. After 24 hours, the enclosure is ready for complete assembly of the project.

*3.1.2.4.4 Final Deliverable Assembly*

To begin, the Raspberry Pi 4 Model B module is fitted, on its underside, with four M3, Male-Female, and Nylon Hex Standoffs to provide short circuit protection and adequate space clearance for the Pi from the base plate. Then, the custom made PCB circuit board is connected to the 40-pin male connector of the Raspberry Pi 4 through its own 40-pin female connector. This stage completes the hardware assembly portion of the process that serves to process signals from and control signals to MAIDS in response to intrusion events.

Once hardware assembly is finished, the assembled enclosure is placed upon the base plate to surround the hardware circuit. When aligned, the enclosure is secured to the base plate by means of two acrylic, laser-cut joint plates and acrylic glue.

Finally, the top acrylic plate of the enclosure is pressure snapped onto the top of the enclosure; the top plate serves to provide accessibility to internal components, in case of needed replacement dues to malfunction.

3.1.3 Tools and Facilities

3.1.3.1 Fabrication and Research Facilities: Humber College

The MAIDS project design, development, modification and production was possible by the use of the following lab and library facilities located at the North Campus:

1. The Humber prototype lab facilities (Rapid Prototyping lab) located in building J, Room J201.
2. The Advanced Electronics Lab located in building J, Room J232.
3. The Humber College Library, located on the 4th floor of the Learning Resource Commons was used during the project research phase.

3.1.3.2 PCB Board Cutting and Etching

The PCB board design using Fritzing software and produced a 274X Extended Gerber format file employed by the ProtoMat S103 LPKF. The ProtoMat S103 is a circuit board plotter for Contour routing of the circuit board (double layer copper foil) and an Optical fiducial recognition systems for automatic position detection to assist in drilling and milling of double-sided PCBs. It has a spindle speed of 100,000 rpm, a maximum travel speed of 150 mm/s, repeatability of ± 0.001 mm (± 0.04 mil), drilling speed of 120 strokes/min and a resolution of 0.5 μm (0.02 mil). {Electronics, 2020, Manual Version 0.9`, English}The lead time for the PCB board is 12 hours.

PCB board etching is accomplished by the ProtoLaser S which etches away the copper from the double-sided copper clad PCB board. The ProtoLaser S has a minimum track/gap of 50 µm/25 µm (2 mil/1 mil), a resolution scan field of 2 µm (0.08 mil), a laser pulse frequency 10 - 100 kHz, continuous wave (CW), and cutting bed dimensions of (12“ x 24“) {Electronics, 2008, ProtoLaser S: Operation manual 2.0`, English.}

3.1.3.3 Laser Engraving

Trotec Speedy 100 Laser Engraver is used for acrylic enclosure cutting and etching. The laser engraver requires a design in .pdf format. The Speedy 100 uses a 50 W CO2 laser (Iradion tube), uses 2 inch lens (standard), a cutting speed of 180 cm/sec speed and its bed size can accommodate objects of up to 12" x 24". (Trotec, 2020, Operation Manual Trotec Job Control. Basic`, Advanced`, Expert)

3.1.3.4 3-D Printing

3-D printing requires a SketchUp produced .stl design file which is then created on the Object 30 3-D printer. The Object 30 is a resin-based, ultraviolet light cured, 3-D printer with Support Material SUP705 (WaterJet removable) and SUP706B (soluble), maximum build size of 294 x 192 x 148.6 mm (11.57” x 7.55” x 5.85”), layer thickness of 28 microns (0.0011”) and 16 microns (0.0006”) for VeroClear material, accuracy of 0.1 mm (0.0039”) and employs a fusion deposition system. {Geometries, 2010, Objet30 3-D Printer System: User Guide`, English. Page 6.}

3.1.3.5 Soldering

ESD safe, Small footprint (5.9” X 4.5” X 3.6”) Weller WESD51 Soldering Station with power consumption of 50 watts, temperature range 350 ºF – 850 ºF, operating voltage (output) 24 Volts, Temperature Stability +/-10°F (6°C) and Heating Element Type Nichrome Wound; Fiberglass and ceramic insulated. {Elektrotanya, 2020, Model WES51 Electronic Soldering Station}

3.1.4 Shipping, duties and taxes

When shipping finished goods domestically or internationally, it becomes extremely important to consider the effects of shipping charges, duties, and taxes. Shipping internationally can help a business grow financially, in reach and reputation. However, not understanding shipping taxes and duty costs can create massive headaches for the business. Every country has its own laws and rates, and businesses from different sectors face different compliance challenges when shipping internationally or domestically. Depending on the shipment content and the destination, charges could significantly impact the total shipment cost and the products end price. This section presents the shipping, duty and tax charges incurred during the development of the MAIDS system, along with other costs. It is presented in table form for clarity, in explicit order and includes the following sections: Description, quantity, Unit price, Discount, Federal Tax [GST/HST/TPS/TVH], Provincial Tax [PST/RST/QST/TVP/TVD/TVQ], Shipping charges and total cost. The MAIDS shipping, duties and taxes applicable to each component or part is found in the table below.

Table : MAIDS costs, quantities, discounts, shipping, duties and taxes applicable to each component.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Description | Quantity | Unit Price | Discount | Federal Tax | Provincial Tax | Shipping Charges | Total Cost |
| Sound Sensor Module | 1 | $10.30 | -$1.10 | $0.00 | $0.00 | $3.99 | $13.19 |
| Active Buzzer Module | 1 | $7.99 | -$0.18 | $0.00 | $0.00 | $0.18 | $7.99 |
| Motion Sensor | 1 | $10.99 | $0.00 | $0.00 | $0.00 | $0.00 | $10.99 |
| Raspberry Pi 4 Fan | 1 | $9.99 | $0.00 | $0.00 | $0.00 | $0.00 | $9.99 |
| LED Module | 1 | $12.98 | $0.00 | $0.00 | $0.00 | $0.00 | $12.98 |
| SanDisk Ultra 32GB SDHC Card | 1 | $13.99 | $0.00 | $0.00 | $0.00 | $0.00 | $13.99 |
| Power Supply RPI4 | 1 | $13.59 | -$6.99 | $0.00 | $0.00 | $6.00 | $13.59 |
| Acrylic Sheet | 1 | $13.78 | -$6.99 | $0.00 | $0.00 | $6.99 | $13.78 |

3.1.5 Working time versus lead time

A better understanding of lead time (LT) can lead to very substantial gains. For example, a company can develop a more profitable scheme that can meet customer requirement more efficiently. In addition, a greater understanding of LT leads to the detection and correction of performance issues that can be corrected quickly. Finally, it leads to the improvement of customer relations by increasing the level of communication. {Rajaniemi, 2012, Measuring and Defining Lead Time in a Telecommunication Production}

It is important to emphasize that there was no stipulated time limits on the number of hours one was required to work on the MAIDS project on the part of Instructors or Humber College, other than, completion of project by the course’s schedule end date. The working time schedule adopted was a voluntarily established and followed project schedule.

The order lead time, the time from order received to customer order delivered was approximately 8 weeks. The order handling time, the time from customer order received to sales order created was less than 12 hours. The manufacturing lead time, Time from sales order created to production finished (ready for delivery) was approximately 2 weeks. The production Lead Time - Time from start of physical production of first submodule/part to production finished (ready for delivery) was approximately 2 weeks. The Delivery Lead Time - Time from production finished to customer order delivered was approximately 1 week due to testing and slight software modifications. {Rajaniemi, 2012, Measuring and Defining Lead Time in a Telecommunication Production}

The working time, time to assemble the complete MAIDS deliverable, was 2.0 hours per work day, five days per week (total of 10 hours per week), for a total of 20 hours, total.

3.2 Development Platform

3.2.1 Mobile Application

MAIDS uses an Android-based application written in the Java language and built on the Android Studio IDE version 3.5.3 to control and test components, as well as, display intrusion related information. Powered by Gradle, Android Studio's build system allows for a customized MAIDS build and generates multiple build variants for different devices from a single project. In the case of the MAIDS project, the two variants devices created are:

1. A 10” display generic tablet running a quad-core CPU (Central Processing Unit) with 2 GB of RAM, using Android version 6.0 at a resolution of 1536 x 2048 pixels.
2. A 6” display Google Nexus 6 running a quad-core CPU, with 3 GB RAM, using Android version 6.0 at a resolution of 1440 x 2560 pixels.

In addition, the emulator permits virtual testing of the builds, simulates different MAIDS configurations and features, and provides feedback on feature response and configuration performance used to quickly modify the application.

Building the Android-based MAIDS application requires the use of three distinct file types:

1. manifest
2. activity
3. Drawable resource.

The Android manifest file is named AndroidManifest.xml and must be included with every application in the root directory. The file contains essential application metadata, a set of data that describes and gives information about other data, in Extensible Markup Language (XML) format (a textual data format with strong support via Unicode for different languages). The manifest file presents essential information about the application to the Android system, information the system must have in order to run any of the application's code. Specifically, the MAIDS manifest file contains the basic building blocks of application (i.e. activities, services, permissions, etc.), details about resource permissions (i.e. access the Internet, remote storage devices, etc.) and the set of classes needed before launch.

Generally, an Android activity file refers to one screen of the Android application’s user interface (more commonly referred to as the Application Program Interface (API)) and may contain one or more activities (screens); the main activity is shown first when the application starts. Subsequent screens, require their own activity. Specific to MAIDS, the two pertinent activities will be discussed below in a more detailed fashion under their own section of this report. Each section will outline a general description of its operation mode, as well as, detailed information about the inner workings of the program’s code.

Finally, MAIDS uses a drawable resource file which is a graphic file (i.e. .png, .jpg, .gif) that can be drawn to the screen. Our MAIDS application uses exactly two .jpg format files on the second activity; one is used as a placeholder for the intrusion photo while the remote photo of the intrusion is retrieved and the other is the intrusion photo itself, once retrieved. The intrusion photo will have a caption which contains the following information:

1. MAIDS Alarm System Header
2. Address of Intrusion
3. Room where intrusion took place
4. Date and time of intrusion.

The Android application uses a landscape layout (relative layout to be more specific) on the tablet and a portrait layout for the phone, for better visualization of component views and is divided into two main activities:

1. A login activity (first screen), which allows for user authentication and access to the network
2. An data visualization display and component control activity (second screen) which relays database intrusion data (i.e. intrusion date and time, place of entry, owner contact information, etc.), displays a photograph of the intrusion with captioned information (place of entry, date time, etc.), as well as, a remote control mechanisms to activate and deactivate MAIDS and test some of its components (LED module, in particular).

3.2.2 Login Activity

The login activity is the first screen the user encounters to access MAIDS remotely. The main class of the program is: MainActivity. The class is responsible for presenting the user with a welcoming screen and a MAIDS promotional advertisement photo. In addition, the MainActivity class displays two rectangular, labelled (username and password), user input textboxes used for authentication purposes. Moreover, the class displays two labelled buttons (login and cancel) used to either login into the system and access the remote control features of the application or cancel access to it. It is worth noting that the application has been coded to allow the user only three tries at authentication; otherwise, the application closes and the login process has to be restarted. Once the user inputs the correct username and password, control is transferred to the second screen, MainActivity3.

Programmatically, the main activity consists of a public class named MainActivity. Inside the class, there is the protected onCreate() method containing two button views (login (b1) and cancel login (b2)), two EditText views (user input boxes ed1 and ed2) and one text view (tx1) which displays a red horizontal bar and are arranged in a relative layout. When the user is presented with the initial screen s/he has the option of login into the application or cancel the login. If the user chooses to launch the application s/he must first enter two pieces of information, username and password, into the textboxes available on the screen. When clicking the login button, the activity activates the setOnClickKistener(v) method which retrieves the EditText box inputs and checks the username and password imputed against the programmed login settings. If they match, the application will close the login activity screen and display the second activity screen which contains the data display activity and control activity on the same screen. At the same time the login button is clicked, a Toast message is display (“Redirecting…”) at the bottom of the screen through which the user is informed of the subsequent activity to be displayed (MainActivity3.javaj). The user has three opportunities to launch the application with each try displayed in the form of a horizontal red line increasing in length referencing the number of tries. If, upon the third try, the user does not input the correct username and password authentication fails and the application textbox inputs are cleared and the user is asked to re-enter the information.

3.2.3 Data Visualization Activity

The purpose of the data visualization activity is to present MAIDS-created intrusion data in a visual, easy-to-read-and-see format to the user. The data visualization activity is incorporated within the second activity (or screen). The second screen displays six, sequentially arranged, gray, rectangular buttons (views) situated on the upper portion of the screen. The button are labelled as follows:

1. retrieve intrusion information
2. retrieve photo from server
3. display photo locally
4. activate MAIDS
5. deactivate MAIDS
6. Test LED module.

Each button is a subclass onto itself performing different local and remote activities such as: data visualization, and action control. The main data visualization elements (views=buttons) for the MAIDS application are labelled: retrieve intrusion information and display photo locally. The main action control elements (views) are labelled: retrieve photo from server, activate MAIDS, deactivate MAIDS, and test LED module.

Programmatically, the data visualization activity (Main3Activity class) is contained inside the Main3Activiy.java file of the application. The data visualization portion of the activity consists of one WebView element (htmlWebView) which displays the database information gathered form MAIDS internal server (and reached via the Internet through https://singular-gar-5555.dataplicity.io/maidsintrusion.php link), an ImageView element (htmlImageView) which displays the intrusion photo of the incident and two buttons (mButton1 and mButton3) which activate their respective setOnClickListener(v) method to retrieve the database and photo information remotely. All these view elements are located inside the onCreate() method of the Main3Activity. It is important to emphasize that during the database and photo information retrieval process, Toast messages (messages that provides simple feedback about an operation in a small popup) such as “Retrieving DB information…” and “Displaying Intrusion Image…” are displayed to the user informing them of the action being conducted.

3.2.4 Action control activity

There are four action control elements to the MAIDS project:

1. Test LED module

2. Retrieve photo information (from internal MAIDS server)

3. Activate MAIDS remotely

4. Deactivate Maids remotely.

All of these actions are contained inside the onCreate() method of the Main3Activity class and ran through their respective setOnClickListener(v) method.

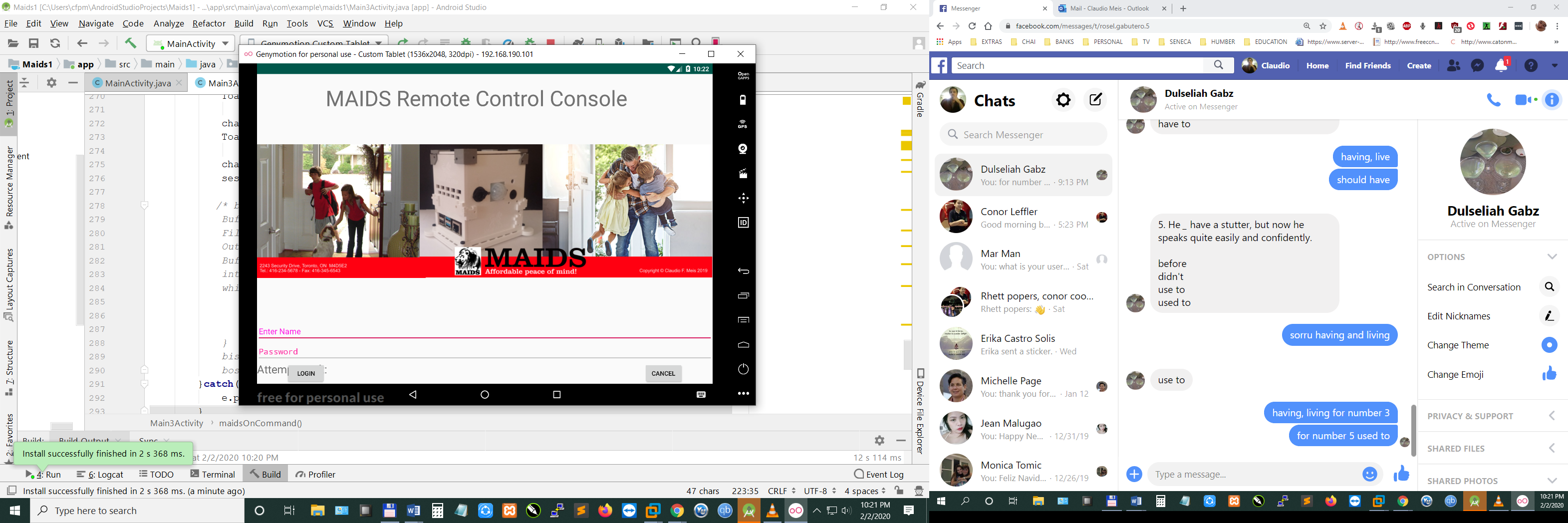
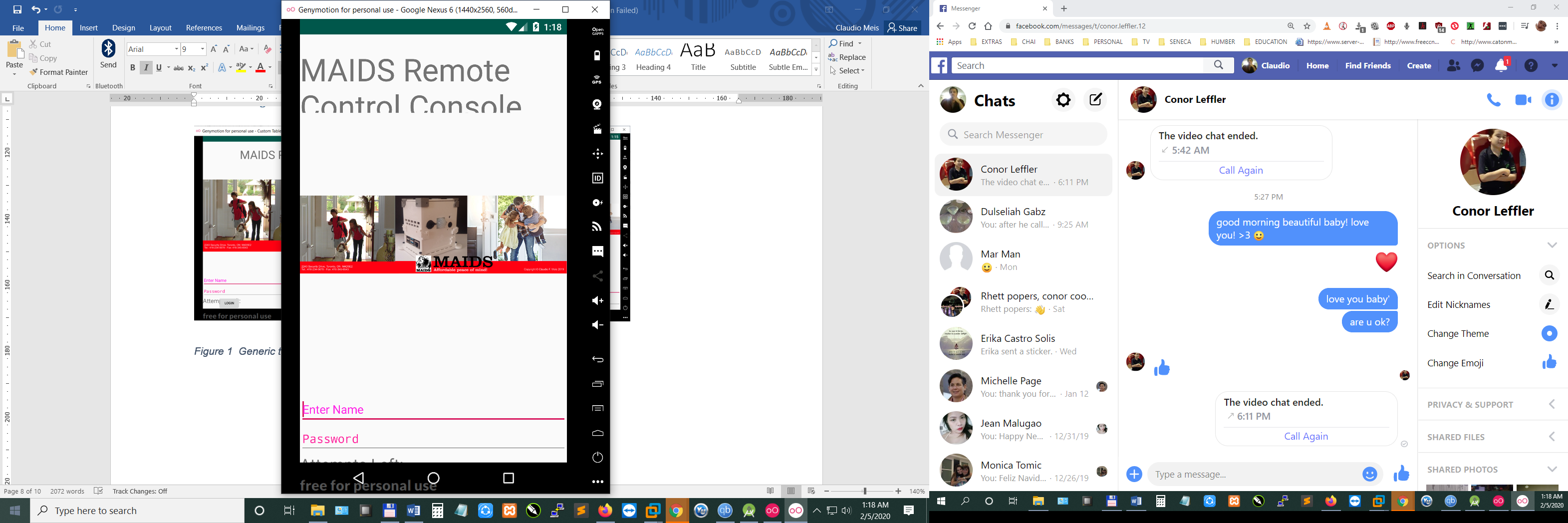
When the button named mButton3 is clicked, the attached listener method displays a Toast message (“Testing LED module…”) and call upon the testLedsCommand() method. The method takes as input the username, password and host strings, as well as, a port integer value. Using these parameters, the method connects via SSH (inside the jsch library) to the MAIDS device and runs an internal python v3.0 program (python3 testleds.py) to test the LED module remotely. The test is programmed to assess the function of the green and red LED lights of the MAIDS device through two output GPIO pins and to intermittently turn them ON and OFF five times for a period of 2 seconds, each.

When the button named mButton2 is clicked, the attached listener method displays a Toast message (“Retrieving Intrusion Photo…”) and calls upon the getRemoteFile() method to actually retrieve the photo form the MAIDS internal server. The getRemoteFile() method defines three strings: REMOTEDIR (/home/pi/webcam), REMOTEFILE (image.jpg) and LOCALDIR (/home/maids1/). These strings serve to define the remote directory where the photo is located, the generic name of the photo file to retrieve and the directory where the file is to be placed on the tablet/phone device once downloaded from the MAIDS device. Using the jsch library it initiates an SFTP session to the remote device which download the file form the remote system to the tablet or phone. Each step of the session creation, session connection, channel connection and the downloading of the remote file is presented to the user in the form of Toast messages at the bottom of the screen.

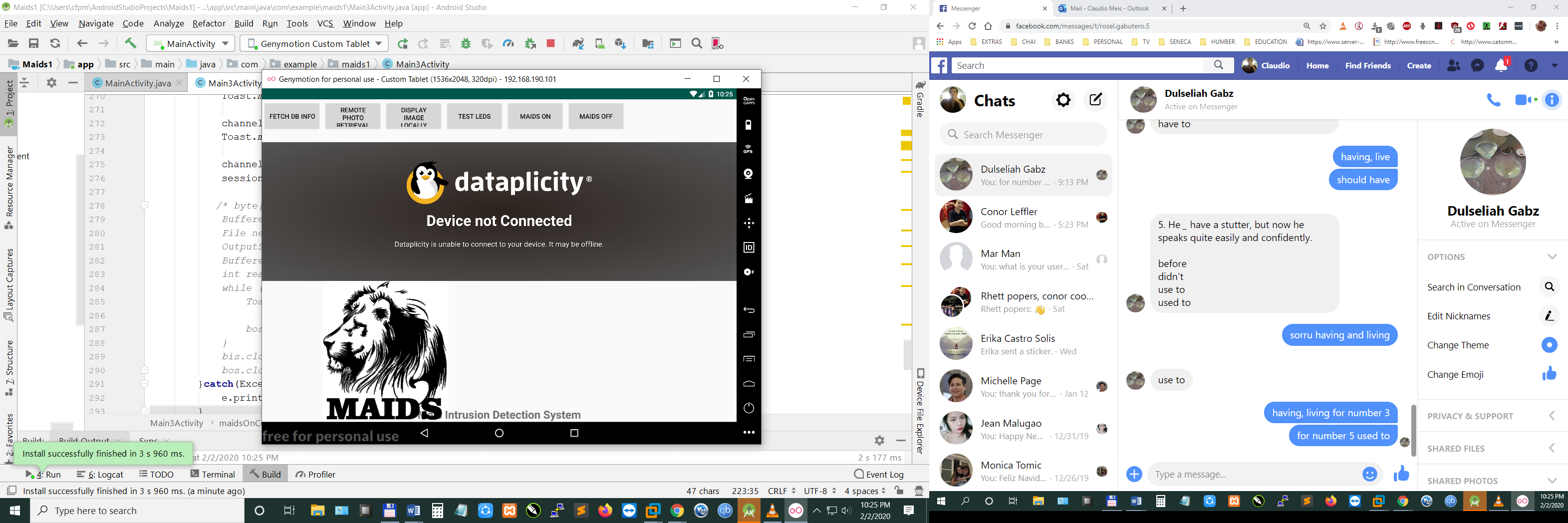
When the button named mButton4 is clicked, the attached listener method displays a Toast message (“Activating MAIDS remotely…”) and calls upon the maidsOnCommand() method. The method takes as input the username, password and host strings, as well as, the port integer value. Using these parameters, the method connects via SSH (using the JSCH library) to the MAIDS device and runs through the ‘exec’ command an internal python v3.0 program (python3 maids\_final\_python\_code\_22102019\_bak1.py) that initializes GPIO pins, sounds audible warnings and activates the MAIDS alarm system. Each step of the session creation, session connection, channel connection and the downloading of the remote file is presented to the user in the form of Toast messages at the bottom of the screen.

At this point in time, the MAIDS OFF command has not yet been implemented. However, the remote OFF command is envisioned to connect in the same manner as the ON command except that when it send the exec command ‘CTRL+C’ remotely to the MAIDS device, it runs the maidsOff.py program which deactivates the MAIDS alarm system. Deactivation of the MAIDS device results in the playing of three audible messages to the user informing them of the system shutdown.

3.2.5 Testing Screen Shots of MAIDS Android Application

*Figure 1 Generic tablet and Google Nexus 6 Login Activity screen shots.*



Section 3: Intrusion photograph (Placeholder shown).

Section 2: MySQL DB information via the Internet.

Section 1: Visualization and control buttons.

*Figure 2 Data Visualization and Control Activity screen shot.*

3.2.6 Android Application Status Report

Prepared by Claudio F. Meis, January 31, 2020.

The presentation of the MAIDS project at the Capstone Project EXPO at 1:00 – 4:00 p.m. on Thursday, April 9, 2020, is still on track.

The following work has been completed on the MAIDS Android-based application:

* Coding for the login activity.
* Coding for the database information retrieval.
* Coding for the remote testing of the LED module.
* Coding for the remote activation of MAIDS device.

**Progress against Milestones**

Login Activity

Milestone 100%

Progress 100%

Data Visualization Activity

Milestone 100%

Progress 70%

Control Activity

Milestone 100%

Progress 75%

**Key Issues**

The two issues need to be resolved on or before February 25, 2020, to meet Capstone Project EXPO deadline:

* Finish coding for the data visualization (remote photo retrieval).
* Coding to remotely turn OFF the MAIDS device.
* Adjust tablet and phone resolution displays.

**Action Steps**

|  |  |  |
| --- | --- | --- |
| **Task** | **Due Date** | **Responsibility** |
| Visualization activity coding | February 12, 2020 | Claudio Meis |
| Remote deactivation coding | February 18, 2020 | Claudio Meis |
| Adjust resolution display | February 24, 2020 | Claudio Meis |

3.2.7 Image/firmware

*3.2.7.1 Image Creation Process for Raspbian OS on 32 GB SCHD Card*

The SCHD card that was used for MAIDS did not come with the Raspbian operating system installed on it. In order to install the Raspbian OS image onto the card, the NOOBS and balenaEtcher software are used. To begin, the NOOBS zip archive is downloaded from https://www.raspberrypi.org/downloads/noobs/. Once NOOBS has been downloaded, the SCHD card must be formatted. The formatting of the card is done with balenaEtcher which is a free and open-source utility used for writing image files onto storage media to create live SD cards and USB flash drives. Next, the files from the NOOBS zip archive are extracted onto a directory. Finally, all the files are selected and dragged onto the SCHD card. Once the files have been copied over, the card can be ejected and used on the MAIDS device.

*3.2.7.2 Firmware General Description and Requirements*

The MAIDS projects incorporates its own custom-made firmware to run and control the functionality of the alarm system. Firmware refers to the firmware program, composed of individual instructions that are programmed onto the hardware device. In MAIDS case, the firmware provides the needed instructions for the computer hardware to communicate and control the PCB board components; it is stored in the 32 GB SCHD card of the device.

The development of the firmware takes into account the need to meet the real-world requirements of the project:

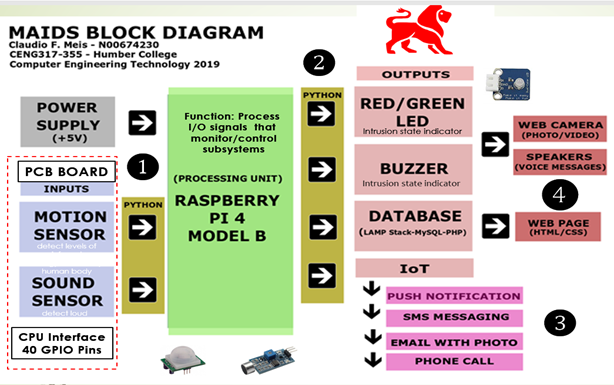
1. Provide a visual alarm through the dual LED module.
2. Provide an audible alert through audible warning and intrusion messages.
3. Provide rapid-response multi-channel alarm notifications (Email w/ photo, push notification, SMS messages and phone calls) in real-time.
4. Provide sound detection for gunfire, loud voices and/or breaking of glass.
5. Provide a remote method for testing visual alarm component functionality
6. Provide Internet-based database (MySQL) information for authorities use for prosecution.

Moreover, the firmware is implemented via version 3.6 of the Pyhton programming language. Python is a multi-purpose, high-level, interpreted programming language. The MAIDS project’s firmware requires the following minimum requirements to run: an Intel Atom® processor or higher, at least one gigabyte of disk space, two gigabytes of RAM (recommended), the Raspbian (Buster) operating system (kernel version 4.19) and a Linux- 64-bit x86 system architecture.

The hardware’s inter-component interaction (Raspberry Pi and PCB board sensors) is mediated via the RPI.GPIO library. The GPIO (general-purpose input/output) pins on a Raspberry Pi (with a 40-pin GPIO header) interfaces with the physical devices of the PCB board (i.e. button, LED module, motion sensor, sound sensor, etc.). The RPi.GPIO library handles the interface with these pins and allows the user, programmatically, to implement their function and control the device at run time.

3.2.7.3 Firmware and Hardware Interaction Description

The following block diagram demonstrates the general hardware and firmware interaction of the MAIDS project; its operative functionality is fully detailed below.



*Figure 2: Block diagram showing hardware and firmware interaction of the MAIDS alarm system project.*

In collaboration, MAIDS hardware and firmware work as follows:

* Start of section ❶ of firmware. Pressing the rocking switch to the ON position powers and activates the MAIDS system, and generates a signal to the green-LED output GPIO pin.
* Then, the firmware runs the welcoming screen and pertinent MAIDS system information function.
* Thereafter, the program displays the message: “MAIDS Surveillance Mode - Arming...” Once the system is armed, it warns the user by means of an audible message to clear the room and a countdown commences (10 down to 1).
* Upon conclusion of the countdown, the program displays the message: “MAIDS Surveillance Mode - Armed and Active...” At this point, MAIDS is activated and actively surveilling the space around it.
* Start of section ❷ of firmware. If motion or sound is detected by the motion (PIR) or sound sensors on the MAIDS PCB board, they will generate an input signal. The motion/sound input signal travel through the connecting wires to the GPIO pins (setup with the BOARD numbering system) to the Raspberry Pi 4 Model B and the firmware processes the input signal on the particular input GPIO pin and provides the following response outputs: (Start of section ❸ of firmware)
  1. An audible message plays stating that either a motion or sound intrusion has been detected, that it is unlawful and that authorities are being notified.
  2. The green LED then turns OFF and the red LED light is turned ON, after which it will flash intermittently ON/OFF five times.
  3. Then, the message is displayed: “Sending push notification to Android phone...” After the message, via the Internet, the Pushover server is reached and originates the push notification to the user’s Android phone.
  4. Afterwards, another message is displayed: “Sending SMS notification to Android phone...”; again via the Internet, a Twilio (cloud communications platform as a service company) SMS server is reached and a SMS message is generated and sent to the user’s Android phone along with a confirmation message that is displayed on the screen (i.e. “Message sent ID: SM79c3534ddeb648ee898b7d4a0e76872f”)
  5. The firmware then displays the message “Sending Intrusion Alert to email...” and initiates the following sequence of events:
     + Logs into the user’s email server with the user’s username and password.
     + Runs a program named ‘fswebcam’ to take a picture of the intruder and adds intrusion information (time, place, address and alert message) onto the picture’s caption.
     + Then, generates the email with picture which is then sent, along with an intrusion alert message, to the user’s email.
     + At this point, the message “Calling Android phone...” is displayed and a phone called is placed to the user via Twilio server; a confirmation of the call made is displayed on the screen (i.e. “Phone call ID: CA3c525429de7a5145939b559285c96095”
  6. Start of section ❹ of firmware. Immediately after the email is sent, the message “Appending Intrusion Alert to Database...” is displayed and the following takes place:
     + A record of the intrusion stating intrusion id, time, place, person to contact, contact’s phone number and email is generated and saved onto the following databases:
       - MySQL Text-based database
       - MySQL GUI-based database (entries accessible via browser)
     + Once the entry is recorded in the database, the program displays the following message: “Record inserted successfully into MAIDS-DB; MySQL connection – CLOSED”
  7. Finally, a siren audible is blasted through the connected speakers to frighten the intruder.

*3.2.7.4 Firmware’s Functional Design*

Programmatically, MAIDS firmware is composed of fourteen Python functions. A function is a block of code that only runs when it is called. Two of the functions (motion and sound) require input parameters, the rest, do not. The firmware includes:

1. The set\_up\_gpio() function which sets up the GPIO numbering system, input and output pins and disables warnings.
2. The maids() function which displays a welcome screen and firmware information (i.e. license, author, version, etc.).
3. The notify() function which updates the database, sends email and sends push notification to android phone.
4. The alarm() function which sets the led flashing pattern.
5. The alert() function which flashes a visual alarm, plays an audible intrusion message and sounds the alarm audible.
6. The sound(sound) function which sets up the sound sensor’s functionality.
7. The motion(motion) function which sets up the motion sensor’s functionality.
8. The send\_mail() function which sends an email alert with picture to recipient.
9. The send\_androidpush() function which sets up the android push notification information with the pushover service.
10. The appendtodb() function which appends the intrusion data to a text database.
11. The intruderwarning() function which plays an intrusion warning message.
12. The siren() function which plays a siren alarm sound.
13. The activationwarning() function which sets up an audible activation countdown.
14. The dbinsert() function which inserts the intrusion information into the MySQL database.

Furthermore, the functionality of the firmware code is derived through the use of the following Python modules:

1. RPi.GPIO
2. time and datetime
3. smtplib
4. ssl
5. os
6. http.client
7. urllib
8. vlc
9. mysql.connector
10. email (with specific module imports email.mime.multipart, email.mime.base, email.mime.text and email.utils)
11. subprocess

No detailed description of each module’s functionality is presented due to their lengthy nature. However, quick online searches can easily provide this information, if needed.

Finally, database creation and implementation required the use of interpolated MySQL programming commands (i.e. SELECT, INSERT, CREATE TABLE, etc.).

*3.2.8 Code runs via CLI or remote desktop*

Remote desktop is a firmware feature which permits users to connect to a remote computer, meaning a computer that is situated in a different geographic location, and interact with it as if the computer is located in front of the user. People use remote desktop access for an assortment of tasks, including: access a workplace computer from home or while roaming, access a home computer from any location, fix computer problems, perform administrative tasks or demonstrate a process or a software application.

In regards to MAIDS, one can connect to the device either locally or remotely, be it from another part of the same room or building, or from halfway around the world. As long as the MAIDS device is connected to the same network or to the Internet, the code for the MAIDS project can be run either through the Raspberry Pi command line interface (CLI) or through a remote desktop. In MAIDS case, remote desktop access refers to the secure access of the MAIDS device through the Android application running on an Android phone, tablet or through the execution of the Python source code from the CLI of another remote computer.

*3.2.9 Wireless connectivity*

Wireless connectivity is achieved via configuration of the wpa\_supplicant.conf file. This file is created manually as ‘root’ and saved in the /etc/wpa\_supplicant directory. The wpa\_supplicant file is configured using a simple text file that specifies all accepted networks and security policies, including pre-shared keys. The file manages the configuration and administration of wireless networks on Raspbian Linux OS so that the MAIDS device can connect to configured and available wireless network. The wpa\_supplicant “… implements WPA key negotiation with a WPA Authenticator and EAP authentication with Authentication Server. In addition, it controls the roaming and IEEE 802.11 authentication/association of the wireless LAN driver.” {Malinen, 2020, wpa\_supplicant(8) - Linux man page}It runs as a background daemon that controls the wireless connection. The wpa\_supplicant “…automatically selects the best network based on the order of network blocks in the configuration file, network security level (WPA/WPA2 is preferred), and signal strength.” {SysTutorials, 2019, wpa\_supplicant.conf (5) - Linux Man Pages}The MAIDS project makes use of Wi-Fi Protected Access (WPA, also known as the IEEE 802.11i-2004 standard.) which is a type of encryption (protocols and security certifications) employed to secure the mainstream of Wi-Fi networks; a unique encryptions key (Pre-Shared Key that is 64 hexadecimal digits long) is used in WPA for every wireless client accessing the network. The main purpose for the use of encryption is to protect the confidentiality of data and to assist in the protection of its integrity. In addition, it is worth noting that WPA2 negligibly impacts network performance because of the extra processing load of encryption and decryption during every connection.

The network configuration (of the wpa\_supplicant.conf file) for the MAIDS project is presented fully in Appendix II of this document and found on the GitHub repository with link:

1. https://github.com/srgawain2264/CENG317-MAIDS\_PROJECT/blob/master/CENG355/wpa\_supplicant.conf

In the MAIDS case, actual wireless connectivity is accomplished through the use of the RealVNC software. Real Virtual Network Computing (RealVNC) is a desktop sharing system that allows for the remote control of another computer; it can be downloaded from https://www.realvnc.com/en/connect/download/vnc. RealVNC works by transmitting all keyboard and mouse movements from one computer to another. All that is required to run RealVNC is a network TCP/IP connection, a VNC server (Installed on the MAIDS device), and a RealVNC viewer (installed on any other device used to communicate with the MAIDS device, i.e. Android tablet or phone) in order to connect to the computer that is running the server. The RealVNC Server application must be running on the device that is being controlled (MAIDS) before a connection is attempted. Once the RealVNC Server is running on the computer to be controlled, it will appear as a selectable option in RealVNC Viewer. A login screen will appear on the device connecting to the server and then the login information (for the MAIDS device) is introduced to log into MAIDS. Once the password is validated, the desktop of the MAIDS device is shown in the RealVNC Viewer of the connecting computer, phone or tablet.

*3.2.10 Sensor/effector code on repository*

The Python source code for the MAIDS project is included in Appendix I of this document. The code file (maids\_final\_python\_code\_ceng355.py) is also found online through the MAIDS GitHub repository link:

1. https://github.com/srgawain2264/CENG317-MAIDS\_PROJECT/blob/master/Python%20Code/maids\_final\_python\_code\_ceng355.py.

In order to maintain the project current, any and all future modifications to the code are promptly updated to the GitHub site.

### 3.2.11 Breadboard/Independent PCBs

#### 3.2.11.1 MAIDS Schematics

Development of the MAIDS breadboard prototype and the custom-made PCB board began with the schematics diagram. The schematic will serve as a blueprint for laying out the traces and placing the components on the PCB board. The MAIDS schematic diagram (also called **wiring diagrams** or **circuit diagrams**) is a representation of the significant components of the system using standardized symbols and lines. That is to say, its schematics show how the different components (LED module, sound and motion sensors) of the circuit are connected. In the schematic diagram, lines represent connecting wires, while other elements like the LED module, and the motion and sound sensors are represented by standardized symbols called **electrical schematic symbols**. In addition, is it worth noting that the MAIDS schematic diagrams is useful to explain the general way that its electronic system works.

MAIDS’ schematic diagram was developed using the University of Applied Sciences Potsdam, English language, Fritzing software version 0.9.4. Fritzing is an open-source CAD (Computer Aided Design) software used in the design of electronics hardware, breadboard prototypes and PCB board circuits. Fritzing installation requires one of the following operating systems:

1. Windows 10 (Windows 7 is reported to work, too)
2. Mac - OSX 10.14 and up, though 10.13 might work too.
3. Linux - a fairly recent Linux distro with libc >= 2.6

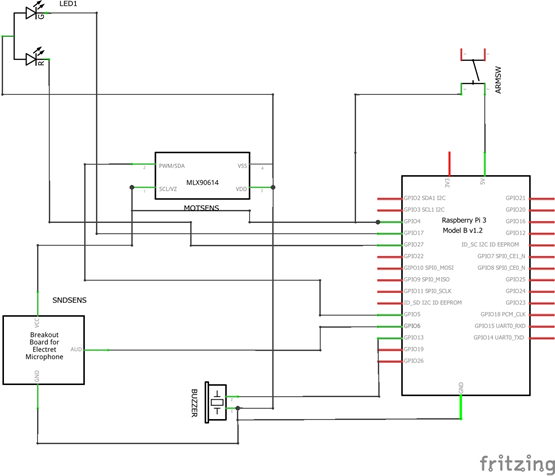


Figure : MAIDS schematic diagram showing main components and connections.

Essentially, the schematic design consisted of dragging and dropping the necessary components from the Fritzing built-in libraries onto the schematics. Once all of the symbols are placed on the schematic and the footprints to each symbol has been assigned, the wires are drawn connecting the components together.

#### 3.2.11.2 MAIDS Breadboard

A solderless breadboard is an invaluable aid to prototyping a circuit for a project. The term breadboard originated during the vacuum tube era in the early 1920s. Tubes were plugged into sockets. The sockets and other large components were then screwed or nailed to wooden boards used for rolling dough. These breadboards made an ideal mounting platform for the components, and gave birth to the technique’s name. Interconnections were made by soldering wires between appropriate pins on the tube sockets. Power and ground buses—made from heavy copper wire—were nailed or screwed to the wooden board. Early breadboards often used additional nails as connection points where wires could be wrapped and soldered. Terminal strips were also used for interconnection points. Nowadays, solderless (do not require soldering to make connections) breadboards are the norm.

The breadboard used in the MAIDS project is a full size board made from plastic and is rectangular in shape. In this typical solderless breadboard, the holes are designed to accept standard IC pins on 0.1" centers. Internally, the center part of the board is divided into two rows that are subdivided into a number of vertical columns having five pins connected together. The two horizontally connected rows at the top and bottom of the board make convenient buses for supply voltages and ground connections.

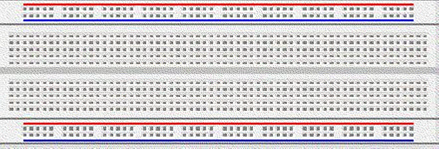


Figure : Showing a typical solderless breadboard (Retrieved from https://www.analog.com/en/analog-dialogue/studentzone/studentzone-november-2016.html#) (Kester, 2016)

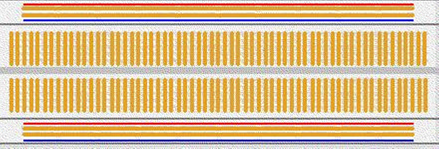


Figure : Internal connections of a breadboard. (Retrieved from https://www.analog.com/en/analog-dialogue/studentzone/studentzone-november-2016.html#) (Kester, 2016)

The leads of components such as LEDS module, sound and motion sensors, are inserted into the holes. Each set of five holes connected by a metal strip underneath forms a node (a point in a circuit where two or more components are connected). Connections between the different MAIDS components are made by inserting their leads in a common node. The long top and bottom row of holes, indicated by the red and blue stripes are used for power supply connections (3.3 V DC and ground (GND)). The rest of the circuit was built by inserting components and connecting them together with jumper wires. It is worth noting that solid core wires rather than stranded wire are best to use with solderless breadboards. The connections are not permanent, so it is easy to remove components.

The resulting MAIDS circuit breadboard prototypes (Fritzing and actual) are shown below.

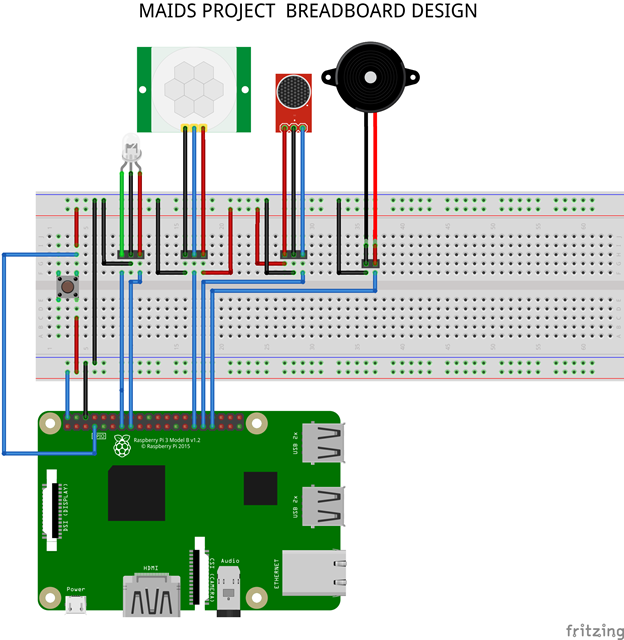
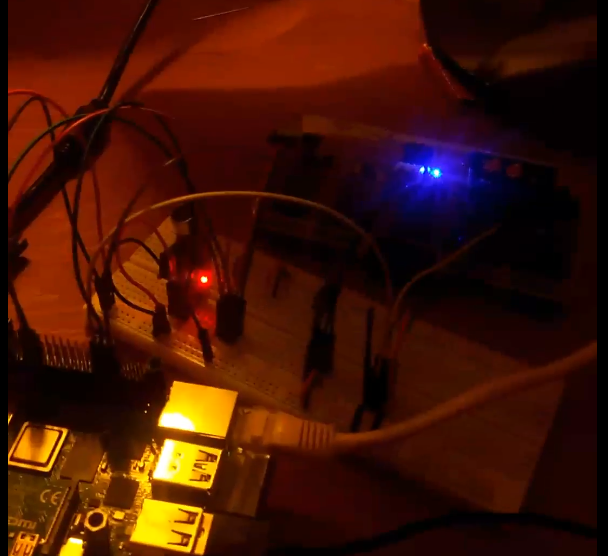
 

Figure : Breadboard circuit prototypes in Fritzing software and actual breadboard for the MAIDS project

#### 3.2.11.3 MAIDS PCB Board

Before the advent of PCB boards, electronic circuits were constructed using the point-to-point wiring process. Unfortunately, “…this approach led to frequent failures at wire junctions and short circuits when wire insulation began to age and crack.” (Sparkfun, 2020) The creation of the PCB board resulted from the electronic industry’s move towards the use of integrated circuits (smaller size and lower cost electronic components) and pressure on manufacturers to reduce the size and manufacturing costs.

PCB (an acronym for Printed Circuit Board) is the traditional name for the bare board which supplies the circuit layout and on which the components are mounted. A printed circuit board is used to mechanically support and electrically connect electronic components using conductive pathways, tracks, traces or vias etched from copper sheets laminated onto a non-conductive substrate. A PCB board permits signals and power to be routed between physical devices. The metal material used to make the electrical connections between the surface of the PCB and the electronic components is called solder. Solder, being a metal, serves as a strong mechanical adhesive for the components.

The MAIDS PCB board is composed of alternating layers of different materials which are laminated together resulting in a single object. The base material of the MAIDS PCB board is a solid fiberglass core designated as FR4 which provides the PCB board’s rigidity and thickness. The thickness of the PCB board is the standard 1.6 mm (0.063"). A thin layer of copper foil is laminated onto the fiberglass board with heat and adhesive. MAIDS’ PCB board contains one ounce of copper per square foot and is double sided board (copper is applied to both sides of the substrate).  Each ounce per square foot translates to about 35 micrometers or 1.4 thousandths of an inch of thickness of copper.

The MAIDS PCB board did not have a layer on top of the copper foil called the solder mask layer (usually used to insulate the copper traces from accidental contact with other metal, solder, or conductive bits) nor did it incorporate a silkscreen (adds letters, numbers, and symbols to the PCB).

The final MAIDS PCB board design is shown below.



Figure : MAIDS PCB board design.

The PCB board requires the following Raspberry Pi 4 and custom-made PCB board GPIO pin connections:

Table : Raspberry Pi 4 and Custom-made PCB board connections.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Raspberry Pi and custom-made PCB Board pin connections | | | | | | |
| Component | Sensor pin | RP4 pin | Sensor pin | RP4 pin | Sensor pin | RP4 pin |
| Motion Sensor | VCC | 3.3V | Middle pin | Pin 29 | GND | GND |
| LED Module | Green | Pin 9 | Red | Pin 11 | GND | GND |
| Sound Sensor | VCC | 3.3V | GND | GND | Digital Input DO | Pin 31 |
| Push Button | VCC | 3.3V | Signal Pin | Pin 7, Motion Sensor and Sound Sensor | | |

The final MAIDS PCB board is shown below displaying the top layer with the via (a hole in a PCB board used to pass a signal from one layer to another) connecting the top and bottom layers of the PCB board, the traces for connecting the LED module, sound and motion sensors, and the bottom layer (ground (GND) layer).



Figure : Final PCB board for MAIDS project showing top and bottom layers and connections.

#### 3.2.11.4 Bill of Materials

The MAIDS’ bill of materials for the design of the PCB board prototype is as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | MG Chemicals 5" x 3" Copper Clad Board, Double Sided, 1 oz Copper, 1/16" Thick, FR4 | 587 | 1 | https://www.amazon.ca/MG-Chemicals-Prototyping-1-Ounce-16-Inch/dp/B008OAFOUO/ref=pd\_sbs\_328\_2/132-5081513-4200133?\_encoding=UTF8&pd\_rd\_i=B008OAFOUO&pd\_rd\_r=95480a50-419b-47d5-91b4-3b88102fc136&pd\_rd\_w=zfGQl&pd\_rd\_wg=FhDkE&pf\_rd\_p=dbebb38c-0e3d-4a67-ac15-432d7c7a2789&pf\_rd\_r=A5QQ0YC5SPEYDWN36ZA7&psc=1&refRID=A5QQ0YC5SPEYDWN36ZA7 |
| 5 | Elegoo 120pcs Multicolored Dupont Wire 40pin Male to Female, 40pin Male to Male, 40pin Female to Female Breadboard Jumper Wires Ribbon Cables Kit for Arduino | EL-CP-004 | 1 | https://www.amazon.ca/Elegoo-120pcs-Multicolored-Breadboard-arduino/dp/B01EV70C78/ref=sr\_1\_1\_sspa?keywords=jumper+cables&qid=1579928593&s=industrial&sr=1-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyVkZXSjU0U1RGSjFQJmVuY3J5cHRlZElkPUEwMDcxMTkxM0tSVVU5WVBKQVhKMiZlbmNyeXB0ZWRBZElkPUEwMzg1ODgyMUwxRTJBRE0zR1dIWCZ3aWRnZXROYW1lPXNwX2F0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU= |
| 6 | AUSTOR Lead Free Solder Wire with Rosin Core 0.6mm | AMA-17-532 | 1 | https://www.amazon.ca/dp/B071XVPJVX/ref=sspa\_dk\_detail\_0?psc=1&pd\_rd\_i=B071XVPJVX&pd\_rd\_w=apWS0&pf\_rd\_p=4b7c8c1c-293f-4b1e-a49a-8787dff31bcb&pd\_rd\_wg=s5ddm&pf\_rd\_r=Y6RJTAX1MR0X3E50MH9X&pd\_rd\_r=b093f5a4-5e04-4c4a-bf07-683669f8db02&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExWUMwVUFXVTBTMzUmZW5jcnlwdGVkSWQ9QTA0Nzk5MzAzSENLOTZDTEhKOTBBJmVuY3J5cHRlZEFkSWQ9QTAyMTk5NjJJTDlaVjVBQUtLRksmd2lkZ2V0TmFtZT1zcF9kZXRhaWwmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG9Ob3RMb2dDbGljaz10cnVl |

#### 3.2.11.5 Time commitment

The order lead time, the time from order received to customer order delivered was approximately 2 weeks. The order handling time, the time from customer order received to sales order created was less than 12 hours. The manufacturing lead time, Time from sales order created to production finished (ready for delivery) was approximately 2 weeks. The production Lead Time - Time from start of physical production of first submodule/part to production finished (ready for delivery) was approximately 2 weeks. The Delivery Lead Time - Time from production finished to customer order delivered was approximately 1 week due to testing and slight software modifications. (Rajaniemi, 2012, Measuring and Defining Lead Time in a Telecommunication Production)

The working time, time to design and fabricate the final MAIDS PCB board deliverable, was 1.5 hours per work day, five days per week (total of 7.5 hours per week), for a total of 15 hours, total.

#### 3.2.11.6 Testing

The testing phase of the PCB board included the following:

* Applying the CRC rules in Fritzing to identify possible trace overlaps that might lead to short circuits which were corrected as before passing on to the manufacturing process.
* Once manufactured, the board was meticulously inspected visually for board discolorations, broken traces, correct connections and cracks on the board itself. By examining the board and the surface-mounted components, one can identify obviously damaged or disconnected parts before beginning testing. In addition, the boards was inspected for obvious signs of oxidation and corrosion such as rust. Wires were also inspected to make sure all of the components were connected. PCB boards was found to be physically sound and correctly connected from node to node.
* A magnifying glass was used to identify tin whiskers between pads and solder joints along with tin bridges. None was found.
* No cracks or blobs of solder were found.
* Opens tests were performed with a multimeter to make sure currents flowed between nodes by means of a LED-Resistor component placed between connecting points (nodes) to check for electrical conductivity. All traces and vias were found to carry currents properly.
* Shorts-test were performed using a multimeter were the resistance between neighboring traces and pads were measured on a PCB resulting in high resistance. No shorts.

#### 3.2.11.8 Final Status Report

Prepared by Claudio F. Meis, February 12, 2020.

The presentation of the MAIDS project at the Capstone Project EXPO at 1:00 – 4:00 p.m. on Thursday, April 9, 2020, is still on track.

The following work has been completed on the MAIDS PCB board:

* PCB Board schematic design.
* PCB Breadboard design (Fritzing and actual)
* PCB board fabrication (laser etching)
* PCB board testing.

**Progress against Milestones**

Schematic Design

Milestone 100%

Progress 100%

Breadboard Design

Milestone 100%

Progress 100%

PCB Board Fabrication

Milestone 100%

Progress 100%

PCB Board Testing

Milestone 100%

Progress 100%

**Key Issues**

No issues need to be resolved to meet Capstone Project EXPO deadline.

**Action Steps**

None.

### 3.2.12 Printed Circuit Board

The success of any project is often dependent on the foundations it is built upon. Much in the same way, the success of any electronic device depends on what it is built on. The PCB board of any electronics device relays electrical signal that performs some function for the equipment. Be it the communication signal between Raspberry Pi 4 and the custom-made PCB board, or a simple on-off signal from the switch, the effectiveness of the design is a function of the capabilities offered by the PCB board itself. A Printed Circuit Board (PCB) does not just connect electrical components using etched copper pathways, but also provides mechanical strength to it.

This section of the report does not concentrate on the actual fabrication process but on the specification, guidelines, considerations and recommendations required to produce an error-free PCB board. The actual fabrication process is delineated in sections 3.1.2.1 PCB Board Manufacturing Process and 3.1.3.2 PCB Board Cutting and Etching of this report.

#### 3.2.12.1 PCB board Design Flow

In order to design a successful MAIDS’ PCB board careful thought was given to its design flow. The design flow for the MAIDS project consisted of six major procedures:

1. Logic design((section 3.2.11.1 MAIDS Schematics)
2. Design verification by circuit simulation (section 3.2.11.1 MAIDS Schematics)
3. Schematic design (section 3.2.11.1 MAIDS Schematics)
4. PCB design (section 3.2.11.1 MAIDS Schematics)
5. Fabrication Specifications of the PCB board (This section)
6. Testing of PCB board (section 3.2.11.1 MAIDS Schematics)

Each section stated above will provide information on the particular part of the design flow process.

#### **3.2.12.2 PCB Fabrication Specifications**

PCB board manufacturing begins with the user-generated artwork that is then sent to the manufacturing facility in a particular format (RS-274X Gerber file) to be a laser etched. MAIDS used the following three standard technologies during the manufacturing of the PCB board: Machining, Imaging and Etching.

##### 3.2.12.2.1 Machining

**Machining** includes drilling, punching holes and routing on a PCB with laser cutting. The strength of the board needs to be taken into account while machining hole-diameters accurately. Small holes were avoided so that plating was easily accomplished.

##### 3.2.12.2.2 Imaging

**Imaging** transfers the circuit artwork onto individual layers. MAIDS’ double sided PCB board design used direct laser imaging for creating the patterns on a print-and-etch basis.

##### 3.2.12.2.3 Etching

**Etching refers to t**he removal of unwanted metal and dielectric from the board that takes place by either dry or wet processes. MAIDS used a dry process. The uniformity of etching is the prime concern in this stage.

#### 3.2.12.3 PCB Board Specifications

The specifications used in the design and fabrication of the MAIDS PCB board are listed in the table below.

Table : Standard Design Specifications used in MAIDS project.

|  |  |
| --- | --- |
|  | Standard |
| Annular ring: Internal Minimum Pad Size | .014" larger than finished hole size |
| Annular ring: External Minimum Pad Size | .014" larger than finished hole size |
| Plane Layer Clearance | |
| Plane Layer Clearance - PTH & NPTH Hole to Inner Layer Trace | .015" Spacing |
| Inner Layer Clearances: | 0.010” |
| Copper to Edge of PCB: | 0.010” for outer layers, 0.015” for inner layers, 0.020” is preferred. |
| Pad Size/Annular Ring: | Pad size should be +0.010” over the finished hole size for Vias  +0.014” over the finished hole size for Component holes |
| Hole Size: | 0,008” minimum finished hole size, 0.015” or larger hole size recommended |
| Copper Trace Width/Spacing: | 0.005”) trace widths Recommended minimum spacing: 8 mils. |
| Inner Layer Line width on 1 ounce copper | Standard-.005" |

#### 3.2.12.4 PCB Board Component Placement

The component placement stage of the PCB layout process is very important. How the designer of the PCB board places the electronic components determine how easy the board is to manufacture, as well as how well it meets the original PCB design requirements. The MAIDS project used the following general board layout guidelines to place the components on the PCB board:

1. **Orientation: All similar** components were placed in the same direction. This helps the operative routing of the PCB board design, as well as, to help ensure a well-organized soldering process during assembly.
2. **Placement: P**lacing components on the solder side of a board that would rest behind plated through-hole components should be avoided.
3. **Organization:** All through-hole (TH) components should be placed on the top side of the PCB board to minimize the number of assembly steps.

#### 3.2.12.5 PCB Board Copper Thickness

Copper thickness of PCB boards can be specified directly or as the weight of copper per area (in ounce per square foot). One ounce per square foot is 1.344 mils or 34 micrometers thickness. MAIDS uses the common FR-4 substrate with one ounce copper per ft2 (35 µm) which is the most common thickness;

#### 3.2.12.6 PCB Board RoHS Compliance

Manufacturers, retailers and suppliers of electrical and electronic products in Canada need to comply with regulations stipulated in the Restriction of Hazardous Substances directive (RoHS2 Directive, 2011/65/EU). The directive bans the use of lead (among other heavy metals) in consumer items. MAIDS’ PCB board is RoHS-compliant, meaning that all manufacturing processes did not involve the use of lead, all solder used was lead-free, and all components mounted on the board were free of lead, mercury, cadmium, and other heavy metals.

#### 3.2.12.7 PCB Board Laminate

FR-4 is by far the most common material used today. The board stock with un-etched copper on it is called: copper-clad laminate. FR-4, is a woven fiberglass cloth impregnated with an epoxy resin (also known as polyepoxides, are a class of reactive polymers which contain epoxide groups).It provides low water absorption (up to about 0.15%), good insulation properties and good arc resistance. Several grades with somewhat different properties are available and is typically rated to 130 °C. The MAIDS’ PCB board uses an FR-4 laminate in its fabrication.

#### 3.2.12.8 PCB Board Trough-Hole Technology

Through-hole technology (also spelled "thru-hole"), refers to the mounting scheme used for electronic components that involves the use of leads (wire or a metal pad designed to connect two locations electrically) on the components that are inserted into holes drilled in printed circuit boards (PCB) and soldered to pads on the opposite side by manual assembly (hand placement). MAIDS’ double-sided PCB board used through-hole technology. It is worth noting that Through-hole manufacturing adds to board cost by requiring many holes to be drilled accurately. Through-hole technology used holes and vias with a diameter of 0.008”.



Figure : Final MAIDS PCB board.



Figure : Final PCB board design using Fritzing software.

#### **3.2.12.9 Routing Guidelines for PCB Layouts**

MAIDS’ PCB layout followed the recommended best practices to achieve a trouble-free layout. In the MAIDS project, traces were placed as directly as possible between components, as well as, providing the shortest path between them. Is it also worth noting that if component placement forces horizontal trace routing on one side of the board, then the designer should route traces vertically on the opposite side.

#### **3.2.12.10 PCB Board Size and Shape**

MAIDS’ PCB board was designed to be rectangular in shape and as small as possible. The board’s size of 63 mm x 56 mm assured that the PCB board did not overlap the Raspberry PI 4 and therefore needlessly increase the size of the projects enclosure. Also, the chosen shape and size design made sure that larger Through-hole components had enough space to make them easier to solder onto the board.

#### **3.2.12.11 PCB Board Trace Angles and Widths**

Professionally designed PCB boards, have most of the copper traces bend at 45° angles. One reason for this is that 45° angles shorten the electrical path between components compared to 90° angles. Another reason is that high speed logic signals can get reflected off the back of the angle, causing interference. Unfortunately, CENG317 course directives stated that traces between components should bend at 90° angles. This directive should be changed in the future to mitigate the problems stated above and produce professional PCB board designs.

Like layer thickness, the width of the PCB board traces affects how much current can flow through the circuit without damaging the circuit. The proximity of traces to components and adjacent traces will also determine how wide your traces can be. MAIDS’ small PCB board design did not have many traces and components. The MAIDS trace width was calculated (0.51 mil) using the PCB Trace Calculator (Bittele Electronics, 2020) and employing the following parameters:

|  |  |  |
| --- | --- | --- |
| Field | Value | Units |
| Current (max. 35A) | 50 | mA |
| Copper Thickness | 1 | oz/ft2 |
| Temperature Rise (max. 100°C) | 10 | °C |
| Ambient Temperature | 25 | °C |
| Conductor Length | 1 | inch |
| Peak Voltage | 3.3 | Volts |
| **Trace width required** | **0.51** | **mil** |

However, having designed the PCB board in Fritzing software, the minimum trace width was set to 8 mils.

#### **3.2.12.12 PCB Board Verification**

MAIDS’ verification process included Fritzing’s Design Rule Check (DRC). DRC imposes limitations on the PCB board layout in order to ensure its successful manufacturing. The common design rules applied to MAIDS were: minimum trace spacing, minimum trace width, minimum drill diameter, and trace overlapping.

#### **3.2.12.13 PCB Board Final Status Report**

Prepared by Claudio F. Meis, February 15, 2020.

The presentation of the MAIDS project at the Capstone Project EXPO at 1:00 – 4:00 p.m. on Thursday, April 9, 2020, is still on track.

The following work has been completed on the MAIDS PCB board:

* PCB Board design flow.
* PCB Board Fabrication Specifications
* PCB Board Specifications
* PCB Board testing.

**Progress against Milestones**

PCB Board Design Flow

Milestone 100%

Progress 100%

PCB Board Fabrication Specifications

Milestone 100%

Progress 100%

PCB Board Specifications

Milestone 100%

Progress 100%

PCB Board Testing

Milestone 100%

Progress 100%

**Key Issues**

No issues need to be resolved to meet Capstone Project EXPO deadline.

**Action Steps**

None.

### 3.2.13 Enclosure

#### 3.2.13.1 Enclosure Design Software

The MAIDS’ enclosure was designed using CorelDraw 2018 for precise laser cutting running under the Windows 10 operating system. CorelDraw 2018 can export either .svg or .pdf files which are the preferred files for laser cutting.

#### 3.2.13.2 Enclosure Design Software

The MAIDS’ design document size was restricted to be within the maximum laser table size of 12″ high by 24″ wide. The document was oriented in landscape and ensuring that any artwork is constrained within the 12″x 24″ document size.

#### 3.2.13.3 Enclosure Design Stroke Width and Line Colors

The laser cutter uses vector lines to cut with the Stroke Width set to Hairline (0.000 mm wide). Outside laser cuts are colored green while inside cuts are colored red. Etching of words or logos requires any other color and lines thicker than 0.000 mm (hairline) which will result in the burning a light layer off of the top of the material.

#### 3.2.13.4 Enclosure Design and Materials

The enclosure for the MAIDS project used 3 mm thick white acrylic sheet as its base material. The design incorporated a small footprint, hollow-shell, 10 layer-stacked model designed for easy assembly and in order to reduce desktop footprint, provide boards protection as well as weight reduction.

#### 3.2.13.5 Enclosure Design Heat Dissipation Consideration

Design of the MAIDS’ enclosure implements heat dissipation measures. The case includes the following heat dissipation components:

1. Four aluminum heat sinks (CPU, memory, Ethernet and USB). The properties that make aluminum heatsinks appropriate for the MAIDS project are: Good thermal and electrical conductivity, Low density with a density ~ 2,700 kg/m3, Low weight, High strength of between 70 and 700 MPa, Easy malleability, Excellent corrosion resistance, non-magnetic which avoids interference of magnetic fields and Easy to recycle. (Radian, 2020)
2. A 30 mm x 30 mm fan for heat dissipation (connected to 3.3 V DC and GND GPIO pins on board).

#### 3.2.13.6 Enclosure Design Physical Characteristics

The MAIDS’ enclosure physical characteristics are as follows:

1. 85 mm (length) x 56 mm (width).
2. Accommodates holes for:
   1. A C-Type power connector
   2. Two micro HDMI connectors
   3. An audio port
   4. Port for USB 3.0
   5. Port for USB 2.0
   6. Port for Ethernet connectors.
   7. Port for a display device
   8. Port for a camera connector.

#### 3.2.13.7 Enclosure Design Etched Icons

The MAIDS’ enclosure integrates case icons clearly identifying available connectors. The icons are etched onto the outward-facing enclosure surfaces and are as follows:

|  |  |
| --- | --- |
| **Icon Description** | **Icon Image** |
| HDMI |  |
| USB |  |
| SD Card |  |
| Power Supply |  |
| Fan |  |

#### 3.2.13.8 Enclosure Final Deliverable

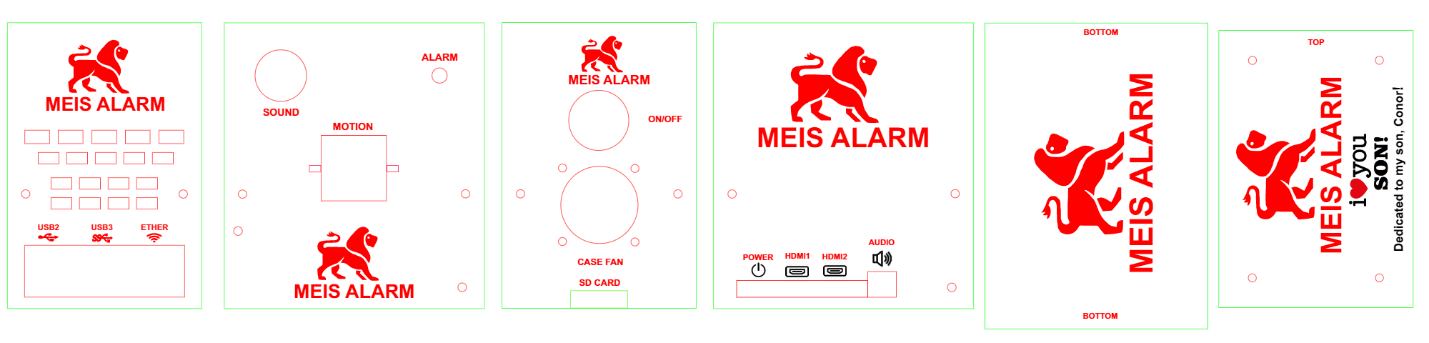


Figure : MAIDS’ enclosure artwork design using CorelDraw 2018.

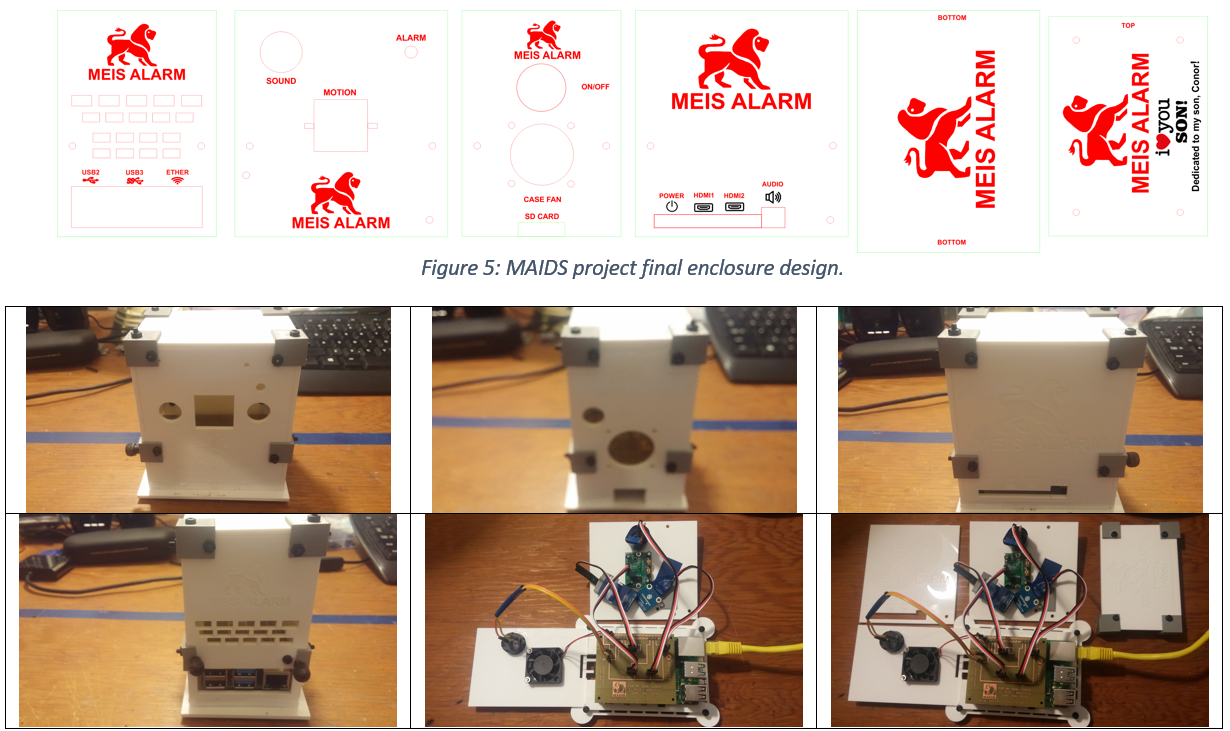


Figure : MAIDS final enclosure deliverable and showing internal component connections.

#### 3.2.13.9 Enclosure Final Report

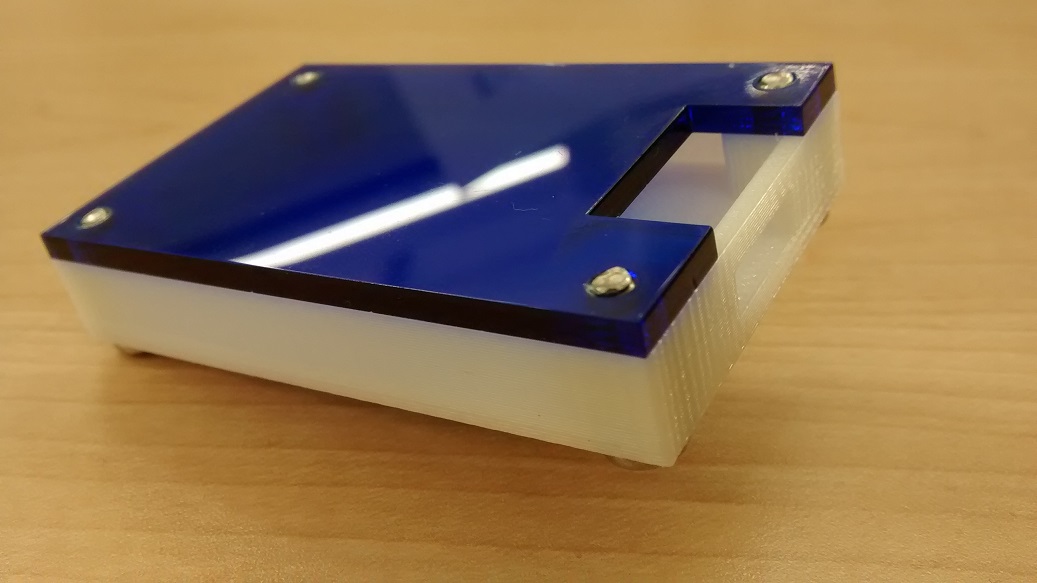


Figure . Example enclosure.

## 3.3 Integration

Demo

/1 Hardware present?

/1 Data sent by hardware

/1 Data retrieved by mobile application

/1 Action initiated by mobile application

/1 Action recieved by hardware

Report

/1 Enterprise wireless connectivity (250)

/1 Database configuration (250 words)

/1 Security considerations (500 words)

/1 Unit testing (900 words)

/1 Production testing (100 words)

### 3.3.1 Enterprise Wireless Connectivity

How did you make a Database accessible by both your Prototype and Mobile Application?

### 3.3.2 Database Configuration

### 3.3.3 Security

### 3.3.4 Testing

Unit testing and Production testing.

# 4.0 Results and Discussions

Is your prototype perfect? What did you learn?

# 5.0 Conclusions

If you were making 1000 of these.

Report

/1 Hardware present?

/1 Checklist truthful

/1 Valid Comments

/1 Results and Discussion (500 words)

/1 Conclusion

# References

Bittele Electronics. (2020). PCB Trace Width Calculator. Retrieved from https://www.7pcb.com/trace-width-calculator.php on February 12, 2020.

Brinks. (2019). Retrieved from https://help.brinkshome.com/hc/en-us/articles/360006895212-Faster-response-with-ASAPer?kbid=117104, September 2019

Canada, S. (2002). *Breaking and Entering in Canada - 2002*. Retrieved from Statistics Canada: http://www.publications.gc.ca/site/archivee-archived.html?url=http://www.publicatio

Canada, S. (2018). *Incident-based crime statistics, by detailed violations, Canada, provinces, territories and Census Metropolitan Areas*. Retrieved from Statistics Canada Table 35-10-0177-01 : https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3510017701&pickMemb

Canada, S. (2020, September). *Preventing break-ins*. Retrieved from SGI CANADA. 2020: https://www.sgicanada.ca/news?title=preventing-break-ins

Electronics, L. L. (2008). *ProtoLaser S: Operation manual 2.0, English.* Bohn: LPKF Laser & Electronics AG. Retrieved from LPKF Laser & Electronics AG. (2008). ProtoLaser S: Operation manual 2.0, English. Page35.

Electronics, L. L. (2020). *Manual Version 0.9, English.* Germany: LPKF Laser & Electronics AG.

Elektrotanya. (2020, January 12). *Model WES51 Electronic Soldering Station.* Retrieved from Model WES51 Electronic Soldering Station: https://elektrotanya.com/weller\_model\_wes51\_electronic\_soldering\_station.pdf/download.html

Geometries, O. (2010). *Objet30 3-D Printer System: User Guide, English. Page 6.* Germany: Objet Geometries Ltd.

Kester, Walt. (2016). Analog Dialogue: Breadboarding and Prototyping Circuits, Vol. 50. Retrieved from https://www.analog.com/en/analog-dialogue/studentzone/studentzone-november-2016.html# on February 10, 2020.

King, R. (2019). *The secret to stopping break-ins.* Toronto: MoneySence Magazine. Retrieved September 22, 2019, from https://www.moneysense.ca/spend/real-estate/the-secret-to-stopping-break-ins/

Malinen, J. (2020, February 8). *wpa\_supplicant(8) - Linux man page*. Retrieved from die.net: https://linux.die.net/man/8/wpa\_supplicant on February 8, 2020.

Medri, K. (2020). *Course Modules: Welcome.* Toronto: Humber College. Retrieved January 8, 2020, from https://learn.humber.ca/webapps/blackboard/content/listContent.jsp?course\_id=\_148549\_1&content\_id=\_7882456\_1

OAECTT. (2017). *Technology Report Guidelines Revised March 2017.* Toronto: Ontario Association of Certified Engineering Technicians And Technologists (OACETT).

Radian Thermal Products, Inc. (2020). Aluminum Heatsinks. Retrieved form https://www.radianheatsinks.com/aluminum-heatsink/ on February 12, 2020.

Rajaniemi, J. (2012). *Measuring and Defining Lead Time in a Telecommunication Production*. Retrieved from leadtimes.org: http://www.leadtimes.org/

Safety.com. (2020, January 22). *The Best Home Security Systems of 2020*. Retrieved from Safety.com: https://www.safety.com/best-home-security-systems/

Seymour, R. (2015, November 1). *Organization & Cleaning - Home security: 10 ways to protect your home from intruders*. Retrieved from Canadian Living: https://www.canadianliving.com/home-and-garden/organization-and-cleaning/article/home-security-10-ways-to-protect-your-home-from-intruders?kbid=117104

SparkFun. (2020). PCB Basics. Retrieved form https://learn.sparkfun.com/tutorials/pcb-basics/all on February 10, 2020.

SysTutorials. (2019, October 20). *wpa\_supplicant.conf (5) - Linux Man Pages*. Retrieved from Linux Manual Pages : https://www.systutorials.com/docs/linux/man/5-wpa\_supplicant.conf/ on February 8, 2020.

Trotec. (2020, January 19). *Operation Manual Trotec Job Control. Basic, Advanced, Expert*. Retrieved from Trotec: Operation Manual Trotec Job Control. Basic, Advanced, Expert: https://www.troteclaser.com/fileadmin/content/images/Contact\_Support/Manuals/JobControl-Manual-EN.pdf

Woodall, M. (2019, September 14). *Canadian Crime Rates Burglary & Home Invasion: A Real Threat*. Retrieved Septrember 14, 2019, from SecureHouse.ca: http://www.securehouse.ca/canadian-crime-rates-burglary-home-invasion-toronto.html

Woodall, M. (2019, December 18). *Top 5 Best Home Security Systems in Canada 2020*. Retrieved from Reviews.org: https://www.reviews.org/home-security/best-security-systems-canada/

Appendix I: MAIDS Python Source Code (maids\_final\_python\_code\_ceng355.py)

#!/usr/bin/env python

# -\*- coding: utf-8 -\*-

#==========================================================================

# BUILT-IN/GENERIC IMPORTS FOR MAIDS

#==========================================================================

import RPi.GPIO as GPIO

import time

import datetime as datetime

import smtplib

import ssl

import os

import http.client

import urllib

import vlc

import mysql.connector

#==========================================================================

# MODULES IMPORTED

#==========================================================================

from email.mime.multipart import MIMEMultipart

from email.mime.base import MIMEBase

from email.mime.text import MIMEText

from email.utils import formatdate

from email import encoders

from subprocess import call

from mysql.connector import Error

#==========================================================================

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

#

# MAIDS PROJECT-SPECIFIC GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#

\_\_author\_\_ = "Claudio F. Meis"

\_\_projectname\_\_ = "MAIDS PROJECT"

\_\_date\_\_ = "October 12, 2019"

\_\_copyright\_\_ = "Copyright (c) 2019, Claudio F. Meis, The MAIDS project"

\_\_credits\_\_ = ["Claudio F. Meis","Conor Meis"]

\_\_license\_\_ = "MIT License"

\_\_version\_\_ = "1.0.0"

\_\_maintainer\_\_ = "Claudio F. Meis"

\_\_email\_\_ = "cfpm@live.ca,claudiomeis57@gmail.com"

\_\_status\_\_ = "Dev"

\_\_school\_\_ = "Humber College"

\_\_program\_\_ = "Computer Engineering Technology"

\_\_course\_\_ = "CENG317"

\_\_studentno\_\_ = "N00674230"

\_\_instructor\_\_ = "Mr. Austin Tian"

\_\_description\_\_ = "MEIS ALARM INTRUSION DETECTION SYSTEM"

#

# MAIDS PROJECT PINOUT GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#

\_\_SWITCH\_PIN\_\_ = 7

\_\_GREEN\_LED\_PIN\_\_ = 11

\_\_RED\_LED\_PIN\_\_ = 13

\_\_MOTION\_PIN\_\_ = 29

\_\_SOUND\_PIN\_\_ = 31

\_\_BUZZER\_PIN\_\_ = 33

chan\_list2 = (\_\_RED\_LED\_PIN\_\_,\_\_GREEN\_LED\_PIN\_\_,\_\_BUZZER\_PIN\_\_)

#

# MAIDS PROJECT SOUND ACTIVATION GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#

\_\_sounds\_\_ = ( '/home/pi/mp3/leaveroom.mp3', '/home/pi/mp3/10.mp3', '/home/pi/mp3/9.mp3', '/home/pi/mp3/8.mp3', \

'/home/pi/mp3/7.mp3', '/home/pi/mp3/6.mp3', '/home/pi/mp3/5.mp3', '/home/pi/mp3/4.mp3', \

'/home/pi/mp3/3.mp3', '/home/pi/mp3/2.mp3', '/home/pi/mp3/1.mp3', '/home/pi/mp3/maids\_activated.mp3' )

\_\_sounds2\_\_ = ( '/home/pi/mp3/s2.wav', '/home/pi/mp3/51267034.mp3')

\_\_sounds3\_\_ = ( '/home/pi/mp3/deactivating.mp3', '/home/pi/mp3/shutdown.mp3', '/home/pi/mp3/goodbye.mp3')

\_\_count\_\_ = 11

#

#MySQL DATABASE GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#

\_\_address\_\_ = "1234 Brook Road, Etobicoke, ON."

\_\_location\_\_ = "Room"

\_\_reportingperson\_\_ = "CONOR PATRICK JOSEPH MEIS"

\_\_contactphone\_\_ = "647-123-4567"

\_\_contactemail\_\_ = "cfpm@live.ca"

intrusiondate = datetime.datetime.now()

#==========================================================================

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* END OF GLOBALS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

#==========================================================================

# MAIDS PYTHON SCRIPT DESCRIPTION

#==========================================================================

#

# This script will set up the inputs/oputput pins for the Meis

# Alarm Intrusion Detection System (MAIDS) and manipulated them

# to provide a fully functional intrusion detection system based

# on motion and sound sensors, warning lights and buzzer alarm.

# Email notifications with pictures, Android Push Notifications,

# SMS message and phone call are sent upon intrusion being

# registered by sensors.

#==========================================================================

# MAIDS MIT LICENSE INFORMATION

#==========================================================================

#

# Copyright 2019 Claudio F. Meis - MAIDS PROJECT

#

# Permission is hereby granted, free of charge, to any person obtaining a

# copy of this software and associated documentation files (the "Software"),

# to deal in the Software without restriction, including without limitation

# the rights to use, copy, modify, merge, publish, distribute, sublicense,

# and/or sell copies of the Software, and to permit persons to whom the

# Software is furnished to do so, subject to the following conditions:

#

# The above copyright notice and this permission notice shall be included

# in all copies or substantial portions of the Software.

#

# THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS

# OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,

# FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL

# THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER

# LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,

# OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN

# THE SOFTWARE.

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

# START OF FUNCTIONS BLOCK

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

# Function block contains the following functions:

# 1. set\_up\_gpio() --> line 160

# 2. maids() --> line 184

# 3. notify() --> line 253

# 4. alarm() --> line 275

# 5. alert() --> line 291

# 6. sound(sound) --> line 302

# 7. motion(motion) --> line 321

# 8. send\_mail() --> line 340

# 9. send\_androidpush() --> line 382

# 10. appendtodb() --> line 403

# 11. intruderwarning() --> line 424

# 12. siren() --> line 437

# 13. activationwarning() --> line 450

# 14. dbinsert() --> line 466

#==========================================================================

# 1. set\_up\_gpio() --> SETUP GPIO NUMBERING SYSTEM AND I/O's

#==========================================================================

def set\_up\_gpio():

GPIO.setmode(GPIO.BOARD) # SETUP NUMBERING SYSTEM FOR GPIO

GPIO.setwarnings(False) # DISABLE WARNINGS

# SETTING UP INPUT/OUTPUT PINS \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

GPIO.setup(\_\_SWITCH\_PIN\_\_, GPIO.IN, pull\_up\_down=GPIO.PUD\_DOWN) #SWITCH - IN

GPIO.setup(\_\_MOTION\_PIN\_\_, GPIO.IN, pull\_up\_down=GPIO.PUD\_DOWN) #MOTION SENSOR - PIR - IN

GPIO.setup(\_\_SOUND\_PIN\_\_, GPIO.IN, pull\_up\_down=GPIO.PUD\_DOWN) #SOUND SENSOR - IN

GPIO.setup(\_\_RED\_LED\_PIN\_\_, GPIO.OUT)

GPIO.setup(\_\_GREEN\_LED\_PIN\_\_, GPIO.OUT)

GPIO.setup(\_\_BUZZER\_PIN\_\_, GPIO.OUT)

GPIO.output(chan\_list2,(GPIO.LOW,GPIO.HIGH,GPIO.HIGH)) #RED LED OFF/GREEN LED OFF/BUZZER OFF

time.sleep(1)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 2. maids() --> WELCOME SCREEN FUNCTION FOR MAIDS

#==========================================================================

def maids():

'''

MAIDS Function -- Displays MAIDS onscreen logo and project information.

Parameters:

:param none:

Input Data:

See MAIDS PROJECT SPECIFIC INFORMATION section

'''

os.system("clear")

print(" \\\\\\\//// ")

print(" \\//\/\\\\\\\/// ")

print(" \\\` \\\\\\///")

print(" \\ ||\ \ ")

print(" \ \\ // \_\ `\ ")

print(" / /. \ \\ /O. `\,")

print(" // |\_\_\\ //\ . \_\_\ ")

print(" /` //\\ , .\ / ")

print(" \\\\ //\ \_\_\_|")

print(" ////\\ \\ ` \ ")

print(" //////////\\\\ //\_\_ |")

print(" |` \\\//////\\ \\_ \\_\_\_\_\_\_|")

print(" | \\\\//\\/////\\\ \ ")

print(" ./ \\\\////////\\ |\ ")

print(" | \\\\////\\//\\\\\\\\ ")

print(" | \\\/// \\\\\\ ")

print(" | \\\// \// ")

print(" | \/ \ |")

print(" | ` \|")

print(" | | \ / ")

print(" | | \ \ // ")

print(" | | \ //// ")

print(" | | . `| ///// ")

print(" | | `\ \\//// ")

print(" \`| `| \\||/ ")

print(" | | \ `| ,--. \ \,")

print(" | \ |./ `\ | |")

print(" | | | | |")

print(" |\_\_\_| . | | |")

print(" / | | | |")

print(" | | ; | |")

print(" | | | |")

print(" \_\_| /` /` ;")

print(" / \ , ; \ ,` ,/ ")

print(" \\_\_\_\_\ \ \,/\_\_\_\_\_\_\_\_\_\_|\_\_.' ,`")

print(" ")

print(" MMM MM MMM AAAAAAAA IIIIIIII DDDDDDD SSSSSSSS")

print(" MMMM MM MMMM AAAAAAAA IIII DDDDDDD SSSSSSSS")

print(" MMMM MM MMMM AAA AAA IIII DDD DDD SSS ")

print(" MMMM MM MMMM AAA AAA IIII DDD DDD SSS ")

print(" MMMMMMMMMMMM AAAAAAAA IIII DDD DDD SSSSSSSS")

print(" MMM MMMM MMM AAAAAAAA IIII DDD DDD SSS")

print(" MMM MM MMM AAA AAA IIII DDD DDD SSS")

print(" MMM MM MMM AAA AAA IIII DDDDDDD SSSSSSSS")

print(" MMM MM MMM AAA AAA IIIIIIII DDDDDDD SSSSSSSS")

print(" ")

print(" ==========================================================================================\n")

print(" Project Name: " + \_\_projectname\_\_ + " - Description: " + \_\_description\_\_)

print(" Author: " + \_\_author\_\_ + " - Stud. No: " + \_\_studentno\_\_ + " Email: " + \_\_email\_\_)

print(" Date: " + \_\_date\_\_ + " - " + \_\_copyright\_\_)

print(" License: " + \_\_license\_\_ + " - Version: " + \_\_version\_\_ + " - Maintainer: " + \_\_maintainer\_\_)

print(" School: " + \_\_school\_\_ + " - Program: " + \_\_program\_\_)

print(" Program: " + \_\_program\_\_)

print(" Course: " + \_\_course\_\_ + " - Instructor: " + \_\_instructor\_\_)

print(" ==========================================================================================\n")

time.sleep(2)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 3. notify() --> UPDATE DATABASE/SEND EMAIL/SEND PUSH TO ANDROID PHONE FUNCTION

#==========================================================================

def notify():

'''

MAIDS Function -- Appends text database/send email/sends android push notification

sends SMS and calls Android phone.

Parameters:

:param none:

Input Data:

none

'''

#SENDING PUSH NOTIFICATION TO ANDROID PHONE

print("Sending push notification to Android phone...")

send\_androidpush()

#SENDING SMSNOTIFICATION TO ANDROID PHONE

print("Sending SMS notification to Android phone...")

sendsms()

#TAKING PIC AND SENDING EMAIL

print("Sending Intrusion Alert to email...")

send\_email()

#APPEND TEXT DATABASE/SENDG EMAIL WITH PICTURE/SEND ANDROID PUSH NOTIFICATION - INTRUSION ALERT

print("Appending Intrusion Alert to Database...")

appendtodb()

#CALLING ANDROID PHONE

print("Calling Android phone...")

callphone()

time.sleep(1)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 4. alarm() --> SET LIGHT/SOUND ALARM FORMAT

#==========================================================================

def alarm():

'''

MAIDS Function -- Sets LED flashing/sound pattern..

Parameters:

:param none:

Input Data:

none

'''

GPIO.output(chan\_list2,(GPIO.HIGH,GPIO.LOW,GPIO.LOW)) #RED LED/BUZZER ON & GREEN LED OFF

time.sleep(0.2)

GPIO.output(chan\_list2,(GPIO.LOW,GPIO.HIGH,GPIO.HIGH)) #RED LEDBUZZER OFF & GREEN LED ON

time.sleep(0.2)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 5. alert() --> SOUND SENSOR FUNCTION

#==========================================================================

def alert():

for x in range(1, 6):

alarm()

GPIO.output(chan\_list2,(GPIO.LOW,GPIO.LOW,GPIO.HIGH)) #RED LED/GREEN LED/BUZZER OFF

time.sleep(0.2)

intruderwarning()

notify()

siren()

time.sleep(1)

#==========================================================================

# 6. sound(sound) --> SOUND SENSOR FUNCTION

#==========================================================================

def sound(sound):

''' MAIDS Function -- Detects sound.

Parameters:

:param none:

Input Data:

none

'''

GPIO.output(\_\_GREEN\_LED\_PIN\_\_,GPIO.HIGH)

if GPIO.input(sound) == False:

print("MAIDS - MAIDS ALERT - Sound Detected!")

player = vlc.MediaPlayer('/home/pi/mp3/sounddetected.mp3')

player.play()

time.sleep(2)

alert()

GPIO.output(\_\_GREEN\_LED\_PIN\_\_, GPIO.HIGH)

else:

GPIO.output(\_\_GREEN\_LED\_PIN\_\_,GPIO.HIGH)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 7. motion(motion) --> MOTION SENSOR FUNCTION

#==========================================================================

def motion(motion):

''' MAIDS Function -- Detects motion.

Parameters:

:param none:

Input Data:

none

'''

GPIO.output(\_\_GREEN\_LED\_PIN\_\_,GPIO.HIGH)

if GPIO.input(motion) == False:

print("MAIDS ALERT - Motion Detected!")

player = vlc.MediaPlayer('/home/pi/mp3/motiondetected.mp3')

player.play()

time.sleep(1)

alert()

GPIO.output(\_\_GREEN\_LED\_PIN\_\_, GPIO.HIGH)

else:

GPIO.output(\_\_GREEN\_LED\_PIN\_\_,GPIO.HIGH)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 8. send\_email() --> SENDING ALERT WITH PICTURE TO RECIPIENT

#==========================================================================

def send\_email():

''' MAIDS Function -- Sends picture of intruder to email address.

Parameters:

:param none:

Input Data:

none

'''

os.system("fswebcam -r 1280x720 --title 'MAIDS INTRUSION ALERT' --subtitle '1234 BROOK ROAD, ETOBICOKE, ON.' --timestamp '%Y-%m-%d %H:%M (%Z)' --info 'LIVING ROOM ENTRY' --jpeg -1 --save /home/pi/webcam/image.jpg")

recipient = "cfpm@live.ca" # recipient email

sender = "claudiomeis57@gmail.com" # sender email

subject = "INTRUSION DETECTED BY MAIDS!\n1234 BROOK ROAD, ETOBICOKE, ON. - LIVING ROOM ENTRY\n" # email Subject

msg = MIMEMultipart()

msg['Subject'] = subject

msg['From'] = sender

msg['To'] = recipient

msg.preamble = "INTRUSION DETECTED BY MAIDS!\n1234 BROOK ROAD, ETOBICOKE, ON. - LIVING ROOM ENTRY\n"

part = MIMEBase('application', "octet-stream")

part.set\_payload(open("/home/pi/webcam/image.jpg", "rb").read())

encoders.encode\_base64(part)

part.add\_header('Content-Disposition', 'attachment; filename="/home/pi/webcam/image.jpg"') # File/format name

msg.attach(part)

try:

# INFORMATION FOR SMTP SERVER

port = 587 # port For starttls

smtp\_server = "smtp.gmail.com" # server address

s = smtplib.SMTP(smtp\_server,port) # Setup SMTP server for Gmail

s.starttls()

# GMAIL LOGIN INFORMATION

username = "claudiomeis57@gmail.com" # Setup username for login

password = "Srgawain2264" # Setup password for login

s.login(username,password) # gmail.com login username/password

# SENDING EMAIL TO RECIPIENT

s.sendmail(sender, recipient, msg.as\_string()) # send email

s.quit()

except:

print ("Error: Unable to send email") # Exception

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 9. send\_androidpush() --> SETUP ANDROID PUSH NOTIFICATION INFORMATION WITH PUSHOVER SERVICE

#==========================================================================

def send\_androidpush():

''' MAIDS Function --Sends push notification to Android phone.

Parameters:

:param none:

Input Data:

token id: "ahztmyszcui2w1svm21bbo813yie44"

user id: "ujt5f9osjotntdhapm64ab4dg8jt2m"

'''

conn = http.client.HTTPSConnection("api.pushover.net:443")

conn.request("POST", "/1/messages.json",

urllib.parse.urlencode({

"token": "ahztmyszcui2w1svm21bbo813yie44",

"user": "ujt5f9osjotntdhapm64ab4dg8jt2m",

"message": "INTRUSION DETECTED BY MAIDS - ALERT SENT! - REPORTING PERSON: JOHN SMITH CONTACT: 647-123-4567 EMAIL: cfpm@live.ca - INTRUSION ADDRESS: 1234 BROOK ROAD, ETOBICOKE, ON. LOCATION: LIVING ROOM",

}), { "Content-type": "application/x-www-form-urlencoded" })

conn.getresponse()

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 10. appendtodb() --> APPEND INTRUSION DATA TO TEXT and MySQL DATABASE

#==========================================================================

def appendtodb():

''' MAIDS Function -- Updates text database.

Parameters:

:param none:

Input Data:

none

'''

# APPENDING INTRUSION INFORMATION TO TEXT DATABASE

filename = "/home/pi/maids\_alarm\_record.txt" #assign text file to update

now = datetime.datetime.now().strftime("%Y-%m-%d\_%H.%M.%S") #create timestamp

file= open(filename,"a+") #open file to append

file.write("\n") #write info to file

#file.write(f"INTRUSION DETECTED -- ALARM ACTIVATED! EMAIL WITH PHOTO SENT! DATE/TIME: {now}\n")

file.write("REPORTING PERSON: JOHN SMITH CONTACT: 647-123-4567 EMAIL: cfpm@live.ca\n")

file.write("INTRUSION ADDRESS: 1234 BROOK ROAD, ETOBICOKE, ON. LOCATION: LIVING ROOM\n\n")

file.close() #close file

# APPENDING INTRUSION INFORMATION TO MySQL DATABASE

dbinsert(\_\_address\_\_, \_\_location\_\_, intrusiondate, \_\_reportingperson\_\_, \_\_contactphone\_\_,\_\_contactemail\_\_)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 11. intruderwarning() -- > PLAY INTRUDER WARNING MESSAGE

#==========================================================================

def intruderwarning():

''' MAIDS Function -- Plays warning message to intruder through vlc.

Parameters:

:param none:

Input Data: /home/pi/mp3/s2.mp3 file

'''

player = vlc.MediaPlayer(\_\_sounds2\_\_[1])

player.play()

time.sleep(1)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 12. siren() -- > PLAY SIREN ALARM SOUND

#==========================================================================

def siren():

''' MAIDS Function -- Plays a siren alarm sound through vlc.

Parameters:

:param none:

Input Data: /home/pi/mp3/51267034.mp3 file

'''

player = vlc.MediaPlayer(\_\_sounds2\_\_[0])

player.play()

time.sleep(0.20)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 13. activationwarning() -- > PLAY SIREN ALARM SOUND

#==========================================================================

def activationwarning():

''' MAIDS Function -- Plays a siren alarm sound through playsound module.

Parameters:

:param none:

Input Data: \_\_sounds\_\_ list

:Needed: pip install playsound

'''

for index in range(len(\_\_sounds\_\_)):

player = vlc.MediaPlayer(\_\_sounds\_\_[index])

player.play()

time.sleep(3)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# 14. dbinsert() -- > INSERT INTRUSION INFORMATION INTO MYSQL DATABASE

#==========================================================================

def dbinsert(address, location, intrusiondate, reportingperson, contactphone, contactemail):

''' MAIDS Function -- inserts intrusion particulars to MySQl database.

Parameters:

:param address:

:param location:

:param intrusiondate:

:param reportingperson:

:param contactphone:

:param contactemail:

:Input Data: \_\_sounds\_\_ list

'''

try:

connection = mysql.connector.connect(host='localhost',

database='maids1',

user='root',

password='')

cursor = connection.cursor()

mySql\_insert\_query = """INSERT INTO maidsintrusion (address, location, intrusiondate, reportingperson, contactphone, contactemail) \

VALUES (%s, %s, %s, %s, %s, %s) """

a = (address, location, intrusiondate, reportingperson, contactphone, contactemail)

cursor.execute(mySql\_insert\_query, a)

connection.commit()

print("Record inserted successfully into MAIDS-DB")

except mysql.connector.Error as error:

print("Failed to insert into MySQL table {}".format(error))

finally:

if (connection.is\_connected()):

cursor.close()

connection.close()

print("MySQL connection - CLOSED")

# 15. shutdown() -- > INSERT INTRUSION INFORMATION INTO MYSQL DATABASE

#==========================================================================

def shutdown():

''' MAIDS Function -- shutdown MAIDS.

Parameters:

none

:Input Data: mp3 sounds

'''

for index in range(len(\_\_sounds3\_\_)):

player = vlc.MediaPlayer(\_\_sounds3\_\_[index])

player.play()

time.sleep(3)

#==========================================================================

# 16. sendsms() -- > SEND SMS INTRUSION ALERT

#==========================================================================

def sendsms():

# Download the helper library from https://www.twilio.com/docs/python/install

from twilio.rest import Client

# Your Account Sid and Auth Token from twilio.com/console

# DANGER! This is insecure. See http://twil.io/secure

account\_sid = 'AC7b062601eca1c3d78642021e82e0eb7b'

auth\_token = 'f83955e36e1df48109a15369eb73fc2e'

client = Client(account\_sid, auth\_token)

message = client.messages \

.create(

body="MAIDS - INTRUSION ALERT - 1234 Brook Road, Etobicoke, ON. - Living Room Intrusion Detected!",

from\_='+16475592395',

to='+14372304874'

)

print("Mesaage sent ID: " + message.sid)

#==========================================================================

# 17. callphone() -- > CALL PHONE WITH INTRUSION ALERT

#==========================================================================

def callphone():

# Download the helper library from https://www.twilio.com/docs/python/install

from twilio.rest import Client

# Your Account Sid and Auth Token from twilio.com/console

# DANGER! This is insecure. See http://twil.io/secure

account\_sid = 'AC7b062601eca1c3d78642021e82e0eb7b'

auth\_token = 'f83955e36e1df48109a15369eb73fc2e'

client = Client(account\_sid, auth\_token)

call = client.calls.create(

url='http://demo.twilio.com/docs/voice.xml',

from\_='+16475592395',

to='+14372304874'

)

print("Phone call ID: " + call.sid)

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

# END OF FUNCTIONS SECTION

#\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#==========================================================================

# STARTTING MAIN SCRIPT

#==========================================================================

if \_\_name\_\_ == '\_\_main\_\_':

#Setup GPIO Information

set\_up\_gpio()

#Display MAIDS logo/project information

maids()

print("MAIDS Surveillance Mode - Arming...")

#warning to vacate the room

activationwarning()

print("MAIDS Surveillance Mode - Armed and Active...\n")

# Sound sensor: Detect when pin goes HIGH or LOW

GPIO.add\_event\_detect(\_\_SOUND\_PIN\_\_, GPIO.BOTH, bouncetime=200)

# assign function to PIN & run it

GPIO.add\_event\_callback(\_\_SOUND\_PIN\_\_, sound)

# Motion sensor: Detect when pin goes HIGH or LOW

GPIO.add\_event\_detect(\_\_MOTION\_PIN\_\_, GPIO.BOTH, bouncetime=200)

# assign function to PIN, and run it

GPIO.add\_event\_callback(\_\_MOTION\_PIN\_\_, motion)

try:

while True: # infinite loop

time.sleep(1)

except KeyboardInterrupt:

shutdown()

#RED LED OFF/GREEN LED ON

GPIO.output(chan\_list2,(GPIO.LOW,GPIO.LOW,GPIO.HIGH))

time.sleep(1)

GPIO.cleanup() #cleanup

GPIO.cleanup() #cleanup

# Appendix II: MAIDS Wireless Connection Configuration - wpa\_supplicant.conf File

ctrl\_interface=DIR=/var/run/wpa\_supplicant GROUP=netdev

update\_config=1

country=CA

network={

ssid="Meis908070-5G"

psk="Srgawain2264"

disabled=1

}

network={

ssid="FkeV-Y2ZwbQ"

psk="cmeis2264"

disabled=1

}

network={

ssid="myWi-Fi@Humber"

key\_mgmt=WPA-EAP

auth\_alg=OPEN

eap=PEAP

identity="mscl0015"

password="Srgawain2264"

phase1="peaplabel=0"

phase2="auth=MSCHAPV2"

priority=999

proactive\_key\_caching=1

}

network={

ssid="eduroam"

key\_mgmt=WPA-EAP

auth\_alg=OPEN

eap=PEAP

identity="mscl0015@humber.ca"

password="Srgawain2264"

phase2="auth=MSCHAPV2"

priority=999

proactive\_key\_caching=1

disabled=1

}

network={

ssid="Welcome to Humber"

key\_mgmt=NONE

}