

I. METHODOLOGY

In this section, the methodology for observing and analyzing intrusion attempts on the MediColBox will be outlined. A description of the phenomenon of interest, data collection methods, sampling strategy, data collection procedures, ethical considerations, data analysis approach, validity and reliability measures, and limitations of the study will be provided.

A. Phenomenon of Interest

The phenomenon of interest in this study is intrusion attempts on the MediColBox. The various aspects of intrusion, including the methods employed by intruders, their motivations behind the attempts, and the potential consequences of successful intrusions, will be investigated. By understanding these aspects, the project aims to enhance the security and protection of the MediColBox and the medications it contains.

B. Data Collection Methods

To collect data on intrusion attempts, the project will primarily utilize the Inertial Measurement Unit (Inertial Measurement Unit (IMU)) as the main data collection method for detecting intrusion attempts on the MediColBox. This choice allows for a more focused investigation into the effectiveness of the IMU in identifying unauthorized access.

The IMU, with its capability to capture physical movements, vibrations, and orientation changes of the MediColBox, provides valuable data for intrusion detection and analysis. By relying on the IMU alone, the project aims to determine if it can effectively detect and alert on intrusion attempts without the need for additional systems.

This approach also enables the project to address the feasibility of implementing other data collection methods mentioned earlier, such as motion sensors, video surveillance, access logs, incident reports, and interviews. By evaluating the standalone performance of the IMU, the project can assess its potential to serve as a cost-effective and efficient solution for intrusion detection on the MediColBox.

The investigation will involve testing and analysis of the IMU data collected during simulated intrusion attempts. This evaluation will focus on assessing the

accuracy, reliability, and timeliness of the IMU in detecting and alerting on unauthorized movements or tampering.

By dedicating the study to evaluating the IMU's effectiveness as a standalone solution, the project aims to determine if the implementation of additional data collection methods is necessary for robust intrusion detection. The results will provide insights into the suitability and viability of relying solely on the IMU for enhancing the security and protection of the MediColBox and its contents.

(Table I) presents potential data collection methods for intrusion attempts.

TABLE I
POTENTIAL DATA COLLECTION METHODS FOR INTRUSION ATTEMPTS

Data Collection Method	Description
Motion Sensors	Implementing motion sensors that can detect the MediColBox.
Inertial Measurements (IMU)	Utilizing an Inertial Measurement Unit (IMU) to capture orientation or movement of the MediColBox for detection and analysis.
Video Surveillance	Installing surveillance cameras around the MediColBox to detect intrusion attempts visually.
Access Logs	Maintaining detailed logs of access attempt activities.
Incident Reports	Gathering information from incident reports filed by individuals who have witnessed intrusion attempts.
Interviews	Conducting interviews with security personnel to gather experiences and observations regarding intrusion attempts.

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This approach also enables the project to address the feasibility of implementing the other data collection methods mentioned earlier, such as motion sensors, video surveillance, access logs, incident reports, and interviews. By evaluating the standalone performance of the IMU, the project can assess its potential to serve as a cost-effective and efficient solution for intrusion detection on the MediColBox.

The investigation will involve comprehensive testing and analysis of the IMU data collected during simulated intrusion attempts. This evaluation will focus on assessing the accuracy, reliability, and

timeliness of the IMU in detecting and alerting on unauthorized movements or tampering.

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C. Prototype Construction

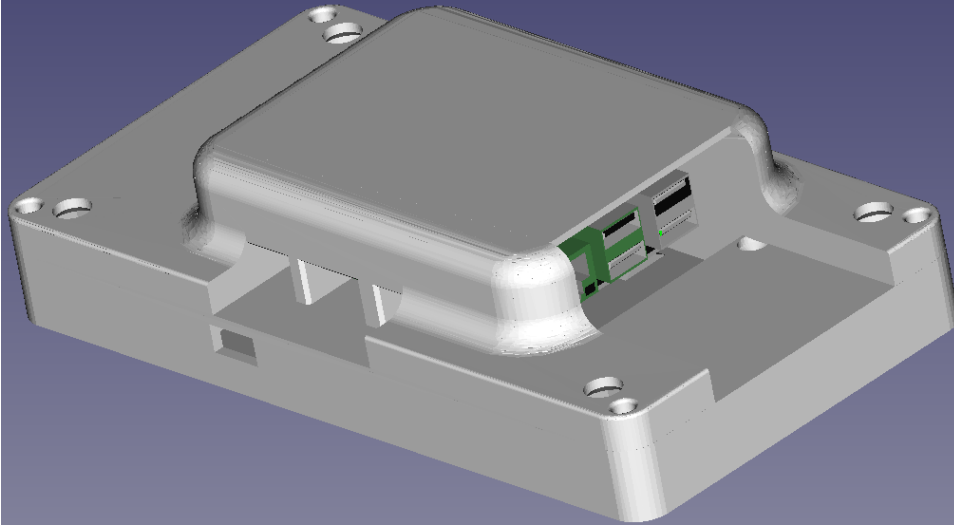


Fig. 1. Design of the prototype with the cover on

The prototype control system is constructed using the following components:

- 1× Single-board computer: Raspberry Pi 4B 8 GB [9] as the CCU
- 1× Human-Machine Interface (HMI): 7-inch touchscreen [10]
- 1× Sensor Card: Raspberry Pi Sense Hat v1.0.0 [11] with an integrated IMU
- 4× M3 8 mm long threaded screws
- 8× M3 8 mm long spacers with 8 mm threaded rods on one side
- 1× 22-pin 0.5 mm pitch cable for the DSI connectors
- 1× USB type A to USB type micro B cable for power and GND between HMI and Raspberry Pi
- 1× USB type A to USB type C cable for power
- 1× 230 V AC to USB type A power adapter
- 1× Custom-designed cover to protect the electronics during testing
- 4× M3.5 8 mm long screws
- 4× M4 10 mm long screws

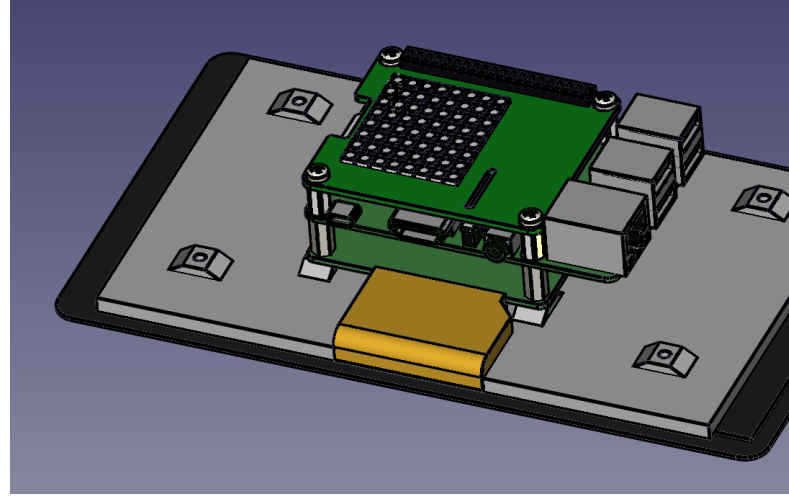


Fig. 2. Design of the prototype without the cover

The construction process involves the following steps:

- 1) Assemble the prototype:
 - a) Mount the Raspberry Pi 4B on the 7-inch touchscreen by using the threaded spacers.
 - b) Mount the Raspberry Pi Sense Hat on the Raspberry Pi 4B by attaching it to the 2×20 pin.
- 2) Connect the components according to the wiring diagram (Figure 3):
 - a) Connect the DSI output from the Raspberry Pi to the DSI input on the 7-inch touchscreen using a suitable ribbon cable.
 - b) Connect the display's USB type micro B power connector input to one of the USB type A connectors on the Raspberry Pi (it does not matter which one).
- 3) Enclose the electronics with the custom-designed cover.
 - a) Attach the screen to the first part of the casing using the M3.5 screws.
 - b) Attach the second part of the casing to the first part of the casing using the M4 screws.
- 4) Configure the software environment for the Raspberry Pi 4B and install the necessary libraries and drivers.
 - a) Open Raspberry Pi Imager. Install it if you don't already have.
 - b) Insert the micro SD card into your computer. You can use an adapter if needed.
 - c) On Raspberry Pi Imager, select the storage device to install the operating system. Select the micro SD card.
 - d) On Raspberry Pi Imager, select operating system to install. Select Raspberry Pi OS.
 - e) Click "write" and wait till complete.
 - f) Remove the micro SD card and insert it into the Raspberry Pi.
 - g) start the Raspberry Pi, open terminal and type the code:


```
sudo raspi-config
```

 - h) Select "Interfacing Options"
 - i) Select the "I2C" option

j) Select "<Yes>"

k) Select "<Ok>"

l) Select "<Yes>"

- 5) Establish communication between the CCU, HMI, and the sensor card by setting up appropriate interfaces and protocols.

- a) implement software that follows this sequence (Figure 4)

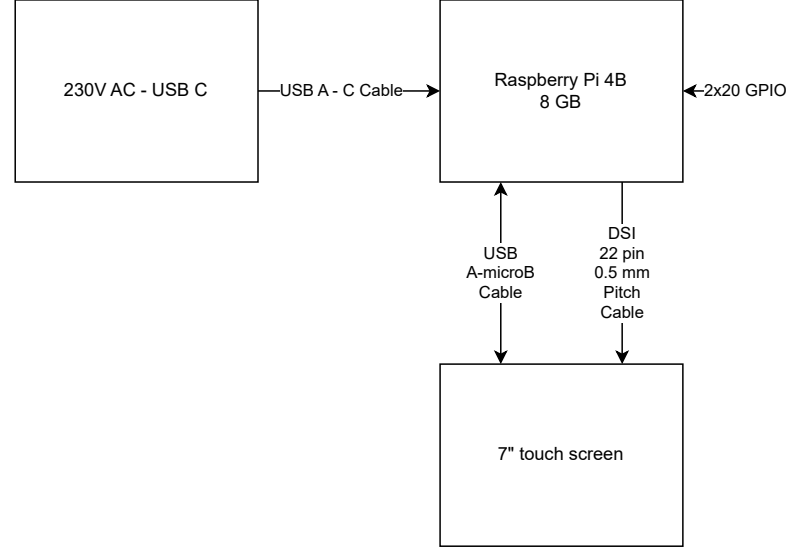


Fig. 3. The wiring diagram used

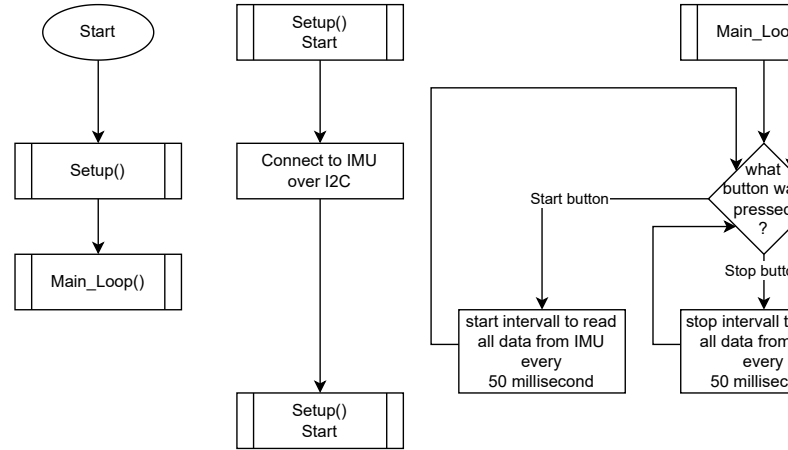


Fig. 4. The wiring diagram used

D. Sampling Strategy

For our study, we define a sampling strategy to ensure the representation of different scenarios and potential risks associated with intrusion attempts on the MediColBox. Our sample may include specific

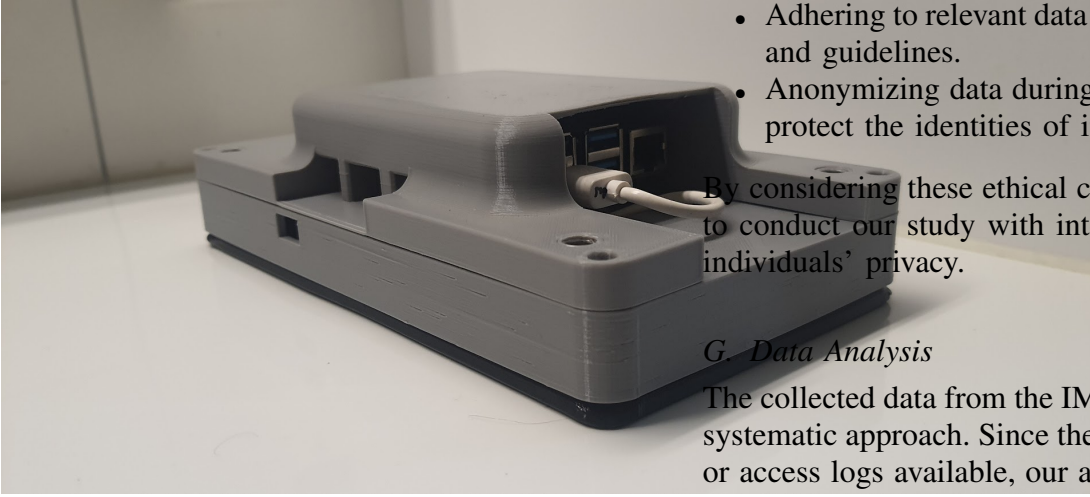


Fig. 5. Photograph of the prototype

locations where the MediColBox is deployed, instances of reported intrusion attempts, or a combination of both. We strive to select a diverse sample that covers a range of demographic and environmental factors to enhance the generalizability of our findings.

E. Data Collection Procedures

To collect data on intrusion attempts, we follow specific procedures to ensure accuracy and completeness. These procedures involve implementing the following data collection methods (Table II):

TABLE II
DATA COLLECTION METHODS FOR INTRUSION ATTEMPTS

Data Collection Method	Description
Installing Surveillance Cameras and Motion Sensors	Installing and validating using a suitable methodology to ensure its effectiveness in detecting unauthorized access based on the IMU readings.
Implementing Protocols for Incident Documentation	Implementing protocols for documenting and reporting intrusion incidents, including recording timestamps, descriptions of the events, and any available contextual information.
Reviewing Video Footage, Access Logs, and Incident Reports	Regularly reviewing video footage, access logs, incident reports, and conducting interviews to gather relevant data.
Ensuring Equipment Functionality and Maintenance	Ensuring the proper functioning and maintenance of surveillance equipment and data storage systems.

These procedures help us capture the necessary data for analysis and provide a comprehensive understanding of intrusion attempts on the MediColBox.

F. Ethical Considerations

We recognize and address ethical considerations related to our study. This includes:

- Adhering to relevant data protection regulations and guidelines.
- Anonymizing data during the analysis phase to protect the identities of individuals involved.

By considering these ethical considerations, we aim to conduct our study with integrity and respect for individuals' privacy.

G. Data Analysis

The collected data from the IMU is analyzed using a systematic approach. Since there is no video footage or access logs available, our analysis focuses solely on the data captured by the IMU. The analysis process includes the following steps:

- Data preprocessing: The collected IMU data is preprocessed to ensure its quality and suitability for analysis. This may involve removing any noise or outliers, normalizing the data, and performing any necessary transformations to prepare it for further analysis.
- Exploratory data analysis: We conduct exploratory data analysis to gain a better understanding of the IMU data. This involves visualizing the data, examining summary statistics, and identifying any patterns or trends that may be present. Exploratory analysis helps in identifying initial insights and forming hypotheses for further investigation.
- intrusion detection algorithm: We develop or utilize an intrusion detection algorithm that can process the IMU data and identify potential intrusion attempts. This algorithm is trained and validated using a suitable methodology to ensure its effectiveness in detecting unauthorized access based on the IMU readings.
- Statistical analysis: If applicable, statistical analysis techniques can be employed to analyze the IMU data further. This may include identifying correlations between different variables or conducting hypothesis testing to validate any observed patterns or relationships.
- Data visualization: Data visualization techniques, such as plots, charts, or graphs, can be employed to present the analyzed IMU data effectively. Visualizations can help in understanding the patterns, trends, and anomalies in the data, making it easier to interpret and communicate the findings.

By conducting an analysis of the anonymized IMU data, we aim to gain insights into the effectiveness of the IMU in detecting intrusion attempts on the MediColBox. This analysis will contribute to the assessment of the IMU as a standalone solution for enhancing the security and protection of the MediColBox and its contents.

H. Limitations

It is essential to acknowledge the limitations inherent in studying intrusion attempts on the MediColBox. These limitations may include:

- **Availability of intrusion data:** The limited availability of documented intrusion attempts may impact the sample size and the generalizability of the findings.
- **Challenges in capturing all intrusion attempts:** Some intrusion attempts may go undetected or unreported, leading to potential underrepresentation in the collected data.
- **Generalizability of findings:** The context of the MediColBox and the specific locations where it is deployed may influence the generalizability of the findings to other similar systems.

We address these limitations by maximizing the available data, selecting a diverse sample, and providing contextual information to aid in the interpretation and application of our findings.

By incorporating these elaborations into the methodology section, we can effectively observe and analyze intrusion attempts on the MediColBox, gaining insights into the methods, motivations, and potential vulnerabilities associated with these attempts.