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# Data Documentation Tool (DDoT) User Manual

LaKenya Walker, Joshua Church, and Amy Bednar

August 2021

JAC JL/P/Mx H-60 Data Documentation

Overview

Army Black Hawk

- Integrated Vehicle Health Monitoring System Data
- Logbook Data
- RIMFIRE Data
- Product Quality Deficiency Report Data
- Sample Data Collection and Analysis Program Data
- Logistics Modernization Program Repair Data
- Defense Logistics Agency Supply & Cost Data
- Flight Regime Recognition Data
- 160th SOAR Voice And Data Recorder Data
- 160th SOAR Unit Level Logistics System-Aviation (Enhanced) Data
- 160th SOAR Health Usage Monitoring System Data

Navy Sea Hawk

Air Force Pave Hawk

Contact Information

About the Data Exploring the Data Using the Data **Army Integrated Vehicle Health Monitoring System (IVHMS) Data**

**Background**

In 2004, Skirkosy selected the Goodrich IVHMS for the U.S. Army's UH-60M Black Hawk program. As a modernization plan, the U.S. Army upgraded existing UH-60A and UH-60L aircraft to the UH-60M configuration and purchased new production UH-60M Black Hawks.

As a derivative of the Goodrich Integrated Mechanical Diagnostics - Health & Usage Monitor System (IMD-HUMS), the IVHMS monitors the aircraft's engines, transmission and rotors to detect developing problems and includes a cockpit voice flight data recorder and crash survivable memory unit. The technology enables the Army to proactively plan maintenance based on the usage and condition of "life limited" parts within a helicopter's critical systems.

**About the Data**

Below are some important information to be considered when using this data.

- Mechanical Diagnostics, RTB, and Vibe Diagnostics are all collected in bursts. The BMU (M model only) and Parametric data is continuous.
- All of the vibration sensors are triggered to record their burst of information based on a particular flight regime. They follow a sequence and if the aircraft is in the regime long enough, the entire sweep will be recorded. The translation tables contain all of the expected parameters.
- Vibe data is sampled at 104167 Hz when the aircraft meets the parameters for the acquisition. Parametric data for the H-60M is recorded at the different rates. The H-60A/L will vary slightly in frequency.
- Time is recorded based on the start of the .jdf. (when the flight began) The time stamp on the file is based on the current time (which is programmed into the IVHMS when it is installed, or when a battery dies and gets changed)

Python

**Python Notebook demonstrating how to read and access IVHMS data**

Example .db are from Army IVHMS.

Import needed libraries.

```
In [1]:
import os
import pandas as pd
import sqlite3
import sqlalchemy
from sqlalchemy import create_engine, cast, Date, Table, Column, Integer, DateTime, MetaData
```

Set the directory to where the data is located.

```
In [2]:
data_dir = <data_path>
```

UH-60 A/L/M models from 2008 - 2019, equating to 1,747,782 flights. Diagnostic Application (MDA) developed by QTEC Aerospace. The format of

date

(aug-17).html

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# Data Documentation Tool (DDoT) User Manual

LaKenya Walker, Joshua Church, and Dr. Amy Bednar

*Information Technology Laboratory  
US Army Engineer Research and Development Center  
3909 Halls Ferry Road  
Vicksburg, MS 39180-6199*

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## Abstract

This manual is intended for new users with minimal or no experience with using the Data Documentation Tool. The goal of this document is to give an overview of the main functions of DDoT. The primary focus of this document is to demonstrate functionality.

Every effort has been made to ensure this document is an accurate representation of the functionality of the DDoT. For additional information about this manual, contact [ERDC.JAIC@erdc.dren.mil](mailto:ERDC.JAIC@erdc.dren.mil).

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## Preface

This study was under MIPR HC1085015834 under Project “ERDC PMx Product Transition to the Joint Artificial Intelligence Center (JAIC) Joint Common Foundation (JCF).” The technical monitor was Dr. Maria Niki Goerger.

The work was performed by the Computational Analysis Branch of the Computational Science and Engineering Division, U.S. Army Engineer Research and Development Center, Information Technology Laboratory (ERDC-ITL). At the time of publication, Mr. Joshua Church was Acting Branch Chief; Dr. Jeffrey Hensley was Division Chief; and Dr. Robert Wallace was Technical Director for the Engineered Resilient Systems (ERS) program. The Deputy Director of ERDC-ITL was Dr. Jackie Pettway, and the Director was Dr. David Horner.

COL Teresa A. Schlosser was the Commander of ERDC, and Dr. David W. Pittman was the Director.

# 1 Introduction

## 1.1 Background

Across the Department of Defense (DoD), there are multiple datasets that support maintenance of the H-60 rotor craft. In an effort to consolidate all the documentation for these datasets into one centralized location, the U.S. Army Engineer Research and Development Center created the Data Documentation Tool (DDoT) to host all the information needed for a user to become familiar with and use these datasets for each service, namely the Army, Air Force and Navy. This application provides the Joint services the capability to explain their datasets without directly communicating with each other. This capability enables ease of access and ultimately reduces the time required to analyze datasets between the Joint services.

## 1.2 Purpose

The DDoT provides users a single, unified, interactive interface for tri-service H-60 data documentation, exploration, and usage to support analytics and artificial intelligence model development.

## 1.3 Usage

DDoT is designed to be user-agnostic. Any user that is interested in the cross-service H-60 helicopter data currently supporting the Joint Artificial Intelligence Center (JAIC) Joint Logistics (JL)/Predictive Maintenance (PMx) efforts should find the tool easy to navigate.

## 1.4 Requirements

This section covers the following recommended operating systems and hardware and software requirements for using DDoT.

### 1.4.1 Recommended operating systems

- *Windows*: Windows 10
- *Mac*: macOS Sierra or newer
- *Linux*: Ubuntu.

### 1.4.2 Hardware

There are no specific hardware requirements for running this tool.

### 1.4.3 Software

DDoT can be executed on any browser that supports R shiny (<https://shiny.rstudio.com/>).

#### *Software Needed*

- R version 4.0 or greater
- RStudio.

#### *Optional Software Needs*

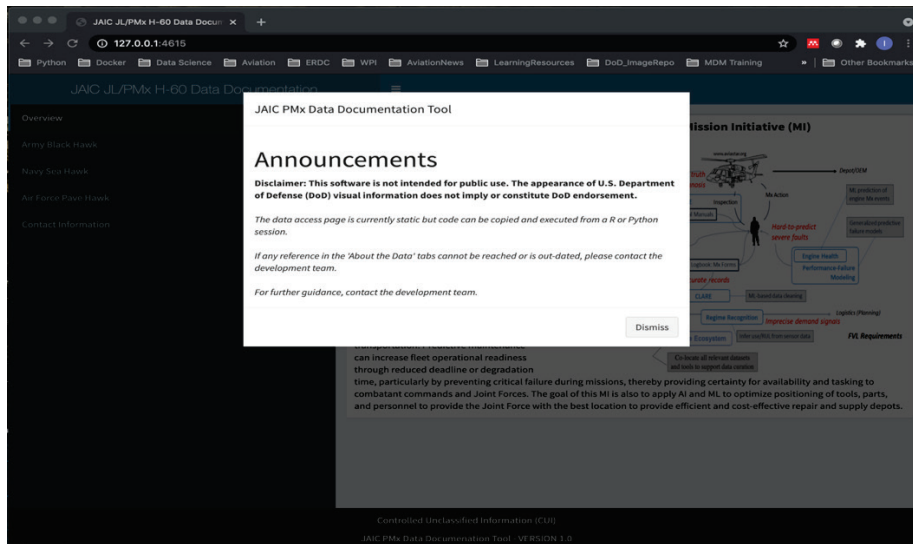
To execute the Python code provided in the tool's **Using the Data** tabs, a user will need to install Python version 3.0 or greater.

## 2 User Interface

### 2.1 Main page

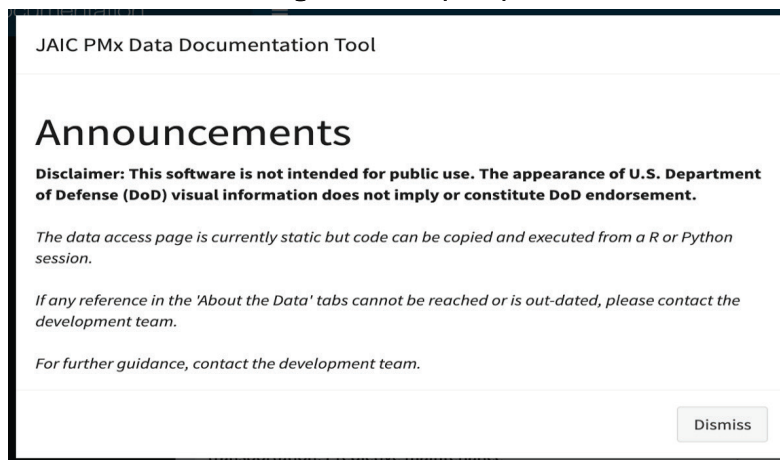
Once the DDoT loads (see Figure 1), the user is presented with the following prompt:

Figure 1. Initial screen after opening DDoT.



The initial prompt is current information on the DDoT (see Figure 2). The user must click the Dismiss button to proceed to the tool.

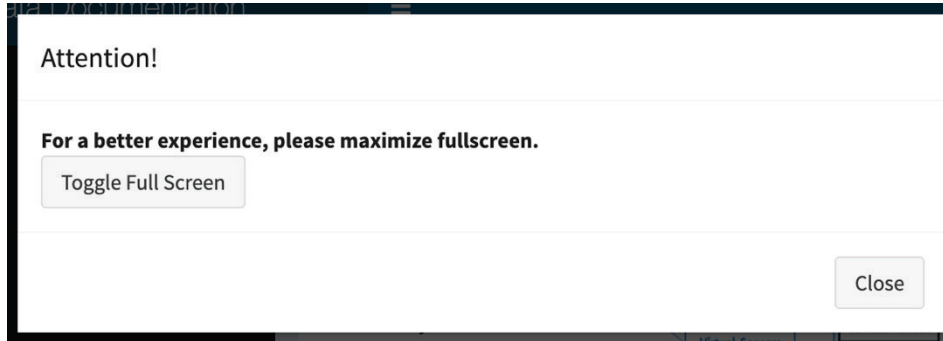
Figure 2. First prompt.



The second prompt (see Figure 3) provides a Toggle Full Screen button for a better experience of the DDoT. The preference is optional for the user.

The user must click the Close button on this prompt to go to the main page of the DDoT.

Figure 3. Second prompt.



## 2.2 Overview

The **Overview** tab (see Figure 4) is the starting page after the prompts. This tab contains information on the purpose of the DDoT.

Figure 4. Overview tab.

**NOTE:** When using the DDoT tool, refreshing or closing the browser tab shuts down the application.

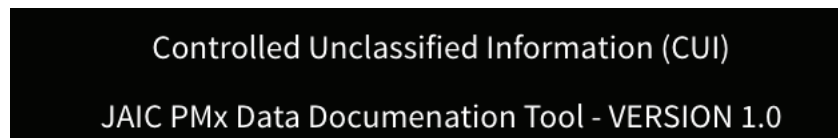
On the left side of the screen, different tab options are available. Information for these tabs can be found under **Main Tabs**. On the right side of the screen, information based on the selected tab is shown. The three-bar button (see Figure 5) will make the main tabs disappear and reappear.

Figure 5. Drop down menu button.



The footer as shown in Figure 6 displays the version of the DDoT that the user is using.

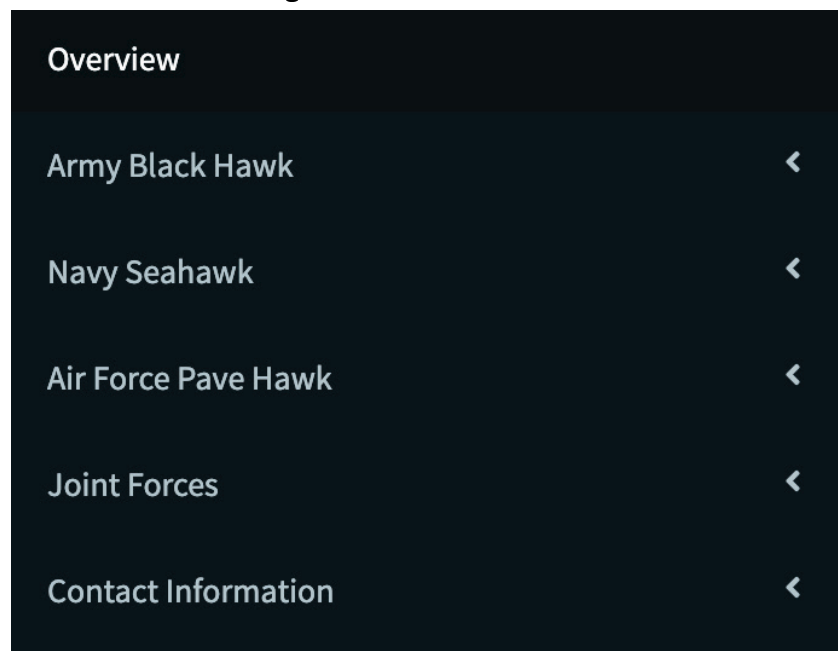
Figure 6. Version footer.



## 2.3 Main tabs

There are six main tab options (see Figure 7) available for the user to select: **Overview**, **Army Black Hawk**, **Navy Sea Hawk**, **Air Force Pave Hawk**, **Joint Forces**, and **Contact Information**.

Figure 7. Main tab selection.



Information about each tab is located in the following sections.

## 2.4 Army Black Hawk, Navy Seahawk, and Air Force Pave Hawk

Once one of the tabs (**Army Black Hawk**, **Navy Sea Hawk**, **Air Force Pave Hawk**) is selected, there is an additional set of selections as shown in Figure 8, Figure 9, and Figure 10. These selections refer to the current dataset for each branch of service that is in the DDoT. For additional information on this section refer to Section 2.4.1 below.

Figure 8. Army Black Hawk tab selection window.

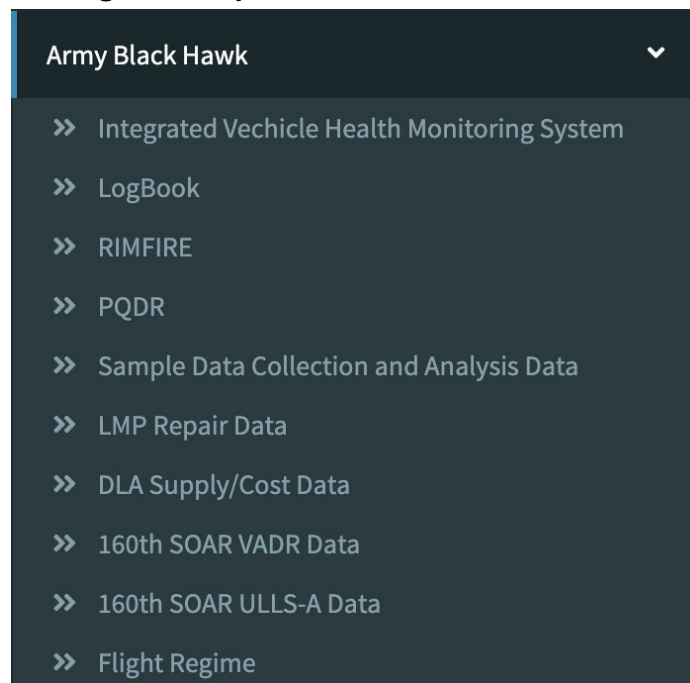


Figure 9. Navy Seahawk tab selection window.

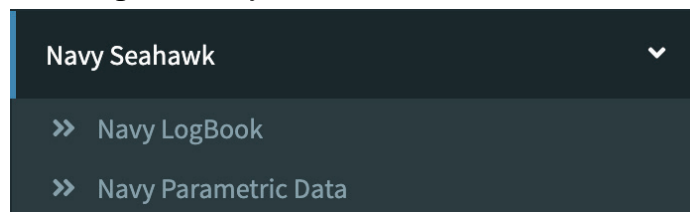
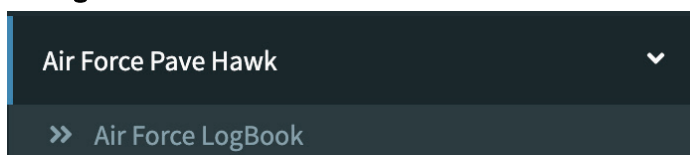


Figure 10. Air Force Pave Hawk tab selection window.



## 2.4.1 Secondary selections

Once a dataset is selected, three different informational tab options appear as show in Figure 11: **About the Data**, **Exploring the Data**, and **Using the Data**. For example, in Figure 12 the Army **Black Hawk Integrated Vehicle Health Monitoring System (IVHMS)** dataset tab is selected.

Figure 11. Informational tab options.

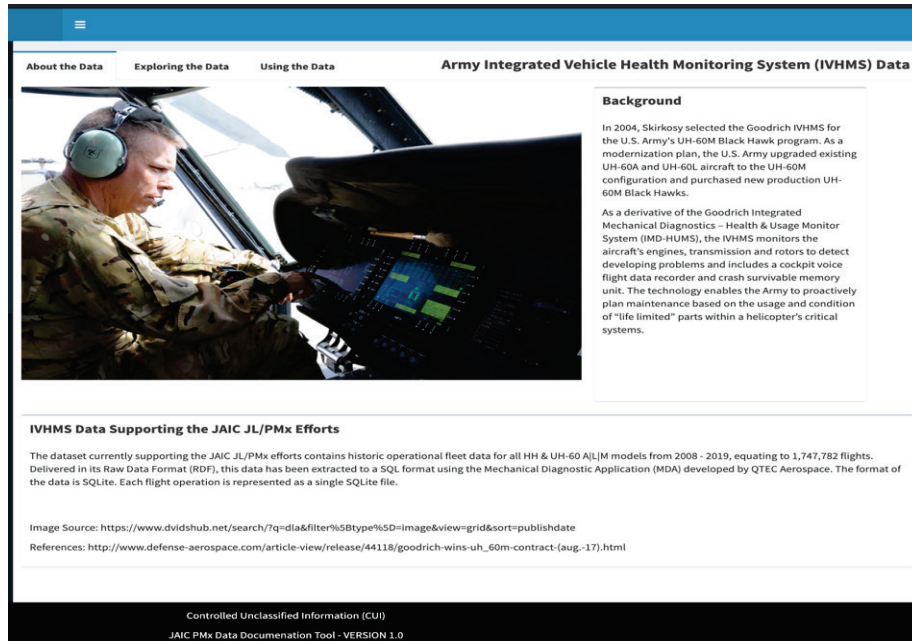


Figure 12. Army IVHMS dataset page.

## 2.4.2 About the data

The **About the Data** tab displays background information on each dataset, such as the source of the data and how the data supports JAIC JL/PMx. For an example, see Figure 13.

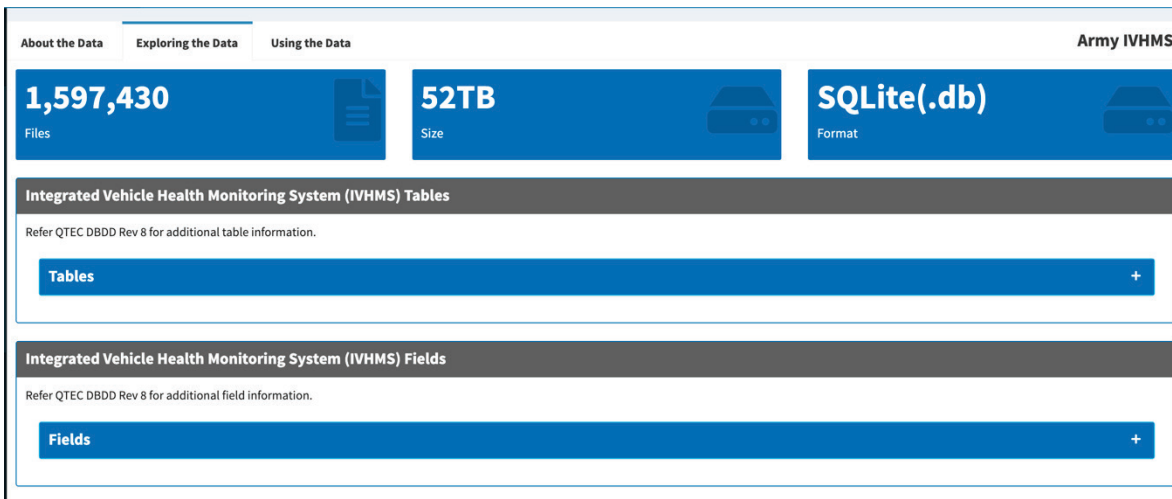
Figure 13. Army IVHMS—About the Data tab.



### 2.4.3 Exploring the data

The **Exploring the Data** tab (see Figure 14) displays information about the number of files in the dataset, dataset size, and dataset format. This page also contains tables and fields related to the selected dataset.

Figure 14. Army IVHMS—Exploring the Data tab.



The + or - buttons on the right side of the table expand (+) or minimize (-) the tables and field boxes. For an example, see Figure 15.

Figure 15. Army IVHMS tables and descriptions.

**Integrated Vehicle Health Monitoring System (IVHMS) Tables**

Refer QTEC DBDD Rev 8 for additional table information.

| Tables                    |   |
|---------------------------|---|
| Table Name                | Description   |
| 1 accel                   | data representing the flight characteristics of a monitored device. The data provided is to determine the quality, duration, environment, and operational characteristics of a device.  |
| 2 accel_config            | data describing the configuration characteristics of devices that are measured by an accelerometer  |
| 3 ah (Acquisition Header) | data corresponding to delineated operation events. The data is stored with overall environment and operating characteristics of an event and the relationship keys necessary for deriving operating characteristics of associated accelerometers, indexers, and other related components. |
| 4 anomaly                 | data from the reporting module of the ADA. Data exceeding a defined set of operating thresholds is organized and stored in this table   |
| 5 arrdata                 | data containing single dimensional arrays of numbers that contain the raw data for mechanical diagnostics.  |
| 6 arraydata               | data containing x/y data points for parametric data   |
| 7 brg                     | data from the bearing component. This data is necessary to identify event and operational characteristics including relationship keys for supporting components and devices   |
| 8 brg_config              | data describing the configuration characteristics of the bearing component  |
| 9 calib_raw_data          | data for the gain ad calibration which accompanies some mechanical diagnostic raw data  |
| 10 env                    | data applicable to deriving related bearing component information   |

Showing 1 to 10 of 45 entries

Previous 1 2 3 4 5 Next

As shown in Figure 16, the user can select which table to display by selecting a table option in the **Choose a Table** dropdown box. A **Search** option is available for the tables displayed. The **Fields** table shows a list of fields and a description for each field.

Figure 16. Army IVHMS fields and descriptions.

**Integrated Vehicle Health Monitoring System (IVHMS) Fields**

Refer QTEC DBDD Rev 8 for additional field information.

| Fields               |                           |
|----------------------|---------------------------|
| Name                 | Description               |
| 1 UniqueKey          | identity column           |
| 2 AHLink             | AH relationship           |
| 3 AILink             | idx relationship          |
| 4 CNFGIdx            | accel_config relationship |
| 5 sampleRate         | condition indicator       |
| 6 sampleDuration     | condition indicator       |
| 7 SpectrumDecimation | condition indicator       |
| 8 FFTSize            | condition indicator       |
| 9 SpectrumType       | condition indicator       |
| 10 adcBitUse         | condition indicator       |

Showing 1 to 10 of 37 entries

Previous 1 2 3 4 Next

### 2.4.4 Using the data

The **Using the Data** tab (see Figure 17) displays information about what the user should consider when using the data. The tab will also contain a Python and R script to read and access the selected data.

Figure 17. Army IVHMS—Using the Data tab.

About the Data   Exploring the Data   **Using the Data**
Army IVHMS

Below are some important information to considered when using this data.

- 1) Mechanical Diagnostics, RTB, and Vibe Diagnostics are all collected in bursts. The BMU (M model only) and Parametric data is continuous.
- 2) All of the vibration sensors are triggered to record their burst of information based on a particular flight regime. They follow a sequence and if the aircraft is in the regime long enough, the entire sweep will be recorded. The translation tables contain all of the expected parameters.
- 3) Vibe data is sampled at 104167 Hz when the aircraft meets the parameters for the acquisition. Parametric data for the H-60M is recorded at the different rates. The H-60A/L will vary slightly in frequency.
- 4) Time is recorded based on the start of the .rdf. (when the flight began) The time stamp on the file is based on the current time (which is programmed into the IVHMU when it is installed, or when a battery dies and gets changed)

Python
R

## Python Notebook demonstrating how to read and access IVHMS data

**Example .db are from Army IVHMS.**

**Import needed libraries.**

```
In [ ]:
import os
import pandas as pd
import sqlite3
import sqlalchemy
from sqlalchemy import create_engine, cast, Date, Table, Column, Integer, DateTime, MetaData
```

**Set the directory to where the data is located.**

```
In [1]:
data_dir = <data_path>
```

The **Contact Information** tab (see Figure 18) provides the contact information for the developers of the DDoT tool.

Figure 18. Contact Information tab.

The screenshot shows a web browser window displaying the 'JAIC JL/PVx H-60 Data Documentation' website. The browser's address bar shows the URL '127.0.0.1:4615'. The website has a dark blue header with the title 'JAIC JL/PVx H-60 Data Documentation'. On the left side, there is a navigation menu with the following items: 'Overview', 'Army Black Hawk', 'Navy Sea Hawk', 'Air Force Pave Hawk', and 'Contact Information'. The 'Contact Information' tab is currently selected. The main content area of the page contains the following text: 'For information or feedback regarding this tool, please contact', 'Information Technology Laboratory', 'US Army Engineer Research and Development Center', 'Vicksburg, MS 39180', and 'Email: ERDC\_JAIC@erdcdren.mil'. At the bottom of the page, there is a footer that reads 'Controlled Unclassified Information (CUI)' and 'JAIC PMx Data Documentation Tool - VERSION 1.0'.

### **3 Summary**

DDoT includes a user-friendly graphical user interface (GUI) which provides access to a centralized location to explore the data history, specifications, and documentation for the multiple datasets used to perform vehicle maintenance for helicopters between the Joint services. The ultimate benefit of this tool is that it provides a single, unified, interactive view for data documentation, exploration, and usage for helicopter data.

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