**User Manual**

**Drilling Machine Digital Twin**

**Introduction**

This user manual provides guidance for interacting with a simplified digital twin of a drilling machine, developed using the Unity game engine as part of an engineering internship project at Saipem SA. The digital twin is designed to simulate the functionality of a real-world drilling machine in a virtual environment, enabling users to explore its components and operations in an interactive and intuitive manner.

In addition to interaction, the system allows real-time visualization of sensor data collected from the physical drilling machine. This integration of monitoring and simulation supports a better understanding of machine behavior, facilitates training, and contributes to operational insight in a safe and controlled setting.

**Installation**

* Download the installer (DM-DigitalTwinSetup.exe)
* Run the installer (DM-DigitalTwinSetup.exe) and follow the instructions
* Follow the instructions of the installer:
  + Choose your preferred language
  + Accept the terms and conditions
  + Select the installation directory (default: C:\Program Files\DrillingMachine-DigitalTwin)
  + Choose whether to create a desktop shortcut or not by checking/unchecking the option
  + Click Install
* After installation:
  + Optionally check ”Launch Drilling Machine Digital Twin”
  + Click Finish to close the installer

You can launch the software in two ways:

* From the desktop (if shortcut was created):  
  Double-click the Drilling Machine Digital Twin icon.
* From the Start Menu:  
  Go to Start > Drilling Machine Digital Twin > Open

**Uninstallation**

* Open Control Panel > Programs > Uninstall a program
* Select DrillingMachine-DigitalTwin and click Uninstall  
  Or:
* Use the Uninstall DrillingMachine-DigitalTwin shortcut from the Start Menu

**Commands (AZERTY configuration)**

In Drilling Mode

|  |  |  |
| --- | --- | --- |
| Action | Key (QWERTY) | Key (AZERTY) |
| Return / Settings Menu | ESC | ESC |
| Open Parameter Menu | TAB | TAB |
| Move camera view | Mouse Right Click + Mouse Movement | Mouse Right Click + Mouse Movement |
| Height Navigation | W/S | W/S |
| Zoom in/out | Mouse scroll | Mouse scroll |
| Select Slip Table | 1 | & |
| Select Rotary Table | 2 | é |
| Reset selection | 3 | “ |
| Lock the table to the Kelly Bar | L | L |
| Move selected upward | Arrow Key Up | Arrow Key Up |
| Move selected downward | Arrow Key Down | Arrow Key Down |
| Change Drilling Leader Tower details visibility | V | V |
| Change Terrain Layer visibility | T | T |

In Replay Mode

|  |  |  |
| --- | --- | --- |
| Action | Key (QWERTY) | Key (AZERTY) |
| Return / Settings Menu | ESC | ESC |
| Move camera view | Mouse Right Click + Mouse Movement | Mouse Right Click + Mouse Movement |
| Zoom in/out | Mouse scroll | Mouse scroll |
| Height Navigation | Arrow Key Up/Down | Arrow Key Up/Down |
| Change Drilling Leader Tower details visibility | V | V |
| Change Terrain Layer visibility | T | T |
| Pause/Unpause | Space | Space |

**Mechanics**

**Main Menu**

Upon launching the software, users can choose between two modes: Interactive Mode and Replay Mode, by selecting the corresponding button.

Additionally, users are directed to the Settings Menu, where various configurable options are available. These include:

* Display Settings: Screen mode and refresh rate.
* Navigation Sensitivity: Mouse control, scroll sensitivity, and height navigation sensitivity.
* Graphics Settings: Fog distance and sensor visibility.

Users also have access to the **Credits Menu**, where information regarding the various assets and development tools utilized in the creation of the software is available.

**Interactive Mode**

In InteractiveMode, users directly interact with and control the drilling machine through a set of commands.

To move the drilling machine, the user must select one of the two available tables: the Slip Table or the Rotary Table. When one of the tables is selected it is highlighted in white.

When a table is locked the user can see (when selected)

These tables move along the Kelly bar. When a table is locked (highlighted in orange), the Kelly bar and drill bit move together with the selected table, enabling the drilling operation.

Height navigation is divided into three distinct layers: Surface, Underwater, and Underground. Within the underground layer, users can observe the different subsea soil.

A Parameters Menu is accessible by pressing the TAB key, allowing adjustment of several drilling machine and subsea soil parameters. These include:

* Time speed, enabling acceleration or deceleration of simulated time.
* Drilling velocity.
* Rotation velocity.
* Subsea soil parameters such as the required weight for each layer and their respective depths.

The **Settings Menu** can be accessed at any time by pressing the **ESC** key, which also allows returning to the main menu.

Sensors installed on the drilling machine are interactive and can be selected with the mouse when highlighted in blue. Selecting a sensor displays its data evolution through a line chart.

**Replay Mode**

The Replay Mode enables users to review and monitor sensor data and observe the drilling process and installation over time.

To use this mode, a properly formatted CSV file containing the required data must be provided. The file must include a header row with the following columns:  
Date, DLT\_B, DLT\_C, DM, ST\_Height, RT\_Height, DrillBit\_Height, DrillBit\_Rotation, ST\_Load, ST\_Temp, RT\_Load, RT\_Temp, WeightOnBit, DrillingVelocity, DB\_Torque, Layer.

|  |  |
| --- | --- |
| Variables | Unit/Format |
| Date | dd/MM/yyyy hh:mm |
| DLT\_B, DLT\_C, DM | Value between 0 and 1 |
| ST\_Height, RT\_Height, DrillBit\_Height | meter |
| DrillBit\_Rotation | RPM |
| ST\_Load, RT\_Load, WeightOnBit | tons |
| ST\_Temp, RT\_Temp | °C |
| DrillingVelocity | mm/s |
| DB\_Torque | N.m |
| Layer | Integer between 0 and 5 |

Sensor data visualization is available through line charts similar to those in Interactive Mode. Users can navigate through the timeline using a slider to move forward or backward to specific timestamps.

Replay playback speed can be adjusted, functioning like a video player within a 3D environment.

Subsea soil corresponding to the data provided in the CSV file are also displayed.

The Settings Menu in Replay Mode offers the same configuration options as in Interactive Mode.

**License**

**Credits**

Name: Drilling Machine Digital Twin

Developed by: Jérôme Lin

Assets:

* Sand texture (<https://europe1.discourse-cdn.com/unity/original/3X/e/f/efe9ca5c1dbe809100073029c8549e13e8021ff1.jpeg>)
* "Skybox Series Free" by Avionx (<https://assetstore.unity.com/packages/2d/textures-materials/sky/skybox-series-free-103633>)
* "Simple Water Shader URP" by IgniteCoders (<https://assetstore.unity.com/packages/2d/textures-materials/water/simple-water-shader-urp-191449>)

Game Engine

* Unity (https://unity.com) Version 6000.1.6f1

Development Tools:

* Unity (<https://unity.com>) – Game engine
* Blender (<https://blender.org>) – 3D modeling
* Git & GitHub – Version control
* Project Repository on GitHub (<https://github.com/Starlight-25/DrillingMachine-DigitalTwin>)
* Adobe Photoshop (<https://www.adobe.com/fr/products/photoshop.html>) – Sprite design
* Adobe Illustrator (<https://www.adobe.com/fr/products/illustrator.html>) - Icon design

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