User Manual
Drilling Machine Digital Twin
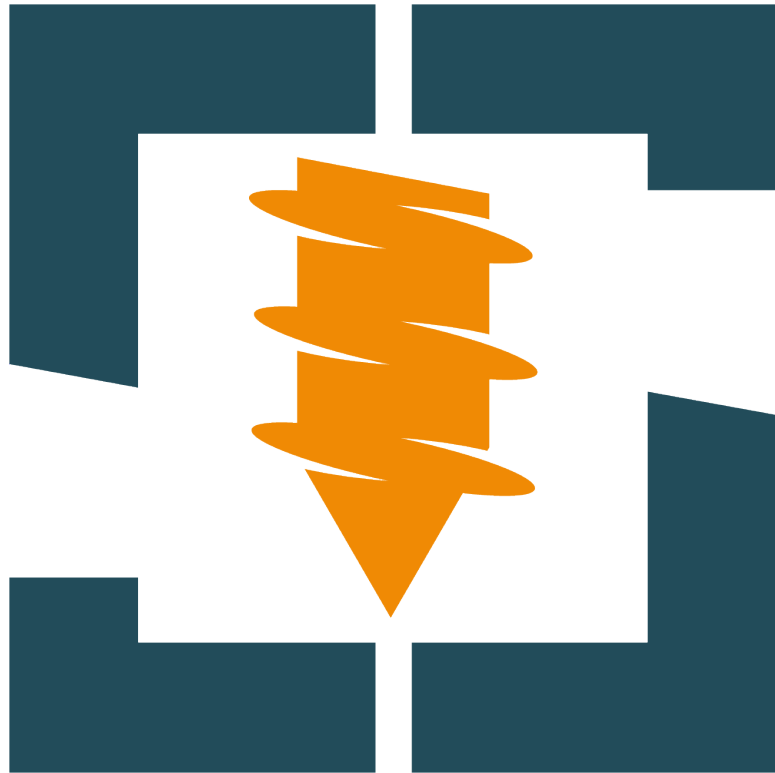
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Summary

1 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.

2 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

3 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

4   Commands

4.1   In Drilling Mode

Action	Key
Return / Settings Menu	ESC
Open Parameter Menu	Tab
Move camera view	Mouse Right Click + Mouse Movement
Zoom in/out	Mouse scroll
Select Slip Table	1
Select Rotary Table	2
Reset selection	'
Move selected upward	W
Move selected downward	S
Change Drilling Leader Tower details visibility	V
Change Terrain Layer visibility	T

4.2   In Replay Mode

Action	Key
Return / Settings Menu	ESC
Move camera view	Mouse Right Click + Mouse Movement
Zoom in/out	Mouse scroll
Change Drilling Leader Tower details visibility	V
Change Terrain Layer visibility	T

5 Mechanics

5.1 Main Menu

Upon launching the software, users can choose between two modes: Drilling 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.

5.2 Drilling Mode

In Drilling Mode, 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. These tables move along the Kelly. When a table is locked, the Kelly 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 terrain strata.

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

- Time speed, enabling acceleration or deceleration of simulated time.

- Drilling velocity.

- Rotation velocity.

- Terrain layer 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.
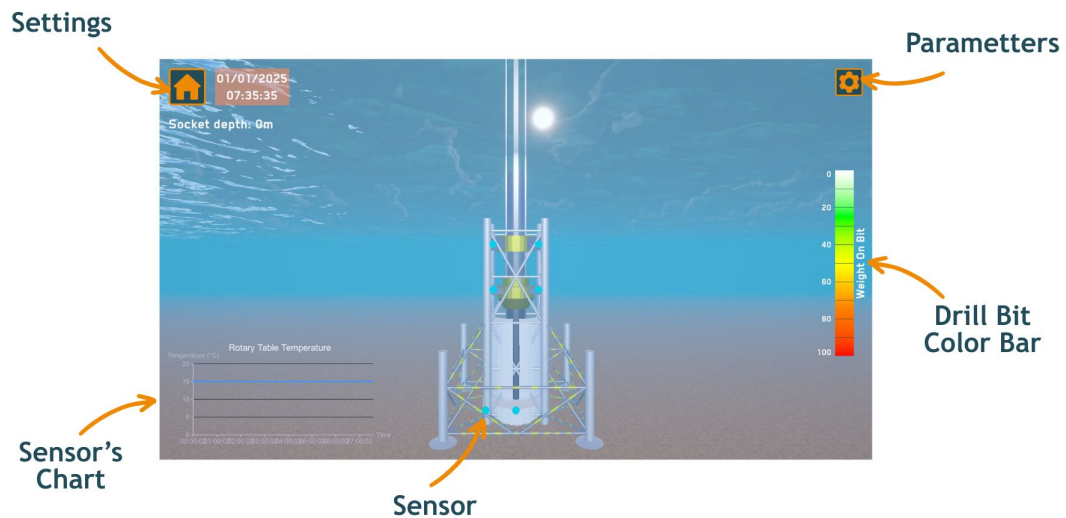
5.3 Replay Mode

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.

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

Terrain layers 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 Drilling Mode.
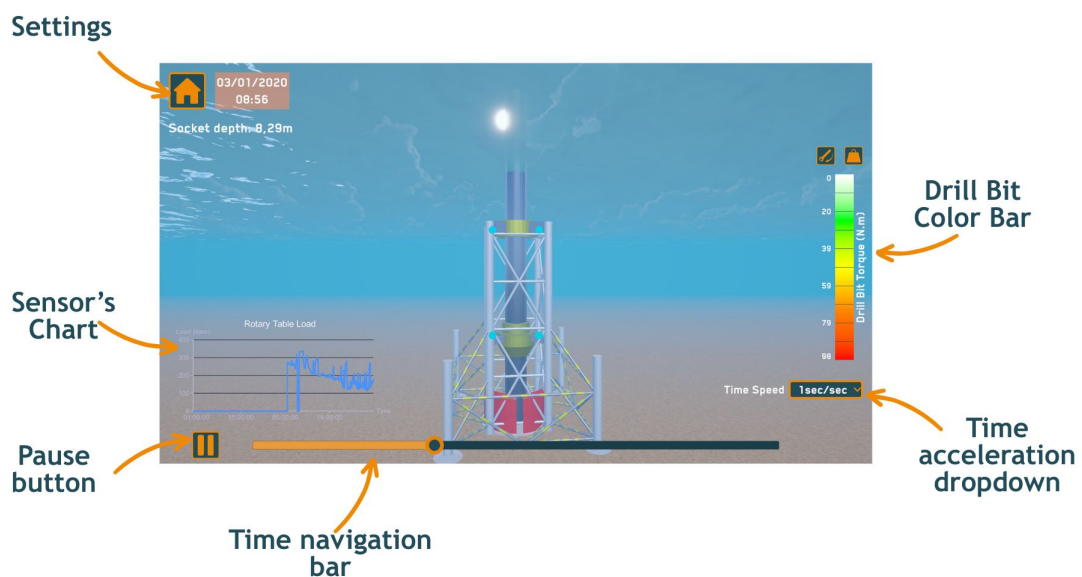
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