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 supervised by Rudy Mauge. 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 (QWERTY)**	**Key (AZERTY)**
Return / Settings Menu	ESC	ESC
Open Parameter Menu	Tab	Tab
Move camera view	Mouse Right Click & Movement	Mouse Right Click & Movement
Height Navigation	W/S	Z/S
Zoom in/out	Mouse scroll	Mouse scroll
Select Slip Table	1	&
Select Rotary Table	2	é
Reset selection	3	”
Move selected upward	Arrow Key Up	Arrow Key Up
Move selected downward	Arrow Key Down	Arrow Key Down
Change DLT* details visibility	V	V
Change Terrain Layer visibility	T	T

4.2 In Replay Mode

Action	**Key (QWERTY)**	**Key (AZERTY)**
Return / Settings Menu	ESC	ESC
Move camera view	Mouse Right Click & Movement	Mouse Right Click & Movement
Height Navigation	W/S	Z/S
Zoom in/out	Mouse scroll	Mouse scroll
Change DLT* details visibility	V	V
Change Subsea soil visibility	T	T

*DLT: Drilling Leader Tower

5 Mechanics

5.1 Main Menu

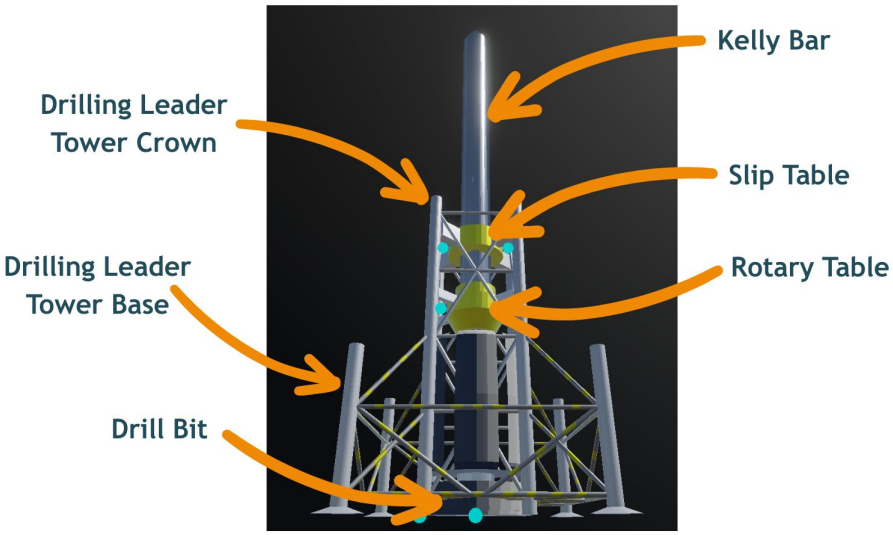
Upon launching the software, users can choose between two modes: Interactive Mode and Replay Mode, by selecting the corresponding button.

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.

5.2 Drilling Machine Structure



5.3 Drilling Mode

In Interactive 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. When one of the tables is selected it is highlighted in white.

When a table is locked, it is highlighted in orange upon selection. In this state, the Kelly bar and drill bit move together with the selected table, enabling the drilling operation. When a table is unlocked (highlighted in white), it moves independently along the Kelly bar when the user triggers movement using the associated keys. Note that if both tables are locked simultaneously, neither of them will be able to move.

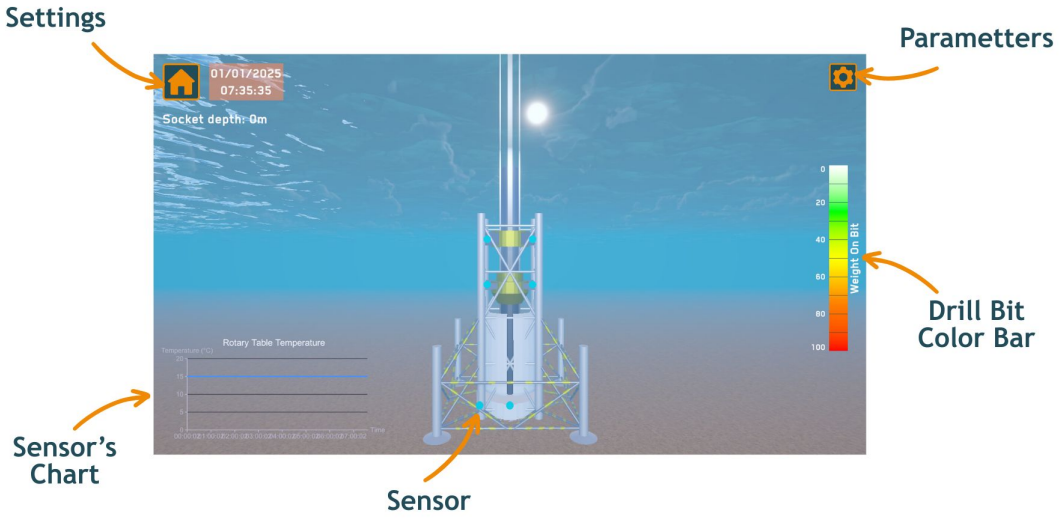
Height navigation is divided into three distinct layers: Surface, Underwater, and Underground. Within the underground layer, users can observe the different terrain strata.

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



5.4 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.

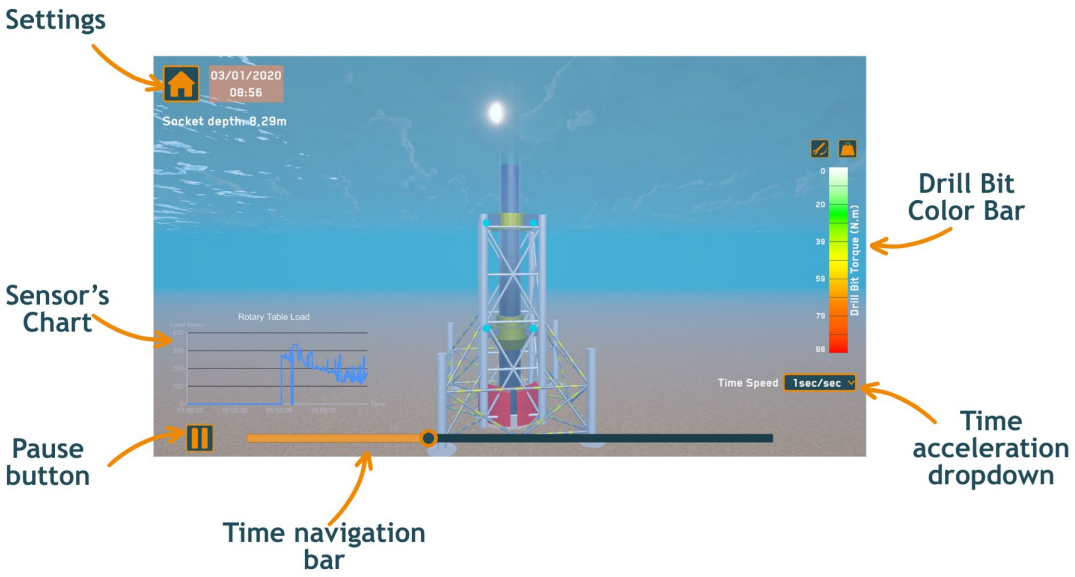
Variables	**Unit/Format**
Date	dd/MM/yyyy hh:mm
DLT_B, DLT_C, DM	Value between 0 and 1
DrillBit_Rotation	RPM
ST_Load, RT_Load	tons
ST_Temp, RT_Temp	°C
DrillingVelocity	mm/s
DB_Torque	N.m
Layer	Integer between 0 and 5

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.

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.



6 Step-by-step example

Start the Interactive mode

- Launch the Digital Twin
- Click on Interactive Mode

Change the time acceleration

- Go to the parameter menu
- Change the Time Speed to “30min/sec”

Drill with the slip table

- Select the slip table (press 1)
- Move the slip table (press Arrow key Down)

Drill with the rotary table

- Unlock the slip table (press L)
- Select the rotary table (press 2)
- Lock the rotary table (press L)
- Move the rotary table (press Arrow key Down)

Move the Drilling Machine Upward

- Move the rotary table (press Arrow key Up)

See the sensors values

- Click on the Rotary Table sensor (click on the blue on one of the blue dots on the rotary table)

Quit the application

- Navigate to the Settings Menu (press ESC)
- Click the quit button to return to the main menu
- Click the quit button to close the application

7 License

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