



Project. RELAR (REmote Learning and examination based on
AR)

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Output 02 Task 5

Scenario 1



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1. Scenario-specific info

1.1 Scenario 1: Shipyard Technician

1.1.1 Lesson Plan

Title of Scenario: <i>Engineering Dynamics / Tractive force against friction</i>	
Partner Leading Scenario	Malta College of Arts, Science & Technology
Partner Supporting Scenario	Aegean University
Scenario	Shipyard Technician
Programme	Diploma in Marine
Subject	Engineering Dynamics
EQF Level	ME-DME-4.1A / Level 4
Title of Lecture:	Tractive force against friction
Time/Duration	3 sessions of 3 hrs each
Aim (s) • To investigate the effect on tractive force due to friction between surfaces on a horizontal and an inclined plane. • To investigate the effect of varying angles of the incline	

- To investigate the effect of varying coefficient of friction between surfaces.

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Objective (s)

To determine the friction coefficients on an inclined surface. Demonstrate the effect of varying angles of incline. Eventually finding the point of equilibrium of forces on an incline due to frictional forces and the transition from static to dynamic friction

Finally verifying the correlation between the calculated and experimental values for friction.

Resources

Gunl TM225 - Friction on an incline plane experimental setup

This equipment is equipped with multiple varying variables, mainly:

- Testing at different angles of incline of the plane
- Testing different frictional coefficient materials.
- Testing at different load forces



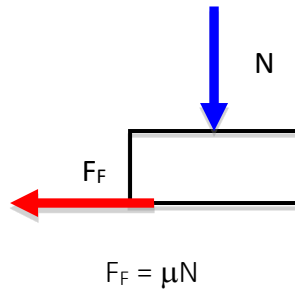
HMT AR Headset to be used to demonstrate the capability of remote learning by the user with a closed loop feedback to the accessor.

During the session the



Introduction of Lecture (Duration: 120 minutes)

Friction is the external force that always acts to oppose motion, due to contact with solid, liquids and / or gases. Example friction force between the car wheels and the road helps it move forward. In real cases the effect of friction must be taken into consideration



Where F_F is the frictional force due to force N

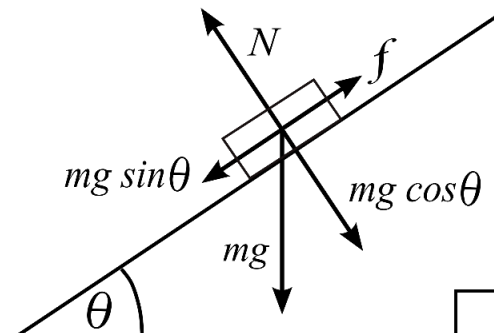
N force being exerted on the box

μ Coefficient of friction

Thus when a body is accelerated, the force causing acceleration is the **NET FORCE**.

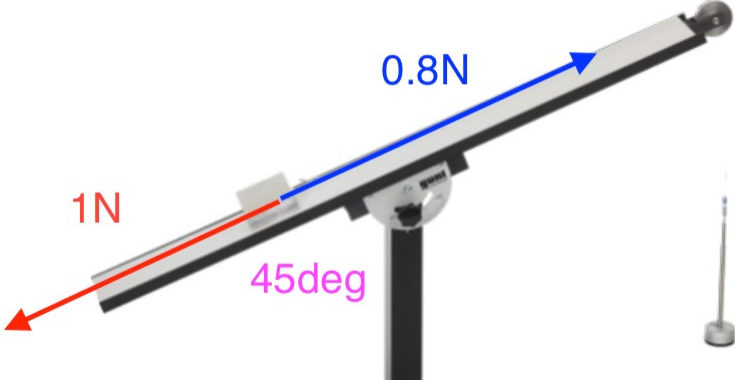
$$\text{Net Force} = \text{Applied Force} - \text{Friction Force}$$

Friction on an incline will vary due to the varying component of the Normal force pushing the object on the incline as seen in the figure below.



Steps in developing Lecture including methodology as well as time allocated per activity

Task/Activity	Time allocated
Explanation of the theory of linear friction	20 minutes
Explanation of the theoretical effect of friction, linearly and on an incline	20 minutes
Present the students with the friction plane and various materials and loading forces to experiment with.	20 minutes
Setup the experiment with the incline plane	
Input the varying parameters such as: • mass • angle • coefficient parameters through voice command and/or using input HMT AR systems (<i>To be confirmed by the ICT team</i>). The application will then show these values at the side of the screen or superimposed	30 minutes

		
	Start experimenting with different materials on a flat plane to determine the frictional coefficient according to the instructions given on the Headset screen	30 minutes
	Vary the inclined angle of the friction plane to determine the effect on the frictional forces according to the Headset screen instructions	30 minutes
Conclusion of Lecture (Duration: 120 minutes total) Students will be able to distinguish the effect of the varying angle of the incline on the friction force acting against the tractive effort. This can be thus compared to the values that they are given in their headsets. Thus, the students will be able to demonstrate that the friction coefficient can be attained experimentally and thus compare the results attained to the values inputted by the lecturer on the Relar Headset, in the answers section. Students will be made thus aware of the relationship between different frictional material and their respective coefficients.		

1.1.2 System Architecture

For the scenario to be applied for the HMT-1, a custom “launcher app” was developed. The app is to do the following:

- Accept pre-defined voice commands.
- Scan a single QR code.
- Load data from a Google Sheet.
- Join a ZOOM video call.

Digital Workflow

As discussed in several RELAR meetings, the concept of a digital workflow is highly recommended for the application of this scenario with AR. What is understood by the term digital workflow, in this use case, are “step-by-step” instructions presented in a digital manner that a learner can follow to achieve a specific learning goal. It is highly recommended that the duration of the activity with the HMT-1 does not last very long to reduce eye strain and fatigue caused by prolonged use (Waard et al., 2020).

- *QR Code Scanning*

The idea for QR code scanning is for the app to be able to identify which learning scenario to load. The QR code has an embedded URL redirecting to the Google Sheet.

- *Public Resource Repository*

A resource repository allowing lecturers to create virtually unlimited learning scenarios without any intervention from the developer is highly recommended. This can be achieved with minimal complexity but using a pre-existing platform that lecturers are comfortable using, such as Moodle. Moodle is licensed as free software (GNU General Public License, 1999) used by

many universities and vocational institutions around the world and can easily be used as a resource repository. Lecturers can be allowed to create their own accounts and have access to the public

resources already available and add their own. Restrictions to account creation can be applied to email addresses containing the .edu prefix.

- *Resources*

It is recommended that text in the resources should be a minimum of 18px – 24px to be easily readable by the user (Introduction to Designing for the RealWear HMT-1 and HMT-1Z1, 2018). Any images used for the HMT-1 should have a resolution of 854 x 480 pixels (“RealWear HMT-1 Data Sheet,” 2018). **Error! Reference source not found.** shows a sample image that can be used as part of the digital workflow.

- *Video Recording*

Triggering video recording can be automated the moment a QR code is scanned. A configuration file containing a Boolean (True/False) value can be set in the resource repository and set to off by default. A lecturer can opt to use video recording when students are using the device for assessment purposes.

- *Video Calling*

Video calling a pre-defined person can be triggered by clicking the device’s “action” button. The person whom to call and whether this feature is active or not should also be set in the configuration file mentioned in the previous section.

1.1.3 Proposed System Manual

The system is very easy to use both from a student's perspective but also from a lecturer's perspective.

- *Setting Up The Application*

Step 1 (Optional Step): Transfer the APK file on the device

Step 2: Register for Google Develop account.

Step 3: Obtain API key,

Step 4: Create a config file with the API key on the device as follows:

API_KEY: NULL

- *Creating A New Learning Scenario*

Step 1: Create Google Sheet from template.

Step 2: Include the links to the resources.

Step 3: Copy the URL of the Google Sheet and use it to generate a QR code.

Step 4: Print the QR code or make it available digitally during the lecture.

- *Using The Container Application*

Step 1: Switch on the application by calling the application name.

Step 2: Start the application.

Step 3: Scan QR code

Step 4: Navigate through the resources by using voice commands.

Optional Step: Call the respective lecturer by speaking “*Call Lecturer*”.

1.1.4 Wearing the HMT device

Step 1: The HMT-1 can be positioned in a way that the display and camera are placed on the left or right side of the head. It is suggested that the screen is displayed in front of the user’s dominant eye to provide better visuals and more comfortable use. . Eye dominance refers to the eye that provides a slightly greater degree of input to the visual part of your brain and more accurately relays information about the location of objects. Hence, before wearing the HMT device, the user should determine his/her eye dominance. There are several simple tests online, which can help the user determine his/her dominant eye. One simple test is as follows:

1. Extend your arms out in front of you and create a triangular opening between your thumbs and forefingers by placing your hands together at a 45-degree angle (see animation).
2. With both eyes open, centre this triangular opening on a distant object — such as a wall clock or doorknob.
3. Close your left eye.
4. If the object stays centred, your right eye (the open one) is your dominant eye. If the object is no longer framed by your hands, your left eye is your dominant eye.

Step 2: Once the dominant eye is identified, the HMT’s display and camera were adjusted accordingly. For the shipyard technician scenario, no head mounting accessories such as hardhat, caps or other accessories were used.

Subsequently, the lecturer was asked to put on the HMT. The head strap was adjusted and positioned along the temple area. Following this, the display screen was adjusted to ensure an optimal fit for the user.

Step 3: Once the HMT was positioned and adjusted over the user’s head, the device was switched on by pressing the button located on the same side of the display monitor. Once the screen is on, the user carried out final fine-tuning to have clear visibility of the home screen.

1.1.5 Scenario Validation

This section aims to present a number of photos showing the testing of the 'Shipyard Technician' scenario. A laptop of the side shows what the user is seeing through the HMT-1 device. Figure 4 – 8 shows the lecturer giving specific commands to the HMT-1.



Figure 1: Physical setup with the QR code.



Figure 2: The lecturer determining his dominant eyes so the display screen is positioned in front of the user's dominant eye to provide better visuals and more comfortable use.



Figure 3: The user adjusting the HMT's display and camera



Figure 4: Voice Command to access the main menu: My Programs



Figure 5: Voice Command to access the Relar Scanner app: Relar Scanner 2



Figure 6: Voice Command to load lab sheet 1. Lab sheet 1 is a pdf document, which contains information on the laboratory experiment to assist the students explore the scientific concept of friction.



Figure 7: Voice Command to adjust the resolution: Zoom Level 3 and freeze window are two commands to zoom further into the document and lock the screen respectively.



Figure 8: The user carrying out the experiment using the physical setup by going through the instructions displayed on the HMT-1 device.



Figure 9: Another photo of the user carrying out the experiment.

The following are the steps that will be followed during the 30-minute experimental session using the HMT-1:

1. Release the Graduated angle screw (4).
2. Setup the inclined plane (1) horizontally for this experiment.
3. Use a spirit level to confirm that the inclined plane is truly horizontal.
4. Place the sliding object (6) on the horizontal plane. Four friction surfaces combinations are provided:
 - Polypropylene/Resopal
 - Steel/Resopal
 - Aluminium/Resopal
 - Brass/Resopal
5. Start your experiment with the Polypropylene
6. Attach the weights hanger (7) using the rope provided over the pulley (5) and with the sliding object (6).
7. Load the weight hanger (7) with the weights provided until the sliding object (6) tends to start moving.
8. Note down the weight (force) of the load and compare it to the experimental results provided.
9. Repeat the experiment with the remaining three material combinations

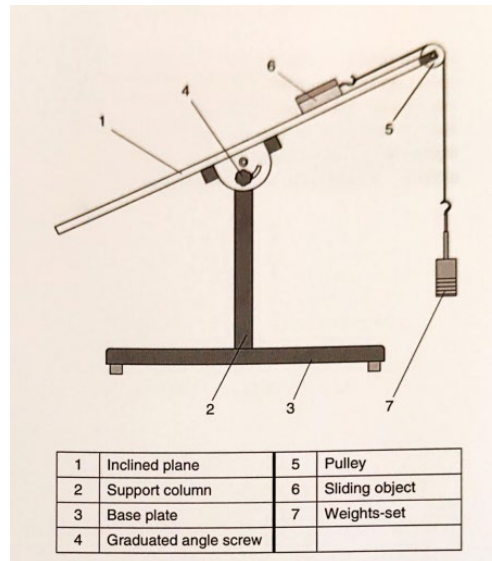


Figure 10: Diagram illustrating the different parts of the equipment used.



Figure 11: Voice Command to go back to the main menu and access the tutorial video: Control Window, Navigate back, Inclined plane video

Figure 12 shows the user recording the session whilst carrying out the experiment. Such session allows the students to record themselves carrying out the experiments. Such tool is useful for the lecturer to eventually assess the students' knowledge on the subject.

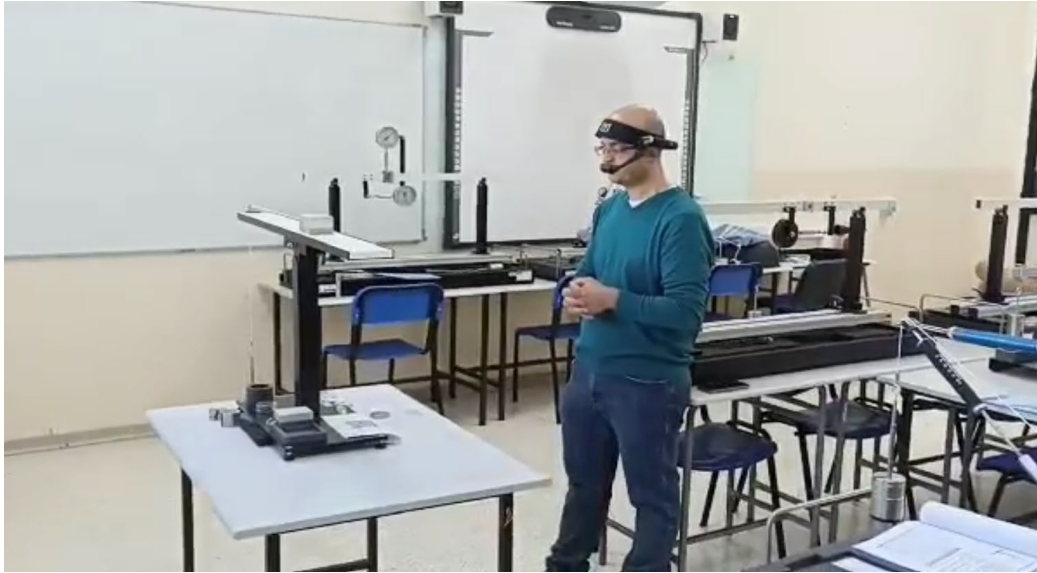


Figure 12: Voice Command to start recording the session from the HMT-1's camera. The commands given are 'start recording', 'record video' and 'stop recording'.