Scilab case study project on

Xcos-Based Implementation of Input Shaping Control for Overhead Crane Swing Reduction

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Abstract

Overhead cranes are widely used for industrial material handling, but the suspended payload may swing like a pendulum during trolley motion. This residual swing reduces positioning accuracy, increases settling time, and may create safety issues. This case study implements input shaping control for overhead crane swing reduction using Scilab and Xcos. The crane payload is modelled as a simplified pendulum system, where trolley acceleration acts as the input and rope angle represents the swing response. Three input cases are compared: unshaped input, standard Zero Vibration input shaping, and modified Zero Vibration input shaping for non-zero initial swing conditions. Scilab is used to generate acceleration and speed input profiles, while Xcos is used as the main simulation environment for rope angle and rope angular speed responses. This case study performs a partial replication of the reference paper, focusing strictly on the Scilab/Xcos time-domain simulation cases, while the hardware implementation and analytical parameter loops are kept out of scope. Two simulation cases based on the reference IEEE paper are implemented, and the obtained responses are analysed for swing reduction performance.

1. Introduction

Overhead cranes are widely used in industries, workshops, warehouses, ports, and manufacturing plants for lifting and transporting heavy loads. A typical overhead crane consists of a trolley moving along a horizontal path and a payload suspended by a rope or cable. When the trolley accelerates or decelerates, the suspended payload may swing like a pendulum due to inertia.

This payload swing is an important problem in crane operation. If the swing remains after the trolley motion is completed, the operator must wait for the load to settle before placing it accurately. This increases settling time, reduces productivity, and may also create safety risks when heavy loads are handled near workers, machines, or other structures.

One practical method to reduce such oscillations is input shaping. In this method, the original acceleration command is not applied directly to the crane. Instead, it is modified using delayed and scaled versions of the same command so that the residual vibration of the payload is reduced. A commonly used method is the Zero Vibration input shaper, which is generally designed for systems starting from rest.

However, in practical crane operation, the payload may already have an initial swing due to previous motion, external disturbance, or manual handling. Under such non-zero initial conditions, a standard ZV shaper may not provide the best swing reduction. Therefore, modified input shaping methods are needed to account for the initial rope angle and rope angular speed.

This case study implements input shaping control for overhead crane swing reduction using Scilab and Xcos. Scilab is used to generate acceleration and speed input profiles, while Xcos is used to model the crane swing response. The study compares unshaped input, standard ZV-shaped input, and modified ZV-shaped input for two simulation cases based on the reference IEEE paper.

This case study performs a partial replication of the reference paper, focusing strictly on the Scilab/Xcos time-domain simulation cases, while the hardware implementation and analytical parameter loops are kept out of scope. The work is limited to input generation, Xcos modelling, and response comparison.

2. Problem Statement

During the operation of an overhead crane, the trolley moves horizontally while the payload is suspended by a rope. When the trolley accelerates or decelerates, the suspended load experiences inertia and begins to swing. This swing is similar to the motion of a pendulum. If the swing remains after the trolley motion is completed, the payload takes more time to settle at the required position. This reduces the efficiency of crane operation and may also affect safety.

In many basic input shaping methods, it is assumed that the payload is initially at rest before the trolley starts moving. However, this condition may not always be true in practical situations. The payload may already have an initial angle or angular velocity due to previous motion, external disturbance, or manual handling. When such non-zero initial conditions are present, a standard input shaper may not suppress the residual swing effectively.

The problem considered in this case study is to reduce the residual swing of an overhead crane payload under non-zero initial conditions. For this purpose, the crane payload is represented using a simplified pendulum-based dynamic model. The trolley acceleration is taken as the input to the system, and the rope angle and rope angular speed are taken as the main output responses.

This case study compares three input conditions: unshaped input, standard Zero Vibration input shaping, and modified Zero Vibration input shaping for non-zero initial conditions. Scilab is used to generate the acceleration and speed input profiles for two simulation cases. These input profiles are then applied to the Xcos model of the overhead crane system. The output responses are compared to evaluate the effectiveness of each input method in reducing residual payload oscillation.

The main aim of the project is to implement the simulation part of the reference IEEE paper using Scilab and Xcos, with Xcos as the primary tool for dynamic response simulation. The hardware experimental part, phasor diagrams, and additional parameter studies from the reference paper are not implemented in this case study.

3. Basic Concepts Related to the Topic

3.1 Overhead Crane Payload Swing

An overhead crane usually consists of a trolley and a payload suspended from it by a rope or cable. When the trolley moves horizontally, the suspended payload may swing because of inertia. This motion is similar to a pendulum. If the trolley suddenly accelerates or decelerates, the payload may lag behind the trolley and continue oscillating even after the trolley motion is completed.

The swing of the payload is represented using the rope angle, denoted by φ. When φ is zero, the rope is vertical and the payload is steady. When φ is not zero, the payload is displaced from the vertical position. The rate of change of this angle is called rope angular velocity and is denoted by $\dot{\varphi}$.

In crane control, reducing φ and $\dot{\varphi}$ after the motion is completed is important because it helps the payload settle faster and improves positioning accuracy.

3.2 Simplified Pendulum Model

For this case study, the payload is treated as a simple pendulum. The rope is assumed to be massless and inextensible, and the payload is treated as a concentrated mass at the end of the rope. For small rope angles, the crane swing dynamics can be simplified using a linear pendulum model.

The natural frequency of the pendulum is given by

$$\boldsymbol{\omega} = \sqrt{\frac{\boldsymbol{g}}{\boldsymbol{L}}} \qquad \textbf{(1)}$$

where $\boldsymbol{\omega}$ is the natural frequency, $\mathbf{g}$ is the acceleration due to gravity, and $\mathbf{L}$ is the rope length. In this case study, the trolley acceleration is considered as the input to the crane system. The relation between trolley acceleration and rope angle can be written in time-domain form as

$$\ddot{\boldsymbol{\phi}} = -\frac{\mathbf{1}}{\boldsymbol{L}}\boldsymbol{a} - \frac{\boldsymbol{g}}{\boldsymbol{L}}\boldsymbol{\phi} \qquad \textbf{(2)}$$

where $\boldsymbol{a}$ is the trolley acceleration, $\boldsymbol{\varphi}$ is the rope angle, and $\ddot{\boldsymbol{\varphi}}$ is the rope angular acceleration.

This equation shows that payload swing depends on both the trolley acceleration and the restoring effect due to gravity. The first term represents the effect of trolley acceleration on the payload, while the second term represents the natural pendulum restoring action.

3.3 Input Shaping

Input shaping is a vibration reduction method used in systems that tend to oscillate. Instead of applying the original input command directly to the system, the input is modified by combining delayed and scaled versions of the same command. The shaped input is designed so that the vibration generated by one part of the command is reduced by the delayed part of the command. The general form of a shaped input can be written as

$$\tilde{a}(t) = \sum_{i=1}^{n} A_i \, a(t - t_i) \tag{3}$$

where **$\tilde{a}(t)$** is the shaped acceleration input, **$a(t)$** is the original acceleration input, **A_i** represents the amplitude of each impulse, and **t_i** represents the time delay of each impulse.

In simple terms, input shaping does not directly apply braking or feedback correction to the payload. Instead, it modifies the command before it enters the system so that the system naturally produces less residual vibration.

3.4 Zero Vibration Input Shaper

A Zero Vibration input shaper is a common input shaping method used to reduce residual oscillation. For an undamped or lightly damped system, a basic two-pulse ZV shaper divides the command into two parts. The second part is applied after a delay related to the natural frequency of the system.

For the standard two-pulse ZV shaper used in this case study,

$$A_1 = 0.5, \quad A_2 = 0.5 \tag{4}$$

The second pulse is delayed by half the natural period of oscillation. This delay is selected so that the vibration caused by the second pulse cancels the vibration caused by the first pulse.

The standard ZV shaper works well when the system starts from rest. However, it may not give the best result if the payload already has some initial swing before the trolley motion starts.

3.5 Non-Zero Initial Conditions

In many theoretical vibration control problems, the system is assumed to start from rest. This means the initial rope angle and initial rope angular velocity are both zero. However, in practical crane operation, this may not always be true. The payload may already be swinging due to previous motion, external disturbance, or manual handling.

Non-zero initial conditions mean that the payload has an initial rope angle or initial rope angular velocity before the trolley command begins. These conditions are represented as

$$\boldsymbol{\phi}(\mathbf{0}) \neq \mathbf{0} \quad \textbf{or} \quad \dot{\boldsymbol{\phi}}(\mathbf{0}) \neq \mathbf{0} \tag{5}$$

When non-zero initial conditions are present, the payload already has some oscillation. Therefore, the input shaper must not only reduce the vibration caused by the trolley command but also account for the swing that already exists at the beginning of motion.

3.6 Modified Input Shaping for Non-Zero Initial Conditions

The modified input shaper considered in this case study is based on the reference paper and is intended to handle non-zero initial swing conditions. In this method, the input shaper parameters are adjusted based on the initial rope angle, initial rope angular velocity, and the acceleration input profile.

This case study compares the following three cases:

- **Unshaped input**: the original acceleration command is applied without input shaping.
- **Standard ZV-shaped input**: the original acceleration command is shaped using the standard two-pulse ZV shaper.
- **Modified ZV-shaped input**: the acceleration command is shaped using modified shaper parameters that account for non-zero initial swing conditions.

By comparing the rope angle and rope angular velocity responses for these three cases, the effectiveness of the modified input shaper can be evaluated.

4. Scope of Implementation

The reference paper presents an input shaping approach for reducing residual payload oscillations in an overhead crane system under non-zero initial conditions. The complete paper includes mathematical modelling, input shaper design, simulation studies, phasor-based explanation, jerk-limit analysis, and hardware validation. In this case study, the work is limited to the simulation-based implementation using Scilab and Xcos. The main objective is to reproduce the input profiles and compare the crane swing responses for two simulation cases.

Table 1. Scope of implementation with respect to the reference IEEE paper

Reference Paper Element	Implementation in This Case Study	Purpose / Output
Overhead crane swing model	Implemented in Xcos using a simplified pendulum equation	Forms the dynamic model for rope angle and rope angular speed response.
Input shaping method	Implemented using delayed and scaled acceleration commands	Generates shaped inputs for reducing residual oscillations.
Standard ZV shaper	Implemented as the baseline input shaping method	Used for comparison with the unshaped input and modified ZV-shaped input.
Modified ZV shaper	Implemented using the shaper parameters reported in the paper	Used to handle non-zero initial swing conditions.
Case 1 simulation	Implemented using the first set of initial conditions and input parameters	Produces acceleration, speed, rope angle, and rope angular speed plots.
Case 2 simulation	Implemented using the second set of initial conditions and input parameters	Produces the same response comparisons for the second case.
Input profile comparison	Generated in Scilab	Gives four plots showing acceleration and speed inputs for both cases.
Crane response comparison	Generated in Xcos	Gives four plots showing rope angle and rope angular speed responses.

Xcos model diagrams	Prepared separately for Case 1 and Case 2	Shows the block-level implementation of the crane dynamic model.
Phasor explanation	Not reproduced	Excluded because the present work focuses on direct time-domain simulation response.
Jerk-limit analysis	Not reproduced	Excluded because it requires a separate parameter-sweep study beyond the selected simulation cases.
Hardware validation	Not reproduced	The physical crane setup is not developed; validation is limited to simulation results.

5. Flowchart

The flowchart shows the overall methodology followed in this case study. The process starts with defining the crane and simulation parameters, followed by selecting the simulation case and assigning the corresponding non-zero initial conditions. The required input profiles are generated in Scilab and then transferred to the Xcos model for dynamic simulation. The rope angle and rope angular speed responses are extracted and compared for unshaped, standard ZV-shaped, and modified ZV-shaped inputs. The same procedure is repeated for both simulation cases, and the final input and response plots are compiled for analysis.

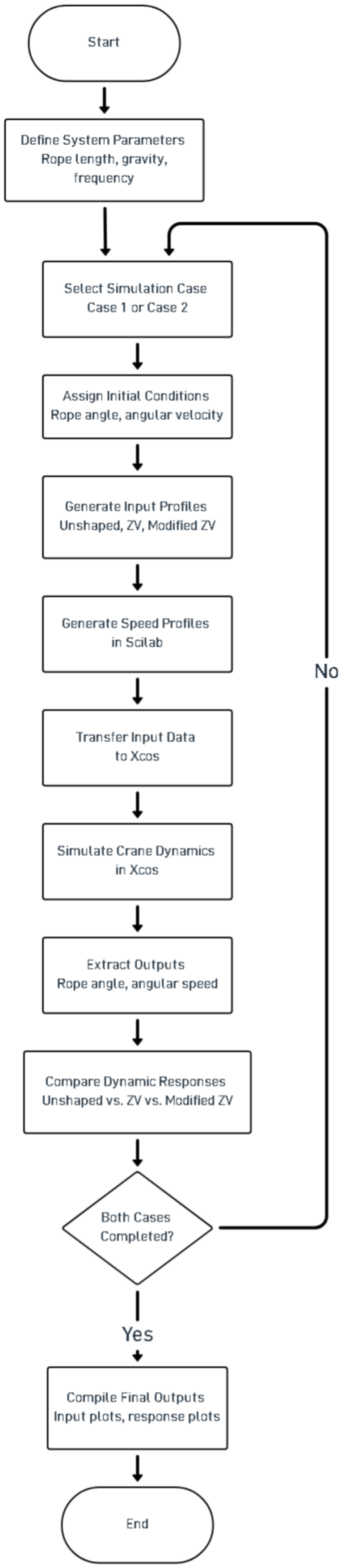

Figure 1. Flowchart of the Scilab/Xcos-based implementation methodology

6. Software/Hardware Used

- Operating System: Windows 11
- Software: Scilab 2026.1.0 and Xcos
- Hardware: Personal laptop/PC with standard processing capability

No physical overhead crane setup, sensors, or data acquisition system was used in this case study. The crane motion, input shaping process, and payload swing response are represented using Scilab simulation logic and Xcos block modelling.

7. Procedure of Execution

The execution of the case study files can be carried out as follows:

1. Open Scilab 2026.1.0.
2. Set the working directory to the Scilab_codes folder inside the main project folder.
3. Run the Case 1 execution file: **run_case1.sce**
4. The file run_case1.sce executes the Case 1 input generation script. It generates the unshaped, standard ZV-shaped, and modified ZV-shaped acceleration inputs, along with the corresponding speed profiles. The required workspace data is then loaded for Xcos simulation.
5. After the Case 1 input data is loaded, the Case 1 Xcos model opens automatically from the Xcos folder.
6. Simulate the Case 1 Xcos model. The model uses the generated acceleration inputs to compute the rope angle and rope angular speed responses of the overhead crane payload.
7. Return to the Scilab_codes folder and run the Case 2 execution file: **run_case2.sce**
8. The file run_case2.sce generates the Case 2 input profiles, loads the required workspace data, and opens the Case 2 Xcos model.
9. Simulate the Case 2 Xcos model. The model produces the corresponding rope angle and rope angular speed responses for the second set of initial conditions.
10. The generated Scilab plots show the acceleration and speed input profiles for both simulation cases. The Xcos outputs show the rope angle and rope angular speed responses for the unshaped input, standard ZV-shaped input, and modified ZV-shaped input.

8. Results

8.1 Simulation Parameters

The important parameters used for the two simulation cases are listed in Table 2. The same overhead crane model is used for both cases, but the initial conditions and modified shaper parameters are different.

Table 2. Simulation parameters used for Case 1 and Case 2

Parameter	Case 1	Case 2	Unit
Rope length, L	0.51	0.51	m
Acceleration due to gravity, g	9.81	9.81	m/s^2
Initial rope angle, $\varphi(0)$	-15	10	degree
Initial rope angular speed, $\dot{\varphi}(0)$	50	0	degree/s
Maximum acceleration, amax	2.5	2.5	m/s^2
Maximum velocity, vmax	5	5	m/s
Standard ZV amplitude, A_1	0.5	0.5	-
Standard ZV amplitude, A_2	0.5	0.5	-
Standard ZV delay, t_2	0.7163	0.7163	s
Modified ZV amplitude, A_1	0.1683	0.3238	-
Modified ZV amplitude, A_2	0.8317	0.6762	-
Modified ZV delay, t_2	1.0631	0.7559	s

The parameter table shows that both cases use the same crane system and standard ZV shaper. The difference between the two cases is mainly in the initial swing condition and the modified ZV shaper parameters. These values are used to generate the input profiles in Scilab and to simulate the dynamic response in Xcos.

8.2 Case 1 Acceleration Input Comparison

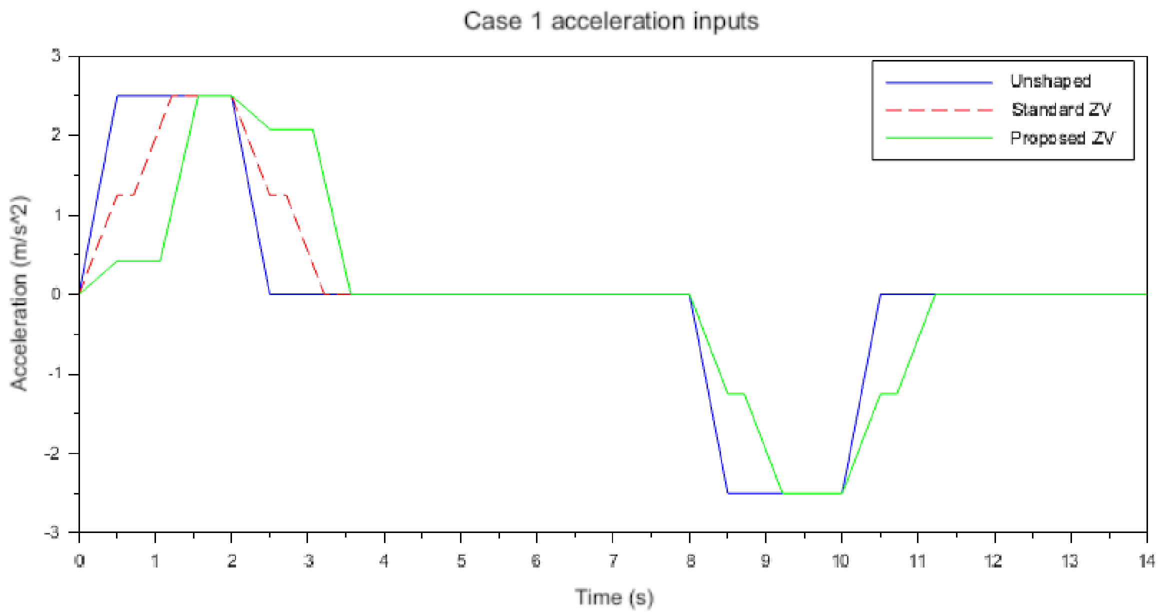

Figure 2. Case 1 acceleration input comparison for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 2 shows the acceleration input profiles generated for Case 1. The plot compares three trolley acceleration commands: unshaped input, standard ZV-shaped input, and modified ZV-shaped input. The unshaped input is the original acceleration command applied without any vibration reduction method.

The standard ZV-shaped input is formed by dividing the original command into two delayed components with equal amplitudes. This helps reduce residual vibration when the system starts from rest. However, in Case 1, the payload has both a non-zero initial rope angle and a non-zero initial rope angular speed. Therefore, the modified ZV-shaped input uses different amplitude and delay values to account for the initial swing condition.

This plot is important because these acceleration profiles are the actual inputs supplied to the Xcos crane model. The difference in input shaping directly affects the rope angle and rope angular speed responses obtained in the later simulation results.

8.3 Case 1 Speed Reference Comparison

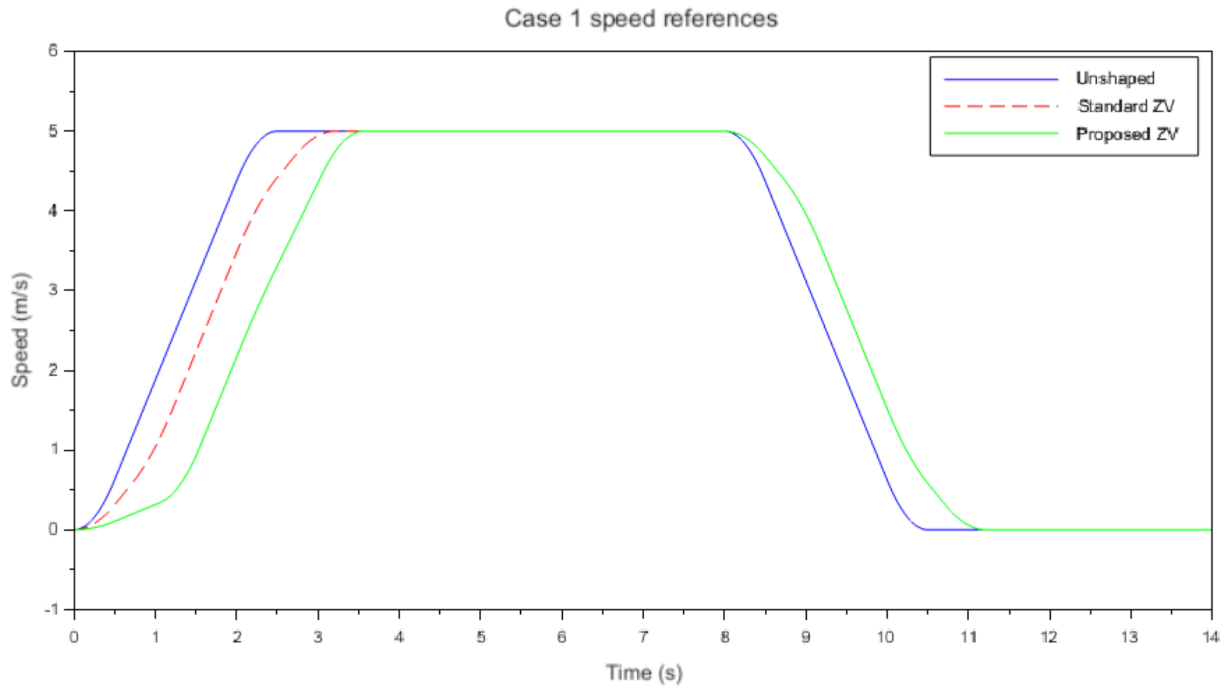

Figure 3. Case 1 speed reference comparison for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 3 shows the speed profiles obtained from the acceleration inputs generated for Case 1. The plot compares the unshaped input, standard ZV-shaped input, and modified ZV-shaped input in terms of trolley speed. Since speed is obtained by integrating acceleration with respect to time, the delayed and scaled acceleration components also produce slight changes in the speed reference.

The unshaped speed profile represents the original trolley motion without input shaping. The standard ZV-shaped and modified ZV-shaped profiles show the effect of input shaping on the motion command. Even though the shaped inputs modify the acceleration timing, the overall trolley motion is maintained. This verifies that the generated input profiles are suitable for supplying to the Xcos crane model.

8.4 Case 1 Xcos Block Diagram

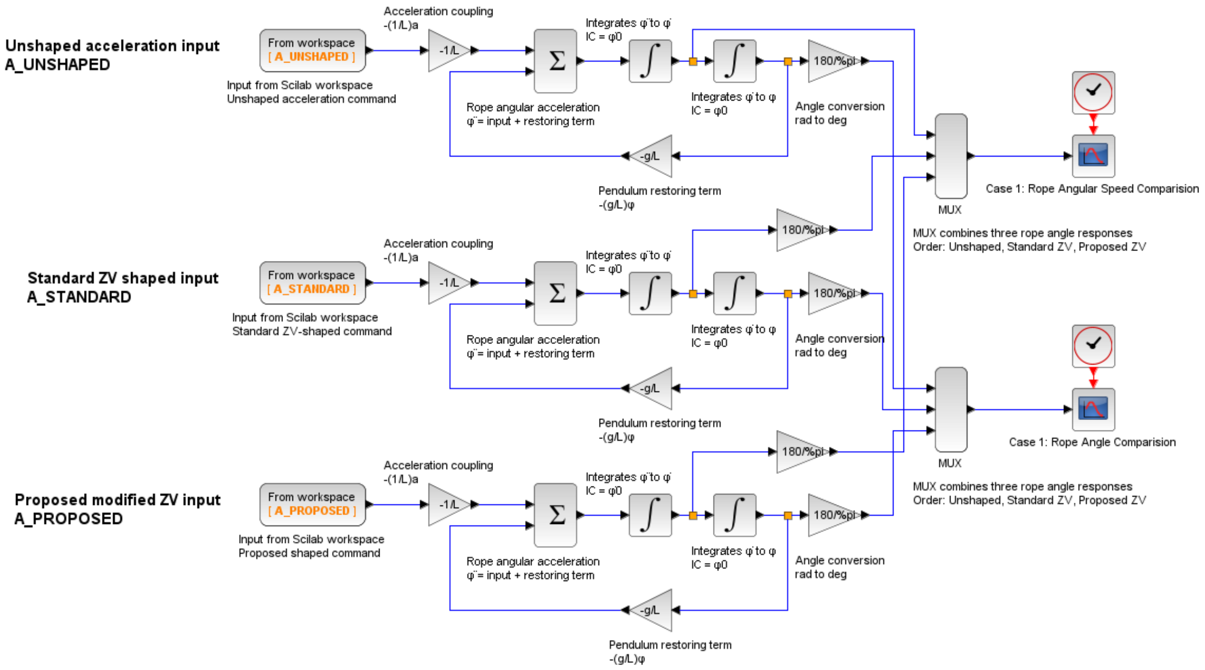

Figure 4. Xcos implementation of the overhead crane swing equation for Case 1

Figure 4 shows the Xcos block diagram used for simulating the overhead crane swing response in Case 1. The model represents the simplified pendulum-based crane equation:

$$\ddot{\phi} = -\frac{1}{L}a - \frac{g}{L}\phi$$

In this equation, the trolley acceleration a acts as the input to the system, while the rope angle φ is obtained as the output response. The term −(1 / L)a represents the effect of trolley acceleration on the suspended payload, and the term −(g / L)φ represents the restoring effect due to gravity.

The Xcos model implements this equation using gain blocks, summation blocks, and integrator blocks. The angular acceleration is integrated once to obtain rope angular speed and integrated again to obtain rope angle. Three parallel branches are used for unshaped input, standard ZV-shaped input, and modified ZV-shaped input, so that all three responses can be compared under the same Case 1 initial conditions.

8.5 Case 1 Rope Angle Response

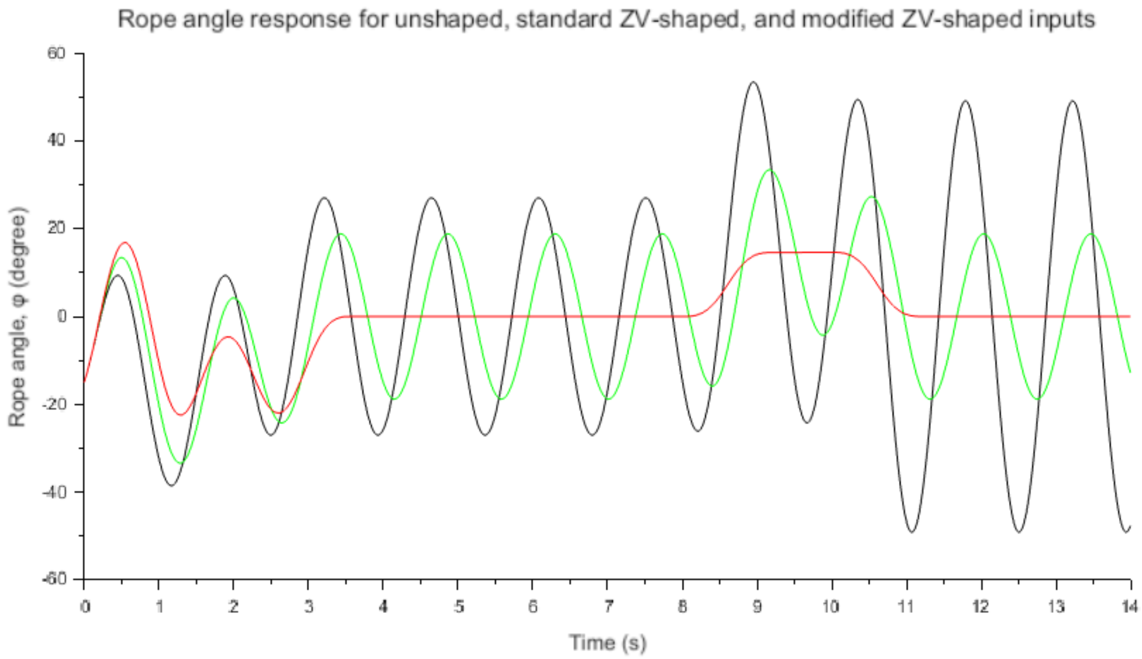

Figure 5. Case 1 rope angle response for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 5 shows the rope angle response obtained from the Xcos simulation for Case 1. In this plot, the black curve represents the unshaped input response, the green curve represents the standard ZV-shaped input response, and the red curve represents the modified ZV-shaped input response. The horizontal axis represents time in seconds, and the vertical axis represents rope angle in degrees.

The unshaped response shows large oscillations because the original acceleration command directly excites the payload swing. The standard ZV-shaped response reduces the swing compared with the unshaped case, but noticeable oscillations are still present. The modified ZV-shaped response gives the lowest residual oscillation after the trolley motion, showing better swing suppression for the non-zero initial condition used in Case 1.

8.6 Case 1 Rope Angular Speed Response

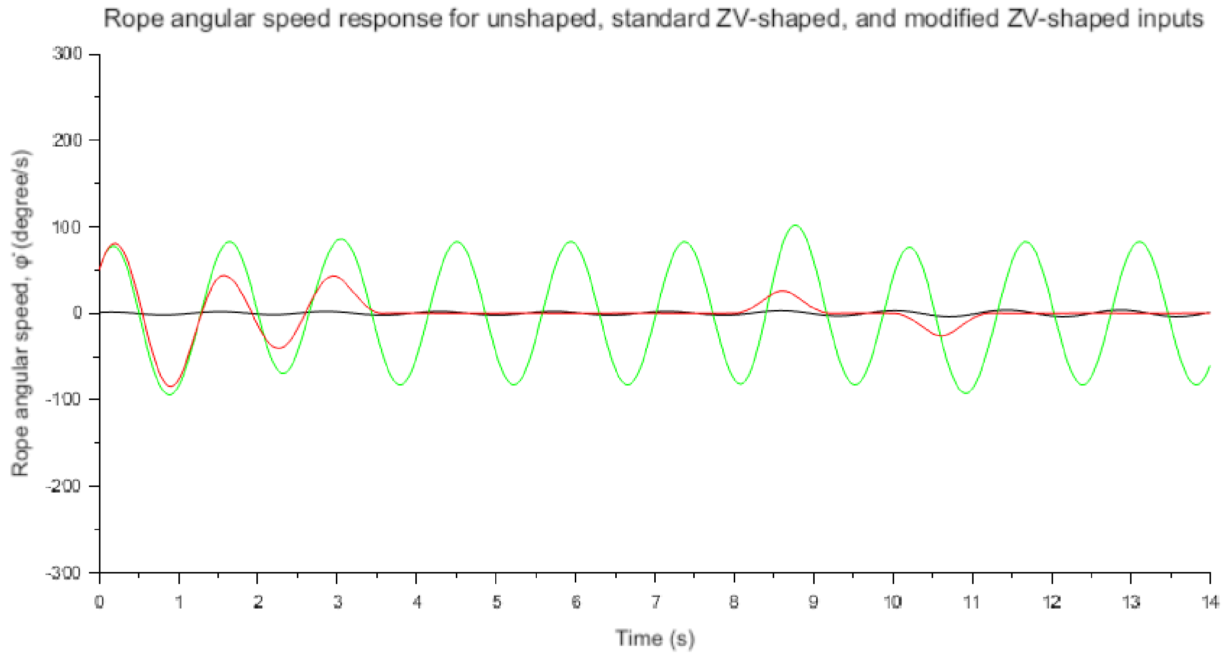

Figure 6. Case 1 rope angular speed response for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 6 shows the rope angular speed response obtained from the Xcos simulation for Case 1. In this plot, the black curve represents the unshaped input response, the green curve represents the standard ZV-shaped input response, and the red curve represents the modified ZV-shaped input response. The horizontal axis represents time in seconds, and the vertical axis represents rope angular speed in degree/s.

The unshaped response shows larger angular speed variations, which indicates stronger payload oscillation. The standard ZV-shaped response reduces the angular speed fluctuation compared with the unshaped case. The modified ZV-shaped response remains closer to zero for most of the motion, showing better reduction of payload swing under the non-zero initial condition of Case 1.

8.7 Case 2 Acceleration Input Comparison

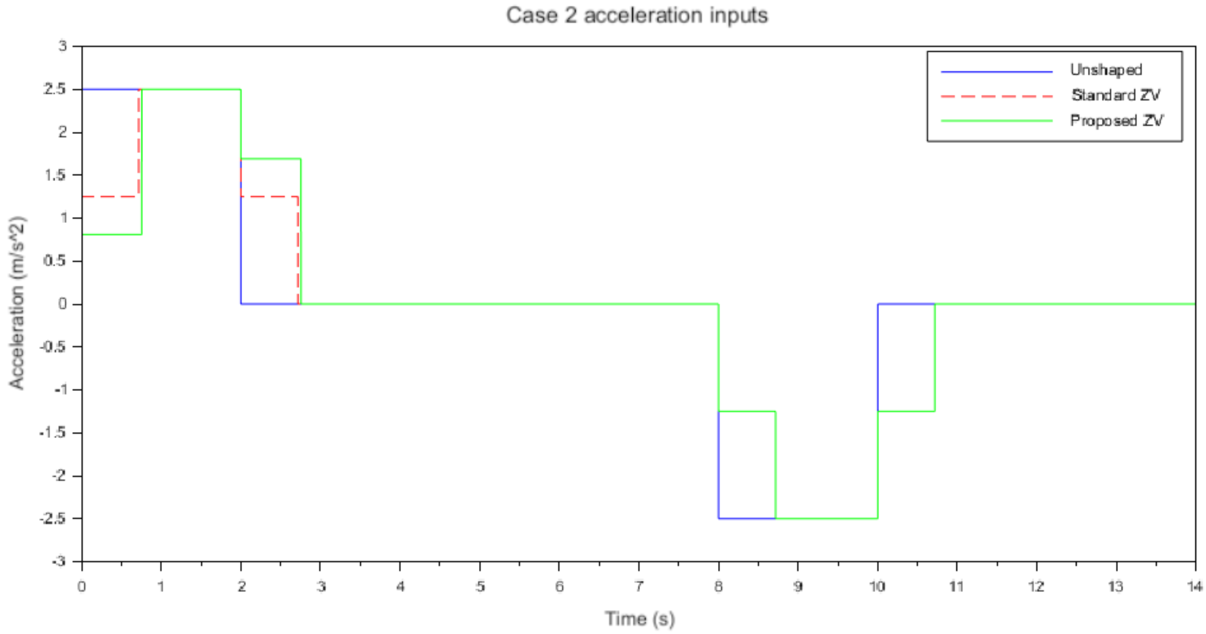

Figure 7. Case 2 acceleration input comparison for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 7 shows the acceleration input profiles generated for Case 2. The plot compares the unshaped input, standard ZV-shaped input, and modified ZV-shaped input. The unshaped input represents the original trolley acceleration command, while the shaped inputs are produced by applying delayed and scaled versions of the same command.

In Case 2, the initial rope angle is non-zero, while the initial rope angular speed is zero. The standard ZV-shaped input is generated using equal shaper amplitudes, whereas the modified ZV-shaped input uses different shaper parameters suitable for the Case 2 initial condition. These acceleration profiles are supplied to the Xcos crane model to compare their effect on payload swing reduction.

8.8 Case 2 Speed Reference Comparison

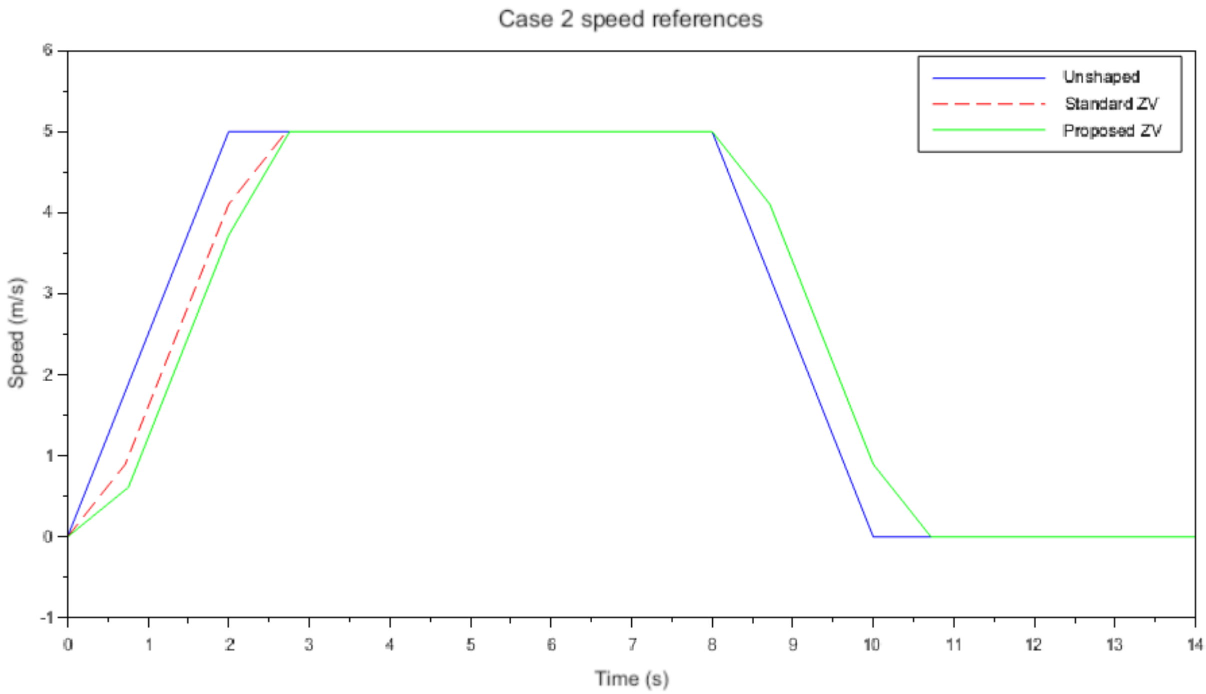

Figure 8. Case 2 speed reference comparison for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 8 shows the speed reference profiles generated from the Case 2 acceleration inputs. The plot compares the unshaped, standard ZV-shaped, and modified ZV-shaped speed profiles. Since the speed profile is obtained by integrating the acceleration input, the effect of input shaping is also reflected in the trolley speed command.

The unshaped curve represents the original speed profile of the trolley. The standard ZV-shaped and modified ZV-shaped curves show slight timing changes caused by the delayed and scaled acceleration components. Even though the input shaping modifies the acceleration command, the overall trolley motion is maintained. These speed profiles are used as a reference to confirm that the Case 2 input signals are properly generated before the Xcos response simulation.

8.9 Case 2 Xcos Block Diagram

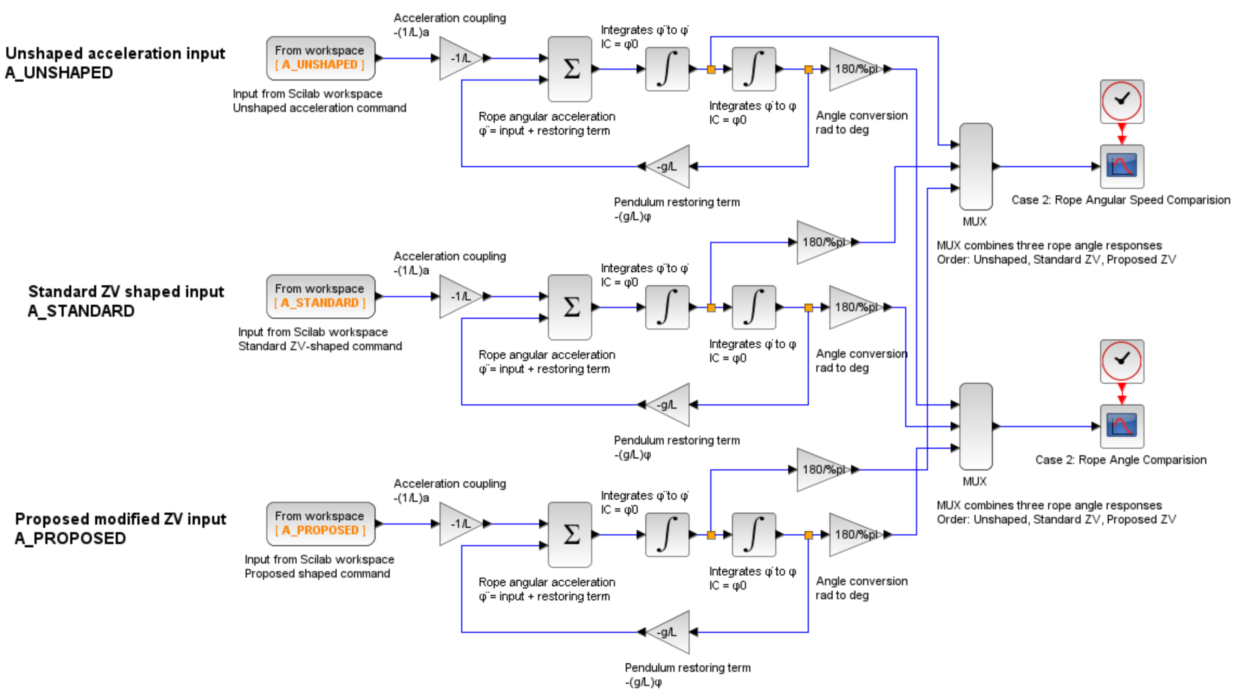

Figure 9. Xcos implementation of the overhead crane swing equation for Case 2

Figure 9 shows the Xcos block diagram used for Case 2 simulation. The same overhead crane dynamic model is used as in Case 1, but the initial conditions and input profiles are changed according to the Case 2 data.

The Xcos model represents the crane swing equation:

$$\ddot{\boldsymbol{\phi}} = -\frac{\mathbf{1}}{\boldsymbol{L}}\boldsymbol{a} - \frac{\boldsymbol{g}}{\boldsymbol{L}}\boldsymbol{\phi}$$

Here, the acceleration input a is supplied from the Scilab-generated workspace data. The model computes rope angular acceleration, which is integrated to obtain rope angular speed and rope angle. Three parallel branches are used to simulate the unshaped input, standard ZV-shaped input, and modified ZV-shaped input under the same Case 2 initial condition.

8.10 Case 2 Rope Angle Response

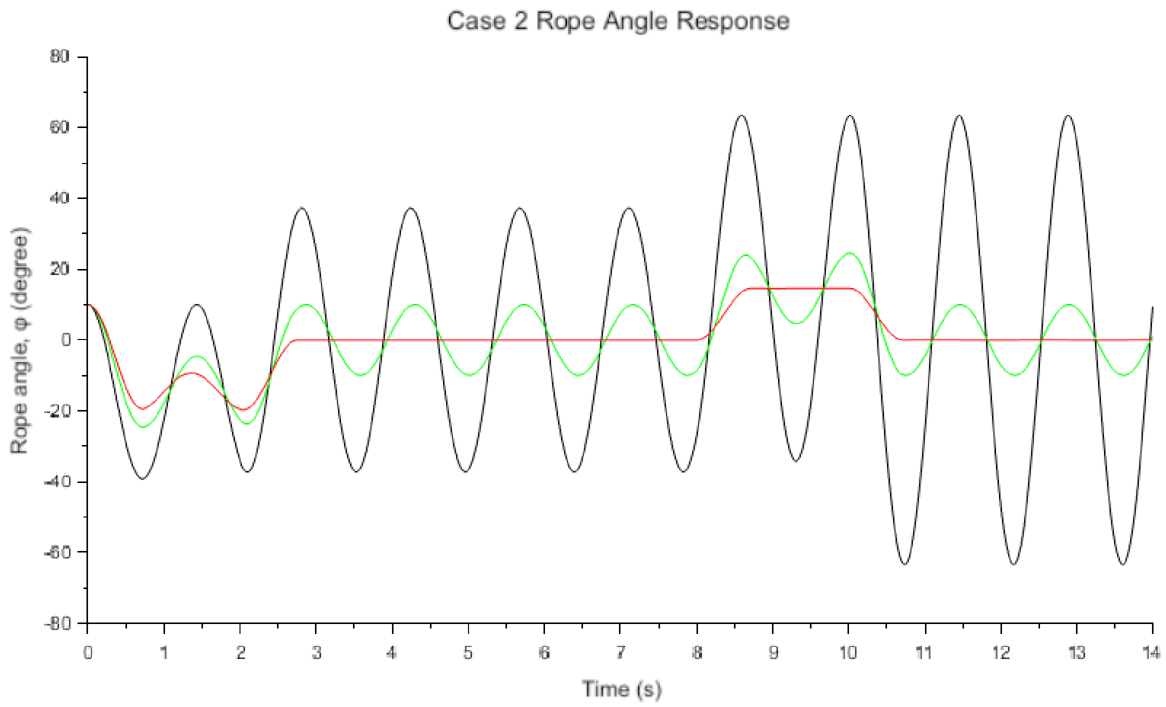

Figure 10. Case 2 rope angle response for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 10 shows the rope angle response obtained from the Xcos simulation for Case 2. In this plot, the black curve represents the unshaped input response, the green curve represents the standard ZV-shaped input response, and the red curve represents the modified ZV-shaped input response. The horizontal axis represents time in seconds, and the vertical axis represents rope angle in degrees.

The unshaped response shows a larger payload swing because the original acceleration input directly excites the pendulum motion. The standard ZV-shaped response reduces the oscillation compared with the unshaped case. The modified ZV-shaped response shows the lowest residual swing, indicating that the modified shaper performs better for the non-zero initial rope angle condition used in Case 2.

8.11 Case 2 Rope Angular Speed Response

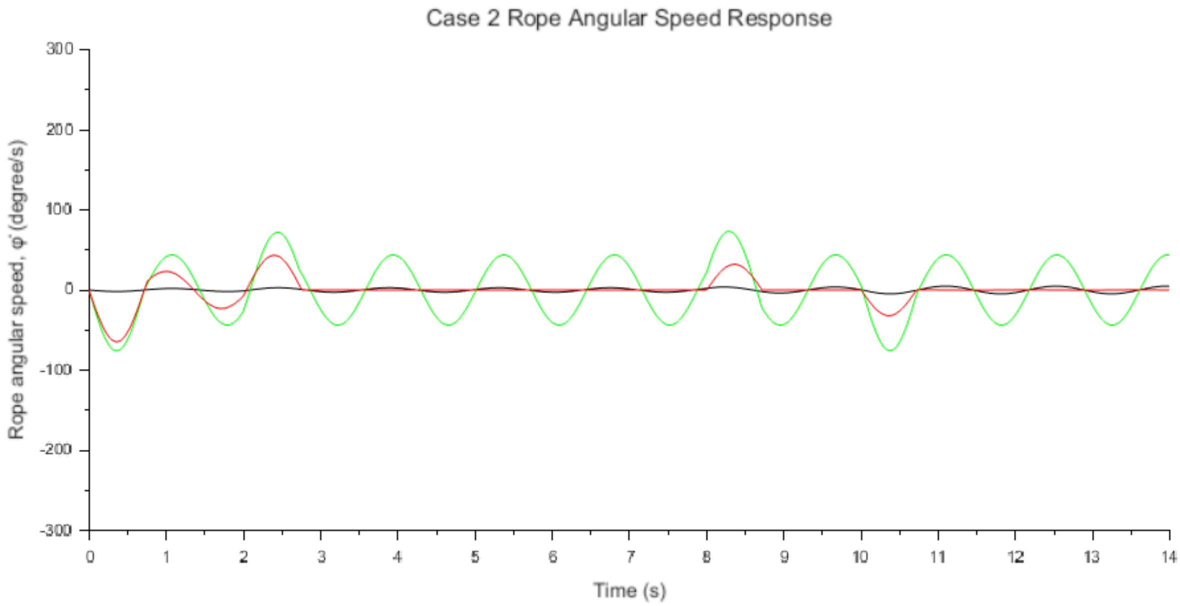

Figure 11. Case 2 rope angular speed response for unshaped, standard ZV-shaped, and modified ZV-shaped inputs

Figure 11 shows the rope angular speed response obtained from the Xcos simulation for Case 2. In this plot, the black curve represents the unshaped input response, the green curve represents the standard ZV-shaped input response, and the red curve represents the modified ZV-shaped input response. The horizontal axis represents time in seconds, and the vertical axis represents rope angular speed in degree/s.

The unshaped response shows larger angular speed variations, which indicates stronger payload oscillation. The standard ZV-shaped response reduces the variation compared with the unshaped input. The modified ZV-shaped response remains closer to zero after the motion, showing better reduction of residual swing for the Case 2 initial condition.

9. Observations

The Scilab-generated acceleration and speed plots show that the input shaping process modifies the original trolley motion command by introducing delayed and scaled components. The unshaped input follows the direct acceleration command, while the standard ZV-shaped and modified ZV-shaped inputs adjust the timing of the command to reduce residual oscillation.

For both simulation cases, the Xcos results show that the unshaped input produces larger rope angle and rope angular speed oscillations. This indicates that applying the original acceleration command directly to the crane system excites the pendulum-like motion of the suspended payload.

The standard ZV-shaped input reduces the oscillations compared with the unshaped input. However, its performance is limited because it is mainly designed for systems starting from rest, while both simulation cases in this study involve non-zero initial swing conditions.

The modified ZV-shaped input gives the best response among the three input cases. It reduces the residual rope angle and rope angular speed more effectively because its shaper parameters account for the non-zero initial condition of the payload.

Although the reference paper reports zero residual oscillation for the modified ZV shaper, the red curve in the present Xcos results still shows a small residual oscillation after the trolley motion. This difference exists because this case study performs a partial time-domain replication using the reported shaper parameters and a simplified Xcos pendulum model, without reproducing the complete analytical parameter-loop calculation used in the reference paper. Therefore, the modified ZV-shaped response is treated as improved swing reduction, not exact zero residual oscillation.

The Xcos block diagrams confirm that the same crane dynamic equation is used for both cases. The difference between Case 1 and Case 2 lies mainly in the initial conditions and the input shaping parameters. Overall, the simulation results show that modified input shaping is more suitable than standard ZV shaping when the overhead crane payload already has initial swing.

10. Conclusion

This case study implemented input shaping control for overhead crane swing reduction using Scilab and Xcos. The overhead crane payload was modelled as a simplified pendulum system, where trolley acceleration acts as the input and rope angle is considered as the main swing response. Two simulation cases with non-zero initial swing conditions were studied.

The acceleration and speed input profiles were generated in Scilab for three input conditions: unshaped input, standard ZV-shaped input, and modified ZV-shaped input. These inputs were then applied to the Xcos crane model to obtain the rope angle and rope angular speed responses. The results show that the unshaped input produces larger payload oscillations, while the standard ZV-shaped input reduces the swing to some extent.

Among the three input cases, the modified ZV-shaped input produced the best swing reduction in both simulation cases. This is because the modified shaper accounts for the non-zero initial swing condition of the payload. Therefore, the simulation results support the idea that modified input shaping is more effective than standard ZV shaping when the overhead crane payload does not start from rest.

The work is limited to simulation-based validation. The phasor diagrams, jerk-limit analysis, and hardware experimental setup from the reference paper were not reproduced in this case study.

11. References

[1] "Input Shaping for Non-Zero Initial Conditions and Arbitrary Input Signals with an Application to Overhead Crane Control," IEEE Xplore, https://ieeexplore.ieee.org/document/9729261

[2] "Scilab Spoken Tutorials," Spoken Tutorials, https://scilab.in/spoken-tutorial