Endless Rotating Furutapendulum with Code-Generation

Up & Down Regulation

Graduate

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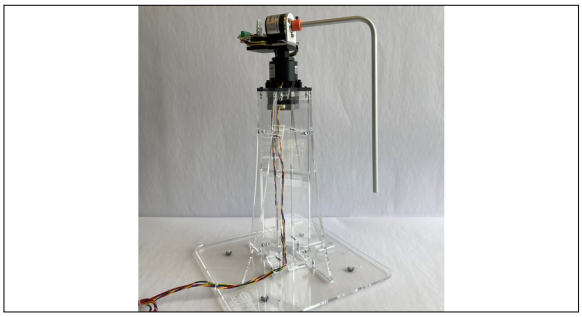
Definition of Task: STMicroelectronics provides an inverted pendulum as an evaluation kit, which is called STEVAL-EDUKIT01. Two rotating axes are the characteristic features of such a system. At its highest point, it represents an unstable process.
In this bachelor thesis, Simulink is used to build a control circuit using automatic code generation. The aim of this assignment is to stabilize the pendulum arm in the lower and upper equilibrium positions, as well as to regulate the position of the motor angle. Furthermore, the construction of the evaluation kit has to be improved by eliminating the cable connection to the encoder. This allows the pendulum to rotate endlessly.

Approach / Technology: A stepper motor performs a motion that causes the pendulum to deflect. With different stimuli, the frequency response of the system is derived. Through the analysis of the root locus as well as the bode diagram, a regulator is tuned to get a stabilized system. Different control methods, such as P-, PI-, PID-, or linear-quadratic regulators (LQR) are designed.
Bluetooth modules are used for the data transfer. They send the encoder value, which represents the pendulum angle to the board which contains the whole control system. A slip ring design is used to provide the power supply for the encoder evaluation.

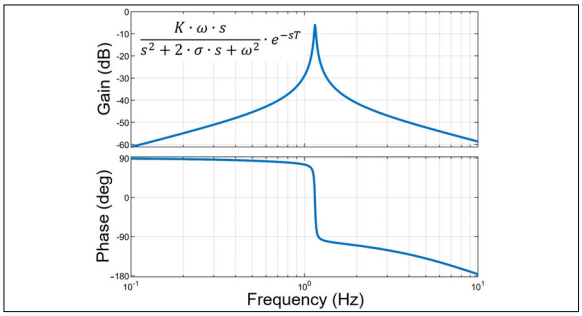
Conclusion: Our system can control the pendulum arm in both the lower and upper position.
With a simple proportional regulator the lower position is controlled, this is achievable because the system is already stable. Due to the fact that the system is unstable in the upper position, an LQR control is implemented.
Wireless data transfer for the encoder values is achieved using Bluetooth and a slip ring.

Finally, with a Simulink model, it is possible to switch between the two regulations and a reset state.

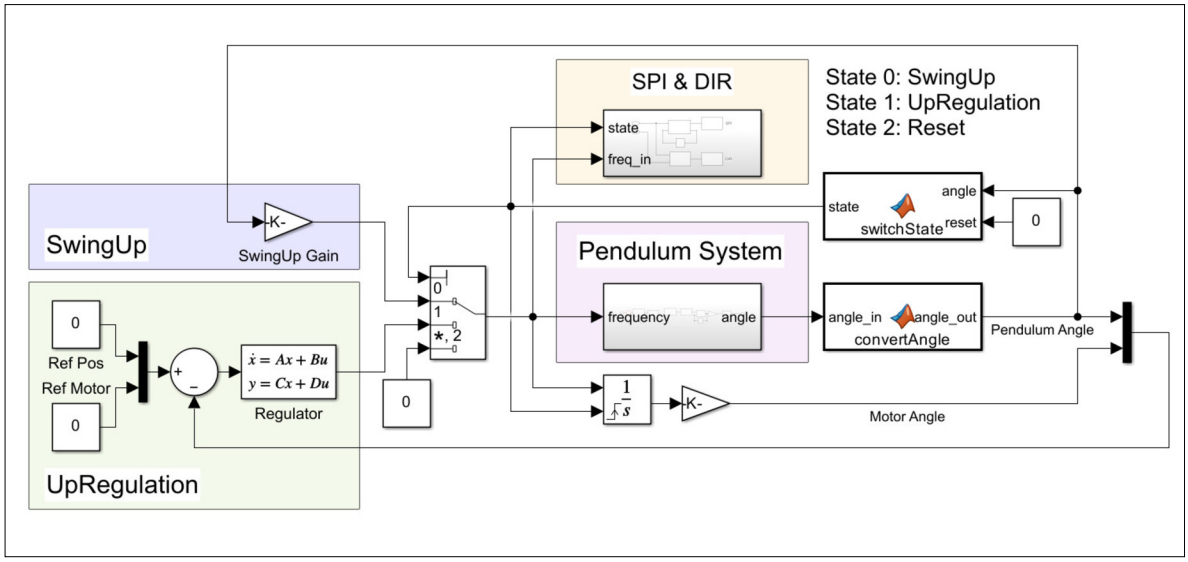
Modified pendulum STEVAL-EDUKIT01 with slip ring and Bluetooth module.
Own presentment



Bode plot of the pendulum in the lower position.
Own presentment



Simulink diagram for controlling the upper position.
Own presentment



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Subject Area
Regelungstechnik / Control Theory

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