MECH545 - Hybrid Electric Vehicle Propulsion
Information on the TwoSpeedShiftController Blocks
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In the file "TwoSpeedShiftControllers.mdl." two shift control blocks have been provided. (See Figure 1.) Both blocks will produce the same result. The second block (Shift Control Stateflow) is the preferred option, but it requires that you have a Simulink Add-on called Stateflow. Stateflow is used to model **Finite State Machines**. The concept of Finite State Machines is a very common concept that is used to develop embedded controllers.

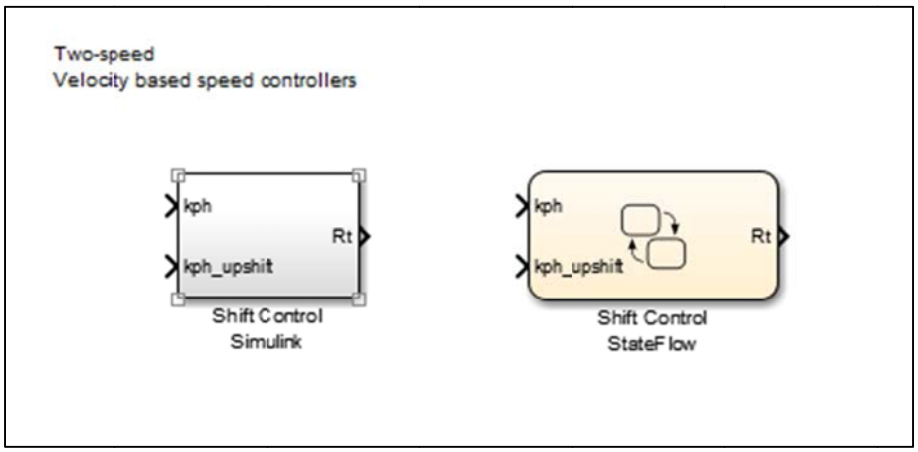

Figure 1 Two-speed shift control models in the file "TwoSpeedShiftControllers.mdl"

My implementation of the two-speed controller in Stateflow is very simple. See Figure 2. The transmission can be in one of two mutually exclusive states; it is either in first gear (R_t = 3.0) or it is in second gear (R_t = 1.0). The controller always starts in first gear. The transition from the first state to the second state is triggered by the condition [kph>kph_upshift]. The transition from the second state to the first state is triggered by the condition [kph<kph_upshift - 5]. Depending on the state the corresponding value for the transmission ratio is provided to the output port.

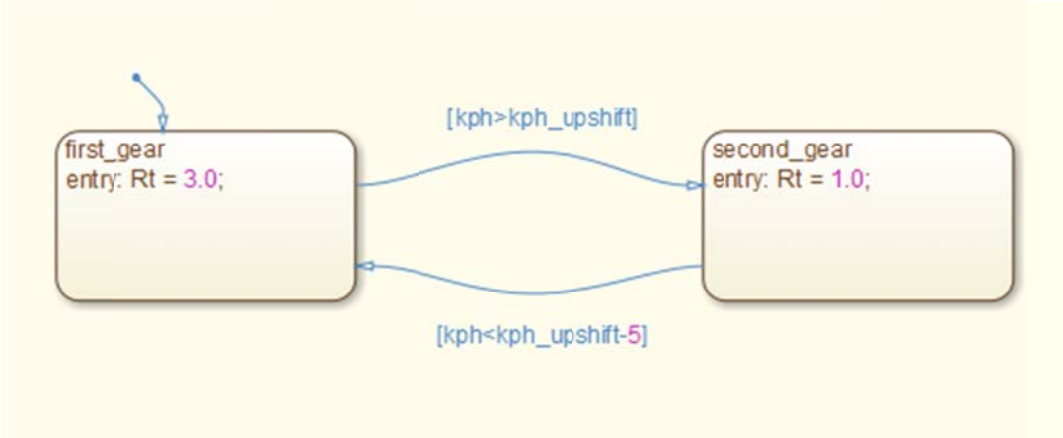

Figure 2 Two-speed control strategy in Stateflow

The simple model in Figure 2 could be embellished in many ways. For instance, I suggested that the transmission had only two mutually-exclusion states (first gear or second gear). Another way to look at the transmission is that it has the following two mutually-exclusive states: in-gear (in one of two mutually-exclusive sub-states: first gear or second gear) or shifting (in one of two mutually-exclusive sub-states: either upshifting or downshifting). This approach would allow us to account for the time-delay required to complete the shift. The improved accuracy of the model goes well beyond the scope of this course, but hopefully you see the possibilities that Stateflow provides.

It is possible to build simple controllers using basic Simulink blocks, but it can be rather cumbersome. A high-level view of the Simulink version of a two-speed shift controller is shown in Figure 3. A “Gear Selection Logic” submodel determines if the transmission is in first or second gear and a switch is used to provide the value of the transmission ratio to the output block.

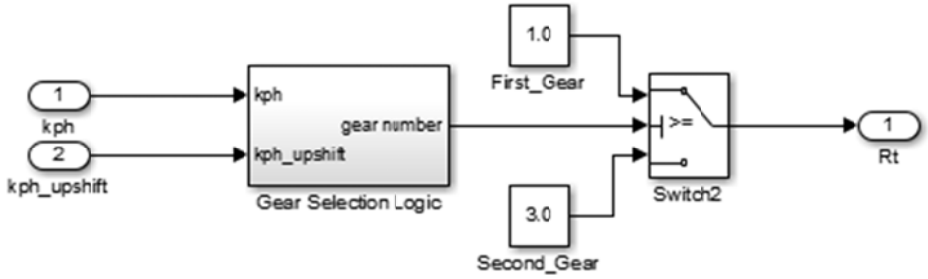

Figure 3 High level view of the Simulink version of a two-speed shift controller

The gear selection logic is shown in Figure 4. The logic blocks test to see if [kph > kph_upshift] or if [kph < kph_downshift] in which case either +1 or -1 is added to the previous gear number (which is tracked with the Memory block). The Saturation block is used to insure that the gear number can only be 1 or 2.

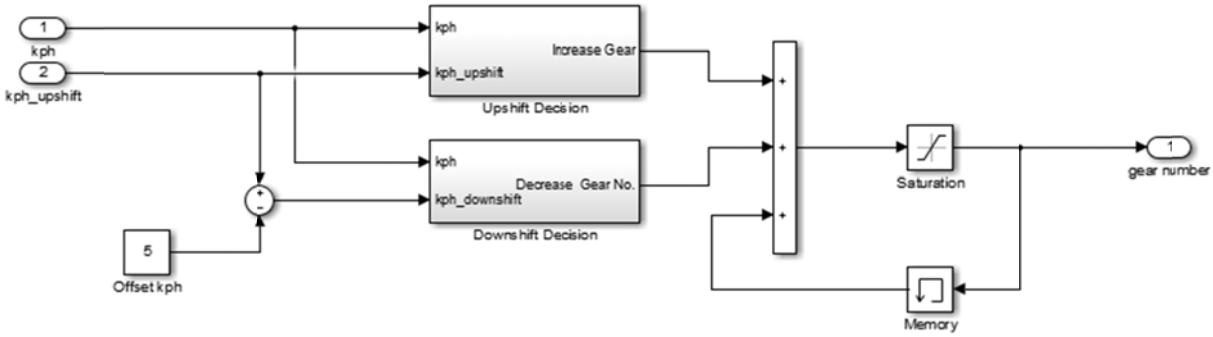

Figure 4 Gear Selection Logic in the Simulink version of a two-speed shift controller

Again, both controllers are functionally equivalent. However, if we wish to develop more complicated controllers there are significant advantages to using Stateflow.

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