Model Based Development of Future Small Electric Vehicle by Modelica

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To satisfy needs for future low-carbon mobility society, development of many new small electric vehicles (EVs) is increasingly active in recent years. Those vehicles are often smaller and lighter than conventional vehicles and are often equipped with low RRC (Rolling Resistance Coefficients) tires for less energy consumption. On the other hand, low RRC tires tend to have less cornering performance than conventional tires in general. Because of light weight and low RRC tires, those vehicles become to have reduced dynamic stability against external disturbances. To analyze and cope with all the problems about energy consumption and vehicle stability, a holistic approach of vehicle system design considering multi-physics of mechanics, electrics, aerodynamics, control and so on is necessary.

In the previous paper (Hirano, 2014), authors showed the capability of new construction of the new EV using new type tire based on 'Large and Narrow concept' and torque vectoring differential (TVD) gear. In this paper, a multi-physics full vehicle model of the new EV is expanded to consider the detailed loss of motors and inverters as shown in Figure 1. Additionally 3D mechanical gear train model of TVD was modified to consider mechanical loss. Also front and rear suspension model which has same 3D mechanical design as the real experimental vehicle was made and verified. By technical investigations using this full vehicle model, structure, specifications and control of the new EV system were researched about vehicle dynamics and energy consumption.

Finally the trade-off between vehicle dynamic performance and energy consumption of TVD system was clarified by simulation results of stead state cornering and winding road driving.
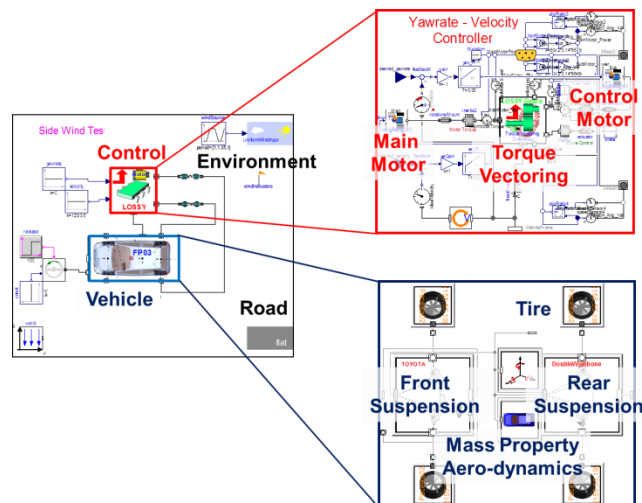

Figure 1. Top level structure of full vehicle mode

References

Y. Hirano, S. Inoue and J. Ota, Model-based Development of Future Small EVs using Modelica, *Proceedings of Modelica Conference 2014*, 2014.