

(17)Title

Hazard analysis for power assist bicycle/Comparison of STAMP/STPA and numerical simulation analysis

Speaker, Authors

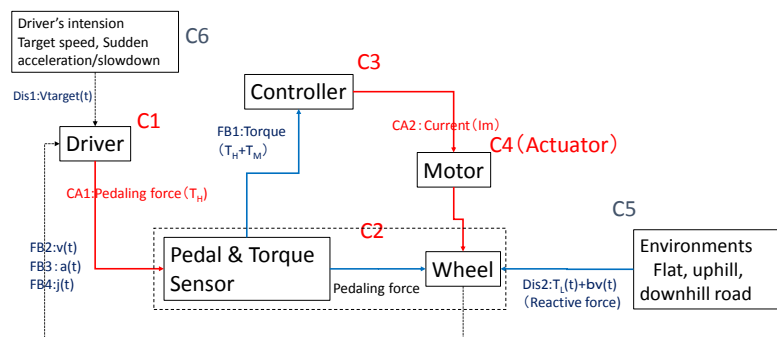
The university of Aizu. Shigeru Kanemoto

Abstract

STAMP/STPA is currently gaining attention as a new safety analysis method for complex systems. Here, the complex systems include complex human/machine interactions, internet communications or advanced software. The conventional safety analysis methods based on reliability engineering are not always applied to them, and, STAMP/STPA is expected as a top down safety analysis tool. The concept of STAMP/STPA includes an important paradigm shift in the conventional safety design process. It is important to understand the benefit of this paradigm shift through the concrete case study.

In the present paper, we apply STAMP/STPA to the hazard analysis of power assist bicycle which would be a typical example of human cooperative system. Furthermore, we compare the results with those of numerical simulation like SIMULINK, and, discuss how STAMP/STPA is useful for the hazard analysis of the system including human. The following figures indicate the control structure diagram of power assist bicycle and the definition of accident, hazard and safety constraints. Here, two control actions (Pedaling force and assist force) and several feedback information are defined. Also, driver's intention and road conditions are defined as disturbances. Especially, to evaluate human actions, we made STPA analysis for three typical contexts (start, stop and normal travelling phases). Also, numerical simulation of hazardous behavior will be made and compared with STPA results.

Control structure diagram of power assist bicycle



- **Accident**
 - self-inflicted accident by falling or collision
- **Hazard**
 - Unbalancing state (Unintentional sudden acceleration or slowdown)
 - Over speed leading to falling or collision
- **Safety constraints**
 - Power assist to prevent unintentional sudden acceleration or slowdown
 - To prevent the assist for over speed
- **Contexts**
 - Analyze the hazards for Start, Stop, Normal travelling phases
 - Consider road conditions such as step of road or uphill or downhill (Downhill and freezing roads are omitted here)

Keywords

- (1) STAMP/STPA
- (2) Power assist bicycle
- (3) Numerical simulation
- (4) Human-machine system
- (5) Hazard analysis