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指導教員 承認印	主	副	副
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学位（博士）論文要旨
(Doctoral thesis abstract)

論文提出者 Ph. D. Candidate	生物システム応用科学府 食料エネルギーシステム科学 専攻 一貫制博士課程 平成 28 年度入学(Your Entrance Fiscal Year) 氏名 渡辺将央 ㊞ (Your Name(Family, First) and Seal)				
主指導教員 氏名 Chief Advisor's Name	酒井憲司	副指導教員 氏名 Vice Advisor's Name	豊田剛己	副指導教員 氏名 Vice Advisor's Name	養王田正文
論文題目 Title	A Study on Nonlinear Dynamics of Agricultural Tractor for Prevention of Overturning Accidents 横転事故防止に向けた農用トラクタの非線形力学に関する研究				

論文要旨（和文要旨(2000字程度)または英文要旨(500words)）
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
Write a summary in Japanese (2000 characters) or in English (500words).
If the abstract is written in Japanese, needed to translate into English.

In the present study, nonlinear dynamics of agricultural tractor extensively was investigated to prevent tractor overturning accidents. Globally, tractor overturning accidents are a serious problem in agriculture. Tractor overturning not only threatens the life and health of farmers but it can be major obstruction towards farm automation.

In Japan, small tractors are used in harsh running environments, such as on rough farm roads, steep passage slopes, and narrow inclined side paths. Due to these potentially dangerous terrain environments, nonlinearity of agricultural tractor, such as vertical jumping and lateral sliding frequently occur. Violent vibrations can happen in the tractor operations and the wheels of the tractor sometimes depart from the ground. Furthermore, even if the wheel does not lose contact with the ground, the vertical forces can be reduced to low enough for lateral sliding resulting in steering instability during operations. Addition to the abovementioned phenomenon, the combination of jumping and sliding cause power hop phenomenon that is a major dynamic instability of agricultural tractor during towing operation on dried soil condition. Nonlinear dynamics of agricultural tractor, thus, is essential for determining tractor dynamic behaviors and preventing overturning accidents.

The aim of the paper is to investigate nonlinear dynamics in agricultural tractor using dynamic modeling and driving simulation. First, nonlinear dynamic modeling of tractor dynamics was conducted to elucidate tractor overturning mechanism. Jumping or bouncing tractor dynamics was modelled as an impact nonlinear based on bouncing ball dynamics. Using the developed bouncing tractor model, the impact dynamic of the tractor intensively investigated in the numerical parametric investigations. The numerical results revealed that the nonlinear characteristics and the parameter sensitivity can lead to overturing accidents. Then, the steering instability of the agricultural tractor was numerically investigated by developing lateral sliding model of agricultural tractor based on friction circle, that is classic Coulomb friction theory. Bouncing tractor model and bicycle model were coupled in lateral sliding modeling. The parametric investigation results obtained in the numerical experiments strongly demonstrated that bouncing and sliding occurring on specific terrain result in steering instability and

are a major cause of overturning accidents. The power hop is a major dynamics instability of agricultural tractor during towing operations on dried soils. The novel power hop model was developed based on coupling three nonlinear elements, that is bouncing, sliding, and free play in the joint between tractor and implement. The developed model revealed the occurrence process of power hop in transitional and steady-state dynamics. In addition to the abovementioned nonlinear dynamic tractor models, tractor driving simulator was developed in this study. First, road profile analysis was conducted to generate road surface in the tractor driving simulator. In road profile modeling, power spectrum density and coherence function are combined to generate random road surface. Then, the tractor driving simulator was developed based on CarSim® DS, MATLAB®/Simulink®, and Logitech® G27. Using the developed tractor driving simulator, the numerical experiments were carried out to identify tractor overturning scenarios.

(英訳) ※和文要旨の場合(300 words)

If the abstract is written in Japanese, needed to translate into English.(300 words)