## 科学研究費助成事業 研究成果報告書

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研究種目: 基盤研究(B)(一般)

研究期間: 2015~2018

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研究課題名(和文)人と不整地作業機械が協調するハイブリッド転倒安全システムの基盤構築

研究課題名(英文)Construction of the fundamentals of a hybrid safety system for tipping in which related human and off-road working machines cooperate

## 研究代表者

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研究成果の概要(和文):不整地作業機械の各種稼働現場で機能する実現性の高い安全システムの開発に資するよう、不整地作業機械モデル等を用いた実験解析、転倒回避システムの設計及び試作、VR機器を組込むハイブリッドシミュレータの開発のほか、高精度三次元動的バーチャルシミュレータを構築して解析し、総合的に考察した。さらに、人と機械が協調するハイブリッド転倒安全システムの原理を考案し、同システムの基盤を構築した。協調が機能しない場合の多重防護対策として、機械が転倒限界状態を超過する前に安定状態へ自然復帰する転倒回避システムの基本設計からバーチャルシミュレータ上試作までも実施し、その発展性を示した。

研究成果の学術的意義や社会的意義 本研究で基盤を構築したハイブリッド転倒安全システムは、移動式クレーンほか多様な不整地作業機械に広く応 用できると考えられ、これら機械の基本要求機能である転倒安全性の快適な確保に貢献できる。今後、発展途上 国の開発やインフラ整備等で不整地作業機械の使用頻度の増加が予想され、運転者の熟練度及び作業環境の多様 化により転倒事故の増加が懸念される。この問題解決にも資する本研究成果は世界的に人的・経済的損失の削減 にも寄与できると期待され意義深い。

研究成果の概要(英文): To contribute to the development of a highly feasible safety system that functions in various operation sites of off-road working machines, experimental analysis using off-road working machine model etc., design and trial manufacture of tipping prevention system as well as hybrid simulator incorporating VR equipment were conducted. A high-precision three-dimensional dynamic virtual simulator was also developed. By using these, analyzed results were comprehensively discussed. Furthermore, we devised the principle of a hybrid tipping safety system in which related human and machines cooperate, and built the foundation of the system. As a multiple protection measure when cooperation does not function, basic design of the tipping avoidance system which returns to the stable state naturally before the machine exceeds the tipping limit state was implemented from the basic design to the virtual simulator trial production, and its feasibility was shown.

研究分野: 機械安全設計工学

キーワード: 安全工学 機械力学・制御 建設機械 不整地 人間工学

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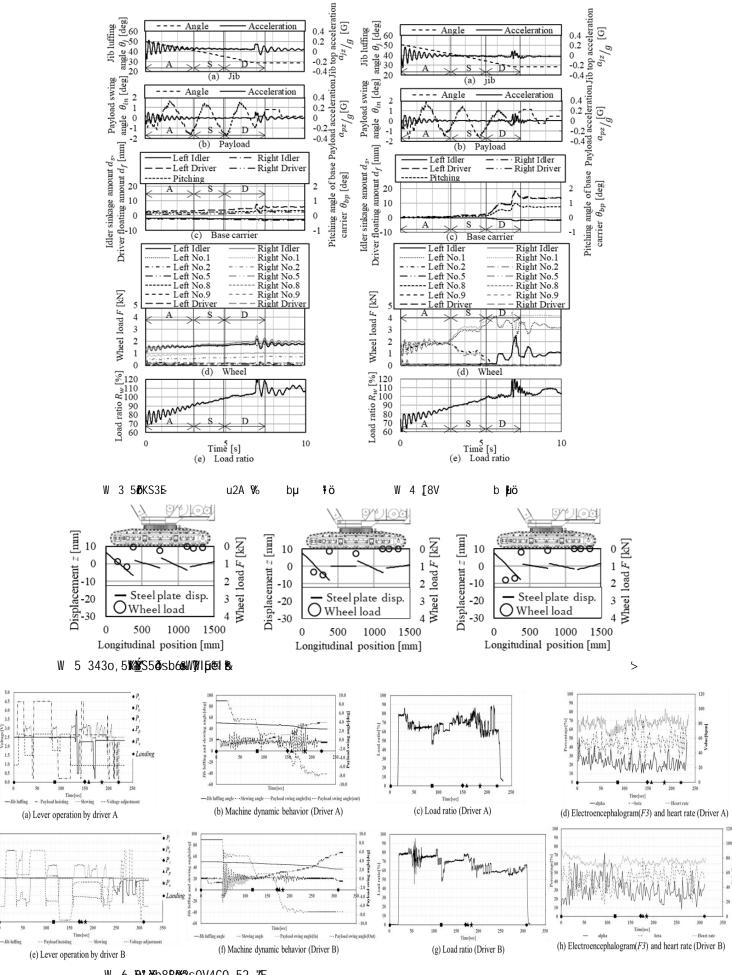
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	Max contact pressure $p_{max}[kPa]$ (Jib luffing angle $\theta_i > 30[deg]$ )(Static state)	32	101
	Ground's yield pressure $q_v$ [kPa]	48	*
	Average penetration resistance[kPa]	385	<b>≯</b>
	Max contact pressure/ Ground's yield pressure [-]	0.67	*
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	Payload lifting direction	Forward	Forward
	Initial jib luffing angle[deg]	51.5	50.4
	Jib luffing angle at operation stop[deg]	28.2	28.6
	Jib luffing time length[s]	6.86	6.91
	Drum rotation velocity[rpm] (Steady state)	21.1	21.0



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