日本学術振興会に紙媒体で提出する必要はありません。

様　式　Ｆ－７－１

科学研究費助成事業（学術研究助成基金助成金）実施状況報告書（研究実施状況報告書）（令和２年度）

機関番号	１４６０３

所属研究機関名称		奈良先端科学技術大学院大学
研究代表者	部局	先端科学技術研究科
	職	助教
	氏名	Ｋｉｍ　ＹｏｕｎｇＷｏｏ

１．研究種目名　若手研究

２．課題番号　20K14719

３．研究課題名　Development of an Ultra-Fast Statistical Signal/Power Integrity Analysis Simulator for the High-speed Digital System Design

４．補助事業期間　令和２年度～令和３年度

５．研究実績の概要

In the first year of the project, the principal investigator of this project have developed statistical eye-diagram estimation simulator considering non-linear power/ground noise and data-coding impacts. The proposed simulator can efficiently analyze signal/power integrity degradation. In the original proposal document, the project is divided into four steps:
(1) Statistical method development based on step-response simulation (SPICE), (2) Modeling to replace the step-response simulation, (3) Tool development combining the 1st and 2nd action items, (4) Application to actual problem solving. Currently, action item (1), (3) (except equation adoption part) are completed. Also, preliminary analysis result (action item (4)) are presented at the conference. The result of this project can provide a promising solution toward a long simulation time using conventional transient SPICE simulation and a large computational resource.

Using the developed simulator and research results, IEEE journals and one IEEE international conference paper are published and presented. Also, after publishing the journal and presentation at the conference, the principal investigator of this project became an associated editor in IEEE transactions. The project is conducted smoothly based on the proposed time-line and deliverables shown in the research proposal document.

６．キーワード

signal/power integrity　high-bandwidth memory　statistical approach　IEEE journal/conference

７．現在までの進捗状況

区分　(1) 当初の計画以上に進展している。

理由

In the original proposal document, the project is divided into four steps:
(1) Statistical method development based on step-response simulation (SPICE), (2) Modeling to replace the step-response simulation, (3) Tool development combining the 1st and 2nd action items, (4) Application to actual problem solving.

Right after the adoption of the project, I've already prepared the 1st action item and published IEEE journal. As I result, I am working on analytical modeling part, which is the 2nd action item. Also, using the proposed method, I applied the proposed method to high-bandwidth memory analysis and presented at IEEE conference (item 4).

The project is progressing smoothly and expected to finish the analytical modeling part by 2021 Q3, completing all items and I will focus on paper writing.

８．今後の研究の推進方策

Currently, analytical modeling part and application to the actual design/analysis remain. The modeling part of the chip-interposer-package-PCB power interconnection is almost finished and modeling of the p/n-channel MOSFET in two different region must be conducted. The modeling will be verified by comparing derived responses based on the analytical modeling and HSPICE will be compared.

After completing the modeling, the response derivation equation will be included into current GUI (developed simulator). Currently, step responses derived based on SPICE should be attached into the GUI. By completing the modeling, this part can be replaced by the analytical equation.

Using the proposed simulator, the HBM is analyzed and presented at the IEEE conference. More analysis will be published.

９．次年度使用が生じた理由と使用計画

Due to COVID-19, travel expenses (international conference, business trip, workshop, and collaboration) could not be conducted. Also, conference fee and article publishing fee were also lowered, since they changed the format into online instead of on-site. As a result, budget could not be used. This project is mainly computational so most of the budget was allocated for article publishing fee and travel cost. In FY2021, the principle investigator (PI) would like to use the left over budget for realizing a simulation server, increasing the computational capacity (DRAM, hard-drives, additional computational devices). Also, in FY2021, the PI is planning to submit open access journal (IEEE Access) which requires about 2,000 US dolor per article to use the budget and foster the research result more widely.

１０．研究発表（令和２年度の研究成果）

〔雑誌論文〕　計3件（うち査読付論文　3件／うち国際共著　3件／うちオープンアクセス　0件）

１．著者名 Youngwoo Kim, Gapyeol Park, Kyungjun Cho, Pulugurtha Markondeya Raj, Rao R. Tummala, and Joungho Kim	４．巻 68
２．論文標題 Wideband Power/Ground Noise Suppression in Low-Loss Glass Interposers Using a Double-Sided Electromagnetic Bandgap Structure	５．発行年 2020年
３．雑誌名 IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES	６．最初と最後の頁 5055-5064
掲載論文のDOI（デジタルオブジェクト識別子） 10.1109/TMTT.2020.3022009	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

１．著者名 Youngwoo Kim	４．巻 62
２．論文標題 Statistical Analysis and Modeling of a High Bandwidth Memory (HBM) Interposer Channel	５．発行年 2020年
３．雑誌名 2020 IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization (NEMO)	６．最初と最後の頁 2
掲載論文のDOI（デジタルオブジェクト識別子） 10.1109/NEMO49486.2020.9343617	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

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１．著者名 Youngwoo Kim, Junyong Park, Joungho Kim, and Yu-Ichi Hayashi	４．巻 62
２．論文標題 Statistical Eye-Diagram Estimation Method Considering Power/Ground Noise Induced by Simultaneous Switching Output (SSO) Buffers	５．発行年 2020年
３．雑誌名 IEEE TRANSACTIONS ON ELECTROMAGNETIC COMPATIBILITY	６．最初と最後の頁 2547-2557
掲載論文のDOI（デジタルオブジェクト識別子） 10.1109/TEMC.2020.2975202	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

〔学会発表〕　計2件（うち招待講演　1件／うち国際学会　1件）

１．発表者名 Youngwoo Kim
２．発表標題 Statistical Analysis and Modeling of a High Bandwidth Memory (HBM) Interposer Channel
３．学会等名 2020 IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization (NEMO)（招待講演）（国際学会）
４．発表年 2020年

１．発表者名 Youngwoo Kim
２．発表標題 Analysis of HDMI Mated Con- nector Electrical Performance Impacts on a Signal Integrity of the High-speed Digital System
３．学会等名 電子情報通信学会 2020-EMD-0010
４．発表年 2020年

〔図書〕　計0件

１１．研究成果による産業財産権の出願・取得状況

計0件（うち出願0件／うち取得0件）

１２．科研費を使用して開催した国際研究集会

計0件

１３．本研究に関連して実施した国際共同研究の実施状況

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１４．備考

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