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2019 年度 生体医歯工学共同研究実施報告書

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生体医歯工学共同研究拠点 研究所長会議 議長 殿

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下 記 により、共 同 研 究 の 実 施 報 告 を 致 します。

記

研　究　題　目	(和)系統的なインタラクティブシステムとバイオメトリクスデバイスの開発統合 (英)Systematic development and integration of interactive systems and biometric devices
研　究　領　域	1. 生体材料に関する基礎・応用研究 2. 生体工学に関する基礎・応用研究 3. 生体機能分子に関する基礎・応用研究 4. 化学・電気・機械・材料工学の生体応用研究
研　究　期　間	2019 年 5 月 14 日 ～ 2020 年 3 月 31 日

研究組織

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Paolo Bottoni	Department of Computer Science, Sapienza University of Rome, Italy	Professor	Leader
Francesco Parisi Presicce	Department of Computer Science, Sapienza University of Rome, Italy	Professor	Participant
Michael Cohen	School of Computer Science and Engineering, The University of Aizu, Japan	Professor	Participant
Shigaku Tei	School of Computer Science and Engineering, The University of Aizu, Japan	Professor	Participant
Roumen Nikolov	State University of Library Studies and Information Technologies, Bulgaria	Professor	Participant
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Maria De Marsico	Department of Computer Science, Sapienza University of Rome, Italy	Associate Professor	Participant

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Roberto Navigli	Department of Computer Science, Sapienza University of Rome, Italy	Associate Professor	Participant
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Pavel Boychev	Faculty of Mathematics and Informatics, Sofia University, Bulgaria	Associate Professor	Participant
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Massimilano Pedone	Info Sapienza, Sapienza University of Rome, Italy	Researcher	Participant
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Kamen Kanev	Graduate School of Science and Technology, Shizuoka University, Japan	Professor	Participant
Hidenori Mimura	Research Institute of Electronics, Shizuoka University, Japan	Professor	Participant

生体医歯工学共同研究拠点内対応教員	（共同研究をした教員名を記載） Prof. Hidenori Mimura, Director Research Institute of Electronics, Shizuoka University

研究成果

Objectives

The present project focuses on multimodal and multimedia augmented interactions with enhanced physical objects and surroundings, analyzing and developing proper methodologies and technological means to realize such experiences. We have studied the generation and retrieval of personalized content through the use of augmented annotations, to obtain the adaptation of the experience to context of work. Specific educational settings have been considered when experimenting and evaluating the practical aspects of the research, with particular reference to technology enhanced learning. In this respect, the project is developing novel educational scaffolds in the context of classroom-based education, through the employment of mobile devices equipped with specialized digital imaging and processing application software. Employed BYOD-based learning interactions allow such a model to foster collaborative use of educational materials and implement novel pedagogical scaffolds for more efficient organization of the instructional design process.

Results

Work has been conducted on modeling of context; a line of research has started in the development of a mobile application able to capture different sources of information, in particular identification of accessible WiFi and

Bluetooth signals, explicit tagging, geographical coordinates and calendar information, to characterize the working context in which annotations are taken, so that they can be retrieved and interactively served when a user is immersed in a similar context [1].

Recent pedagogical and didactic advancements in the context of mobile technologies have prompted for a wider employment in educational settings, while stimulating the design of novel learning methods and materials. In this context, we have considered the relevant pedagogical aspects of a BYOD-mediated Human-Computer Interaction (HCI) approach in the development of interactive learning systems specifically targeting the employment of mobile devices [2]. We are researching in particular novel pedagogical frameworks that will allow students to engage in augmented learning experiences through the usage of their own mobile devices in the interaction with enhanced materials and surroundings. The pedagogical model addresses the employment of QR and other specialized optical codes that are seamlessly accessible through smart devices cameras, in order to give the students the possibility to perform meaningful interaction with multimedia learning materials and thus boost their skills development. Such infrastructure allows students to have a multimodal access to content and share knowledge on assignments thus constructing a truly collaborative learning environment.

An experimental practical implementation of this approach focused on testing of a Tangible-Technology Enhanced Learning (T-TEL) setup for collaborative interaction in digitally encoded surroundings encodings where image and sound processing mobile devices are used. The specific application area that has been addressed was memorization support. Our study focused in particular on logographic scripts and the facilitation of the retention and recalling process connected to the acquisition of pictograms through a mobile device-supported augmented implementation of the Method of Loci (aMOL). Augmented Reality functionalities have been added to the memorization support of the aMOL, giving the possibility to apply the framework to various disciplines other than language studies [6].

The biometric component of the research lead to an extensive study on topics related to gait tracking for recognition and authentication purposes in complex environments [3,4]. The study has considered factors such as the increasing accuracy of sensors, the ubiquitous presence of mobile devices, and the low cost of related techniques, which contribute to making such biometric approaches more attractive and suggest continuing investigating.

Some theoretical work has started on the notion of contract, whereby a contract is seen as a way of imposing constraints on processes resulting into the exchange of resources, so as to provide a logical framework in which to reason about possible outcomes of execution of contracts [5].

Meetings/Presentations

We have submitted an abstract and registered for a poster presentation at the CRP meeting in Tokyo on March 13th but due to the coronavirus outbreak the reporting session was cancelled.

使用した設備・資料・試料等	The equipment employed in the context of the conducted research includes large size tabletop computers with multi-touch tracking capabilities for surface based interaction experiments, optical readers for interactions with digitally enhanced surfaces, mobile routers and other communication equipment for network integration, posture sensing and motion tracking equipment for hand gesture and gait analysis, and others. The project also takes advantage of the BYOD (Bring Your Own Device) approach that allows participants in the experiments to use the communication and interaction devices that they are most comfortable with. The approach is complemented by dedicated communication devices with firmware, functionally enhanced to meet the requirements of the current

	project, that are made available at the premises of the project participants for conducting remote experiments. A novel Data Glove with embedded carbon nano-tube (CNT) stretchable sensors developed at RIE has also been made available to the project team. We have conducted some preliminary experiments that indicated different potential uses of the Data Glove in educational settings. We deem the Data Glove particularly suitable for teaching and learning of sign languages and are thus planning to conduct some research along this line.

本研究成果に関連する論文発表状況

[1] Paolo Bottoni, Francesco Di Tommaso, Emanuele Panizzi, "Capturing and using context in a mobile annotation application". *Proc. MUM 2019*: 49:1-49:4

[2] Gelsomini, F., Kanev, K., Barneva, R.P., Walters, L.M., Technological Enhancements of the Method of Loci for Facilitating Logographic Language Learning, Journal of Educational Technology Systems, Sage, March 2020, 440-459.

[3] Maria De Marsico, Alessio Mecca, Silvio Barra: Walking in a smart city: Investigating the gait stabilization effect for biometric recognition via wearable sensors. *Comput. Electr. Eng.* 80 (2019)

[4] Maria De Marsico, Alessio Mecca: A Survey on Gait Recognition via Wearable Sensors. *ACM Comput. Surv.* 52(4): 86:1-86:39 (2019)

[5] Paolo Bottoni, Daniele Gorla, Stefano Kasangian, Anna Labella: Modal Epistemic Logic on Contracts: A Doctrinal Approach. *Models, Languages, and Tools for Concurrent and Distributed Programming,* LNCS 11665; 2019: 298-314.

次年度の共同研究継続の有無	有 ・ 無	拠点内対応教員とご相談の上ご記入ください。 継続の場合には次年度の研究計画をご記入願います。

次年度の研究計画（継続の場合）

In the next fiscal year we are planning to continue the work on this project and further explore various types of sensors, devices, and specialized equipment for integration of biometrics into different interaction models. Possible experimental applications are envisaged in educational settings where we will seek to identify areas of teaching and learning suitable for biometric enhancements.

We will build upon the work conducted in this and the previous years of the project and thus employ the obtained so far theoretical results. With respect to the methodological development, work on the notion of contract will proceed towards the integration of notions of events, including those generated by interactive devices, into contract execution.

Concerning the use of augmented artifacts to support the learning processes employing the BYOD paradigm, work will proceed with the preparation of materials for classroom experiments by the project members that could also be disseminated for wider usage.

Work on the development of algorithms, techniques, and tools for applying biometric techniques to provide access to different information components and processes will proceed, following the successful results obtained so far. More specifically, we are planning to conduct biometric experiments with the Data Glove developed at RIE and evaluate its potential for use in different educational settings, including but not limited to sign language teaching and learning.