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平成29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) (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	平成 29 年 4 月 17 日 ～ 平成 30 年 3 月 31 日

研究組織

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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

The research work has been conducted mainly by the group of Professor Bottoni in Rome and of Professor Kanev in Hamamatsu and has also taken advantage of the visit of Professor Kanev to Sapienza University of Rome for 3 months in the fall of 2017. Federico Gelsomini visited the Hamamatsu Campus in December 2017 and Professor Bottoni visited the Hamamatsu Campus in February 2018. Dr. Gelsomini (in person) and Professor Bottoni (remotely) delivered presentations resulting from joint work at the Hamamatsu session of HC 2017. During his visit, Professor Bottoni, delivered a seminar on advances in the work on annotations and of their relation to the deployment of systems based on biometric sensors.

The work of this year has focused on the integration of different modalities, also based on gestures and relying on mobile devices, in facilitating the learning process, especially regarding people with disabilities, in particular deaf people, or with specific hindrances to learning, e.g. in learning of foreign languages. Besides, the work on annotations and on gait detection has proceeded.

As concerns work on annotations, we have progressed in our research on the use of annotation techniques to cover the whole development process from a high-level specification of requirements to the generation of deployment

configurations, through the derivation of admissible dynamics, also considering the case where deployment involves connection with biometric sensors [BP18, Bot18a, Bot18b]. Moreover, we have considered that in several situations the possibility of complying with policies in the execution of some task is dependent on the availability of specific resources. Hence, we have introduced a synchronization mechanism, based on annotation of instances with resources, so that the transformations required by a policy occur with respect to available resources. In particular, resources can be atomically produced or consumed or can change their state consistently with the evolution of the entities subject to the policy [BFHP17]. The use of annotations in an interactive setting has also taken into consideration the possibility of creating and perusing annotations addressed to a group of users, rather than to oneself or to the general public [ABA17]. Access to open and linked data, where most of the annotations live, has been facilitated by proposing a visual language and an environment, based on the popular notion of visual block, to query endpoints of online resources, even without knowing a priori their internal schema [CB17].

As concerns work on gait detection, an approach to gait recognition has been developed, which is based on a single consumer accelerometer, built in most present mobile devices. The approach investigates better ways to exploit the Dynamic Time Warping (DTW), making use of a new segmentation algorithm to split the gait signal into cycles/steps, and investigating the best way to use the segmented signal for recognition. The new algorithm does not require any pre-processing to enhance the original signal. Extensive tests have been performed to compare different methods for matching an observed gait to the model of a user [DMM17]. Experimentations have also been conducted regarding the automatic extraction of relevant features computed from the three raw accelerometer signals (one for each axis) [DFM18].

Particular attention has been devoted to topics related to learning, and to the usage of personal devices for accessing and integrating learning material of various nature, according to the Bring-Your-Own-Device (BYOD) concept. From the point of view of the learning model made possible by this concept, we have proceeded by considering the image sensors embedded into Smart phones and other mobile devices as a basis for direct point-and-click functionalities that link printed content to multimedia material on DVDs or online [BGKB18]. Proofs of concept are being developed in the context of learning the Italian language both by deaf users conversant in the Italian Sign Language (LIS) [RGKGB18] and by foreign people, immigrants or overseas students [GKB17]. As a further extension, access to Virtual and Augmented Reality LIS content that can be presented on mobile devices synchronously with material from workbooks is also envisaged. Moreover, access to Sign Language pictorial dictionaries is made possible by recognizing either the corresponding gestures or a still picture from a video demonstrating the sign [BKG17]. From the technical point of view, the requirements and the possible threats related to integrating own devices with WAN or LAN in order to protect access to material intended for restricted groups, while preventing malicious users to exploit their devices for attacking the host network have been discussed in [PKBVM18]. In particular, a framework is under construction for experiments with mobile routers applicable to both home and business networks.

References

[RGKGB18] M.Roccaforte, F.Gelsomini, K.Kanev, P.Giunchi, P.Bottoni, “Applying the BYOD Concept to Italian Sign Language learning” presentation at *DILLE 2018*, Siena (Italy)

[Bot18a] P.Bottoni, “Advances in Software Development: Interactive Systems”, invited talk at *Global Bridge Workshop*, Hamamatsu, 21 February 2018

[Bot18b] P.Bottoni, Formal descriptions of annotations, policies, and patterns for flexible design, Invited Talk at *iCOMET 2018*, Sukkur, Pakistan, 4 March 2018

[BKG17] P.Bottoni, K.Kanev, F.Gelsomini, “Tangible Interfaces and Multimedia to Enhance Sign Language Understanding”, presentation at *HC17*, Hamamatsu (Japan)

[GKB17] F.Gelsomini, K.Kanev, P.Bottoni, “Activity and Content Design for Improved Collaborative Learning”, presentation at *HC17*, Hamamatsu (Japan)

Meetings/Presentations

[Bot18a] Research Advancements in Software Development: Interactive Systems (P.Bottoni, 2018.02.21, RIE204)

使用した設備・資料・試料等	Spatial motion tracking including gait and gesture analysis is based on data gathered by a 9-axis sensor system comprising of a 3-axis magnetometer, 3-axis accelerometer, and a 3-axis gyroscope employing sensor fusion technology for more accurate orientation solution and consecutive dynamic path extraction. A large size tabletop computer capable of simultaneous tracking of up to 12 surface motions is used for reference experimental work at the Research Institute of Electronics under the supervision of Profs Kanev and Mimura.

本研究成果に関連する論文発表状況

[ABA17] A.Hawash, P.Bottoni, D.Avola, "Supporting Group Collaboration in an Annotation System", *Journal of Visual Languages and Computing*, vol. 41,pp.22-40, 2017.

[BFHP17] P.Bottoni, A.Fish, A.Heußner, F.Parisi Presicce, "Resource-aware Policies", *Journal of Visual Languages and Computing*. vol.38, pp.84-96, 2017.

[BGKB18] R.P.Barneva, F.Gelsomini, K.Kanev, P.Bottoni, "Tangible Technology-Enhanced Learning for Improvement of Student Collaboration", *Journal of Educational Technology Systems*, vol.46, n.3, pp.284–302, 2018

[BP18] P.Bottoni, F.Parisi Presicce, "From requirements to deployment via graph transformation techniques", *in preparation*.

[DFM18] M.De Marsico, E.G.Fartade, A.Mecca, "Feature-based Analysis of Gait Signals for Biometric Recognition - Automatic Extraction and Selection of Features from Accelerometer Signals", *Proc. ICPRAM 2018*, pp.630-637

[CB17] M.Ceriani, P.Bottoni, "SparqlBlocks: Using Blocks to Design Structured Linked Data Queries", *Journal of Visual Languages and Sentient Systems*, vol.3, 2017, doi: 10.18293/VLSS2017-011

[DMM17] Maria De Marsico, Alessio Mecca, "Biometric walk recognizer - Gait recognition by a single smartphone accelerometer", *Multimedia Tools Appl.* 76(4): 4713-4745 (2017)

[PKBVM18] M.Pedone, K.Kanev, P.Bottoni, D.Vitali, A.Mei, "Firmware Enhancements for BYOD-Aware Network Security", in *Recent Advances in Technology Research and Education*, Springer International Publishing, ch.34, 2018.

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)

The work will capitalize results obtained in the previous year, both on the theoretical/methodological side and on the experimental side.

As concerns the first aspect, we plan to lift the notion of annotation so as to allow the annotation of metaclasses and of roles in patterns. This will allow modelers to annotate generic description of entities, and to have annotations automatically associated with entities complying with those descriptions, independent of the specific type of these entities. For example, one could annotate with some security information every component (i.e. every entity whose metaclass is Component) which plays the role of an Observable in the Observer pattern, so that it can only be observed by entities with some suitable security level. An implementation of the theory of annotations on the base of AGG, the reference tool for specification and execution of graph transformation systems will also be undertaken.

Concerning the use of augmented artifacts to support the learning processes, also adopting the BYOD paradigm, we will proceed to a more extensive coverage of the approach in a real learning environment, also considering the possibility of providing access to different types of materials. In particular, we will experiment with learning techniques aimed at promoting collaboration among students in the learning process by forcing them to integrate gaps in one's knowledge with partial information available to other participants. This will require the generalization of notions of content integrated with information gap filling in order to support the automatic generation of materials to be distributed to students. The proper definition of supports to the interactions required in the integration process and the assessment of the correctness of the information reconstructed from the interactions becomes essential in this process.

Finally, we will proceed with the development of algorithms, techniques, and tools for applying biometric techniques to provide access to different information components and processes.

The different lines of research and development will also concur to an integrated view of context as defined by its multiple facets, e.g. availability of resources and different forms of access to them, user profiles, also reflecting their abilities/disabilities and the capabilities of their devices, also impacting the forms of adaptation of the content, of particular relevance for the learning case study. Annotations provide a easily manageable and formally sound way to deal with constructing this integrated view and the deployment of suitable contextual adaptations.