

Digital Imaging for Active Knowledge Semantic Surfaces

[1] Organization

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[2] Progress of the Research

In this project we address some technological aspects of Ambient Assisted Learning (AAL) by investigating and deploying innovative methods and facilities for ambient information control. We attach spatial connotation to real world surfaces and create semantic surfaces for direct ambient interactions. Although different technologies can be employed for the implementation of semantic surfaces, our work focuses mainly on optical methods for surface encoding and consecutive code extraction and recognition.

Surfaces around us such as indoor walls, windows, product packing, newspapers and many others could be digitally enhanced with embedded spatial information for surface based interactions. Recognition of surface semantic could then be implemented through specialized optical readers that extract the spatial digital content and employ it for ambient interface control.

Within the scope of this project we also develop an infrastructure for visualizing the invisible and for supporting the understanding of corresponding things and their features. The infrastructure builds

on the concepts of semantic surfaces and totally identified objects.

A *semantic surface* is an object surface enhanced by special images (codes) [and/or embedded chips (devices)] for supporting access to information about object features, etc., and for organizing interactions between objects and people.

A *world of totally identified objects* is a real world infrastructure, where most of the physical objects have their IDs (or sets of IDs for various parts, their connections, etc.), which are recognizable by appropriate portable or fixed devices for getting real-time and/or archive information related to the objects.

In the course of the research the following problems have been identified and addressed:

- creation and deployment of semantic surfaces
- extraction of semantic surface encoded information
- access to meaning through semantic surfaces

On a more practical level, the following tasks have been carried out:

- analysis of existing codes and evaluation of their applicability to semantic surfaces of different scales
- comparison of semantic surfaces with other localization (e.g. GPS) and identification (e.g. RFID) methods
- consideration of different watermarking techniques in the context of semantic surfaces

During the project period 7 visits for presentations and research meetings at Shizuoka University have been accomplished.

[3] Results

(3.1) Research results

Results obtained within the scope of this project have been reported at international conferences and published in books and reputable international journals. With a total of 12 published works the research outcome of the project well exceeds the initial goals and makes a very good foundation for a continuing collaboration.

The more detailed investigation of the newspaper concept has already started with possible functionality and applications being identified as follows:

- obtaining ratings of articles and topics, etc. as well as various statistics
- organizing new types of polls to better know people needs, feelings, intensions, problems, and troubles
- multimedia support to people with special needs including the elderly and disabled
- static text/picture advertising with dynamic video and sound support
- direct real-time access to databases, dictionaries, encyclopedias, weather sites, stock exchange data, etc.
- ontology-based information retrieval

(3.2) Future work

In our future research we are planning to build on the potential of semantic surfaces to offer solutions such as:

- robot vision for navigation in indoor and outdoor environments, based on recognition of semantic surface codes
- magic sticks with semantic surface tracking capabilities for guidance of visually impaired
- newsputers (an abbreviation from newspaper & computer) that offer a new way to create and access information resources

Semantic surfaces along with the practical implementation of the newsputer concept are expected to become a basis for a new form of *active knowledge* acquisition with embedded clarity. Such active knowledge is for easily finding necessary information and for understanding and using it with no delays. To realize it, multiple views and self-explanatory components that pronounce the semantic richness of knowledge data will be employed.

For further strengthening the research team and internationalizing the project we will be inviting prominent researchers from outside of Japan to join.

[4] Publications

- (1) Kanev, K., Mirenkov, N., Pervasive Carpet Encoding for Active Knowledge Semantic Surfaces, Book chapter in "Ubiquitous Multimedia Computing", Qing Li and Timothy K. Shih (Eds), Chapman & Hall/CRC Press, 2010, pp.197-213.
- (2) Dimitrov, K., Kanev, K., Kimura, S., Product Recommendations in Mobile Environments, Information Technologies and Control, Vol. 7, No 3, pp.10-14, 2009.
- (3) Mirenkov, N., Kanev, K., Takezawa, H., Mobile Music Therapy with Multimedia Quality of Life Supporters for Elderly and Disabled, Journal of Mobile Multimedia:

Special Issue on Multimedia Networking and Applications, Vol. 5, No. 1, pp. 29-44, 2009.

- (4) Cohen, M., Gyorburo, N., Kanev, K., Print-based Interfaces for Multimodal Virtual Tours. Cryptosteganographic Affordances for Multimodal Interfaces and Immersive Experiences, In *Proceedings of the 12th Int. Conf. on Humans and Computers HC'09*, Hamamatsu, Japan, Dec. 9-10, 2009, pp.26-32.
- (5) Dimitrov, K., Mirenkov, N., Kanev, K., Towards a World of Totally Identified Objects, In Proc. of the 2009 Joint Conf. on Pervasive Computing (JCPC2009), Taiwan, Dec. 3-5, 2009, pp.83-88.
- (6) Kanev, K., Mirenkov, N., Brimkov, B., Dimitrov, K., Semantic Surfaces for Business Applications, In *Proceedings of the Int. Conf. on Software, Services and Semantic Technologies s3t2009*, Sofia, Bulgaria, Oct. 28-29, 2009, pp.36-43.
- (7) Dimitrov, K., Kanev, K., Kimura, S., Product Recommendations in Mobile Environments, In *Proceedings of the Int. Conf. Automatics and Informatics'09*, Sofia, Bulgaria, Sept. 29-Oct. 4, 2009, pp.17-20.
- (8) Dimitrov, K., Kanev, K., Mirenkov, N., Semantic Surfaces in Ambient Assisted Living Environments, In *Proceedings of the First Int. Workshop on Aware Computing (IWAC09)*, Aizu Wakamatsu, Japan, Sept. 17-18, 2009, pp.717-722.
- (9) Watanobe, Y., Mirenkov, N., Yoshioka, R., Algorithm library based on algorithmic cyberFilms. Knowledge-Based Syst. 22(3): 195-208 (2009)
- (10) Watanobe, Y., Malyshkin, V., Yoshioka, R., Mirenkov, N., Fujita, H., Filmification of Methods: Representation of Particle-In-Cell Algorithms, In Proceedings of 10th International Conference on Parallel Computing Technologies, PaCT-2009, September, Novosibirsk, Russia, LNCS 5698, Springer, 360-376.
- (11) Watanobe, Y., Yoshioka, R., Tsukumoto, S., Mirenkov, N., Filmification of methods: Convex Hull algorithms, in Proceedings of IEEE TENCOP 2009 (Emerging Technologies for Sustainable Development), November, Singapore, 2009, THU2.4.1, 1-6.
- (12) Bottoni, P., Vazhenin, D., Vazhenin, A., Mirenkov, N., Shape-based computation on regular processor networks, in Proceedings of IEEE Symposium on Visual Languages and Human Centric Computing, Corvallis, Oregon, September 2009, 165-169.

Travelling report

Name: Nikolay Mirenkov
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: July 16, 2009 – July 19, 2009
Destination: Shizuoka University, Japan
Purpose: To carry out a joint research and project organization meetings and to schedule future research activities
Name of receiver: Prof. Kamen Kanev

Name: Jungpil Shin
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: September 3, 2009 – September 5, 2009
Destination: Shizuoka University, Japan
Purpose: To participate in joint research meetings and to schedule future research activities
Name of receiver: Prof. Kamen Kanev

Name: Kamen Kanev
Affiliation: Research Institute of Electronics, Shizuoka University, Japan
Period of time: September 17, 2009 – September 18, 2009
Destination: The University of Aizu, Japan
Purpose: To attend joint research and project organization meetings and to participate in IWAC 2009 where project results were reported
Name of receiver: Prof. Nikolay Mirenkov

Name: Michael Cohen
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: December 9, 2009 – December 10, 2009
Destination: Shizuoka University, Japan
Purpose: To participate in joint research meetings and to give a presentation, based on project results, at HC-2009
Name of receiver: Prof. Kamen Kanev

Name: Norbert Gyorbrio
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: December 9, 2009 – December 11, 2009
Destination: Shizuoka University, Japan
Purpose: To participate in joint research collaborative meetings and discussions
Name of receiver: Prof. Kamen Kanev

Name: Jungpil Shin
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: January 27, 2010 – January 29, 2009
Destination: Shizuoka University, Japan
Purpose: To discuss joint research and give a presentation supported by this project
Name of receiver: Prof. Kamen Kanev

Name: Nikolay Mirenkov
Affiliation: Department of Computer Science and Engineering, The University of Aizu
Period of time: February 4, 2010 – February 6, 2009
Destination: Shizuoka University, Japan
Purpose: To conduct joint research and project organization meeting and to give a presentation about the project research progress
Name of receiver: Prof. Kamen Kanev

Name: Paolo Bottoni
Affiliation: Department of Computer Science, “Sapienza” University of Rome, Italy
Period of time: February 11, 2010 – February 13, 2010
Destination: Shizuoka University, Japan
Purpose: To discuss joint research and to give a presentation, supported by this project
Name of receiver: Prof. Kamen Kanev