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Digital Imaging for Active Knowledge Semantic Surfaces

[1] Organization

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[2] Progress of the Research

This year we have addressed and employed new aspects of digital imaging and by

a) considering various technical aspects of laser volumetric marking for creation of encoding areas on surfaces and in the bulk of different objects and investigating optical means for code extraction and consequent analysis,

b) conducting experiments and numerical simulations of environmental conditions related to time-varying flows and dynamic solid phase changes addressing e-learning in engineering education,

c) constructing and implementing special installations (environments) with digitally enhanced tangible interface components for direct and augmented reality interactions ,

d) devising and studying image based interactions oriented to explanations of meaning of information resources within various educational processes, and

e) conducting integration between annotations, surface-based interaction and tangibles.

More precisely, prospects and technical aspects of creation of encoding areas inside different objects by laser volumetric marking have been analyzed. Unique capabilities of focused, short laser pulses, to create different kinds of marks (local structure damages, micro-cracks, voids, pores, optically active nanoparticles, light-emitting centers, and other optical inhomogeneities) in the volume of materials, which are transparent for the selected laser wavelength have been studied. Laser-induced marks with varying appearance (or *data pixels*) can serve as multi-bit information carriers that open a wide range of new possibilities for volumetric parameterized marking, encoding, and recording of digital information. Promising results of experiments with different approaches and laser techniques for creation, monitoring, and measurement of such marks have been obtained [1, 4].

The laser-assisted methods and technologies have been considered which can be applied for optical recording of information by creation of micro-marks (pixels) in the bulk of various objects transparent for laser radiation. Along with existing laser marking technologies based on changing the refractive index of a local material area and its shape and size, the possibilities of formation of color marks have been discussed, and a new approach has been analyzed when laser-induced marks are absorption or emission centers under backlight illumination [4, 5].

We studied the solid phase dynamic response due to time-varying duct flows when a portion of a duct wall is cooled to below the liquidus temperature, along which unidirectional

solidification from the cooling duct wall, perpendicular to the flow direction, is assumed. A one-dimensional numerical model for the average solid phase thickness has been formulated employing the boundary tracking method. It is shown that a quasi-steady state temperature in the solid layer allows us to develop an analytical solution, making use of perturbation technique. The afore-mentioned perturbation analysis identifies important three non-dimensional parameters, i.e. the Biot number based on the solid phase thickness at steady state, the Stefan number based on the temperature difference between the cooling wall and the liquidus temperatures, and the Stefan number based on the liquidus and the flowing liquid temperatures. Results obtained by both approaches agree well in general, and the time-variation trends of solid phase thickness and its phase delay have been obtained as a function of the non-dimensional angular frequency of the modulating duct flow velocity, with the above three non-dimensional parameters. Various applications in practical engineering and in engineering education have been identified and are being addressed by the developed Graphical Interface Framework for Educational and Engineering Support [2].

Our work has also included considering digital object and environmental enhancements through durable surface and undersurface encoding by printing and laser marking. While resulting augmented physical objects and environmental surfaces preserve their usual appearance, they become easily recognizable and tractable by optical means. Based on such encodings novel interaction mechanisms have been developed and concrete works on interior pattern design and physical interface component constructions have been done along with their applications in the creation and employment of tangible interfaces and image-based interactions [3].

The natural intelligence is related, in a great part, with people abilities to perform mental simulation, including thinking/reasoning, problem solving, and decision making. However, this simulation depends not only on internal information processing mechanisms of the brain, but also on levels of abstraction connecting the physical world things and corresponding abstract models. Perception and cognition of people are usually much higher if they perform mental manipulations with real objects, and essentially decreased if abstract information objects are involved. Syntax-semantics gap is a fundamental basis for many problems related to the perception and cognition. This gap is predefined by existing systems of symbols, notations, languages, as well as by ambiguous terminologies, trans-disciplinary and cross-cultural contexts, etc. We have addressed this issue in our tangible interfaces and image-based interactions and obtained really new results [6, 7].

We also considered DfPL, an RDF-based pipeline language for RDF and XML processing [8]. Applications are built using a few basic operators that compose single RDF graphs or datasets to create new graphs or datasets. RDF graphs can include both static and dynamic content. The language includes stateless operators (graph union and SPARQL CON-STRUCT) as well as a stateful one ("SPARQL updatable" graph). We also present SWOWS, an environment running event-based applications specified via DfPL, supporting both GUIs and touch/tangible interfaces.

During the project period several visits for presentations and research meetings at Shizuoka University have been accomplished, and a few researchers from outside of Japan have participated. In particular the Project Leader Professor Mirenkov travelled to Hamamatsu in February 2012 to carry out joint research and project organization meetings, to schedule future research activities, and to participate and report obtained results at the 15th International Conference on Human and Computers HC2012. Dr. Gnatyuk's visit to Hamamatsu in January-February 2012 was also partially covered by the budget of this cooperative research project. In the course of his visit research meetings were held and the presentation "Volumetric Marking with Laser-Induced Parameterized Centers" was made at the 15th International Conference on Human and Computers HC2012. Professor Kanev visited Sapienza Universita di Roma in June 2012 and was hosted by Professor Bottoni who is scheduled for a three-month research visit to Shizuoka University in April-June 2013.

[3] Results

(3.1) Research results

Results obtained within the scope of this project have been presented at nine International conferences and published in corresponding Proceedings. International collaboration with researchers from Bulgaria, Canada, Ukraine and Italy has been successfully continued. In particular, some work in view of an integration between annotations, surface-based interaction and tangibles has been conducted in Italy, leading to two publications, concerning the definition of a

language for managing interaction with elements based on RDF, with application to surface-based interaction [8], and protection of annotations to groups of users sharing some common interest identified via semantic web techniques [9].

(3.2) Future work

We are planning to use the potential of our results obtained within the project during the previous years. We will consider extensions of the tangible and image based interfaces, cognitive aspects of such interfaces and their use in research and educational processes.

[4] Publications

(1) Gnatyuk, V.A., Kanev, K.D., Mizeikis, V., Aoki, T., Gagarsky, S.V., Poperenko, L.V., Laser Volumetric Marking and Recording of Digital Information, *The 10th Int. Conf. on Global Research and Education InterAcademia2012*, Budapest, Hungary, August 26-30, 2012, pp.189-200.

(2) Kimura, S., Yamamoto, H., Kanev, K., Periodic Solidification in a Rectangular Duct Due to Velocity Modulation; One-dimensional Analysis, In *Proceedings of the Int. Conf. Automatics and Informatics'12*, Sofia, Bulgaria, October 3-5, 2012, pp.17-21.

(3) Kanev, K., Augmented Tangible Interface Components and Image Based Interactions, *International Conference on Computer Systems and Technologies CompSysTech'12*, Ruse, Bulgaria, June 22-23, 2012, pp.23-29.

(4) Gnatyuk, V., Kanev, K., Mizeikis, V., Aoki, T., Gagarsky, S., Poperenko, L., Volumetric Marking with Laser-Induced Parameterized Centers, In *El. Abs. of the 15th Int. Conf. on Humans and Computers HC2012*, Hamamtsu, Japan, February 11-12, 2013, pp.21-22.

(5) Mizeikis, V., Kanev, K., Gnatyuk, V., Automated System for Experimental Localization Encoding by Laser-induced Damage, *2012 Symposium on Nanovision Technology*, Taipei, Taiwan, October 19, 2012.

(6) Watanobe, Y., Mirenkov, N., F-modeling environment: acquisition techniques for obtaining special-purpose features, Proceedings of Databases in Networked Information Systems, DNIS-2013, LNCS 7813.

(7) Watanobe Y., Shiota, T., Mirenkov, N., Units of Measure Analysis and its Implementation for AIDA, New Trends in Software Methodologies, Tools, and Technologies (Proceedings of the 11-th SoMet-12), IOS Press, 2012, 198-212.

(8) Bottoni, P., Ceriani, M.G., Medaglia C.M., An Event-Supporting RDF-Based Pipeline Language for RDF Processing, Proc. of the First Workshop on Programming the Semantic Web (PSW 2012), http://www.inf.puc-rio.br/~psw12/2.pdf

(9) Avola, D., Bottoni, P., Hawash, A. Using Ontologies for Users-Groups Matching in an Annotation System, Proc. of CSIT 2013, (to appear).

Travelling report

Name:	Nikolay Mirenkov
Affiliation:	School of Computer Science and Engineering, The University of Aizu
Period of time:	February 10, 2013 – February 16, 2013
Destination:	Shizuoka University, Japan
Purpose:	To carry out joint research and project organization meetings, to schedule future research activities, and to participate and report obtained results at the 15th International Conference on Human and Computers HC2012.
Name of receiver:	Prof. Kamen Kanev

Name:	Volodymyr Gnatyuk
Affiliation:	V.E. Lashkaryov Institute of Semiconductor Physics, National Academy of Sciences of Ukraine
Period of time:	January 14, 2013 – February 17, 2013
Destination:	Shizuoka University, Japan
Purpose:	To carry out joint research, plan the future collaboration, and participate and report obtained results at the 15th International Conference on Human and Computers HC2012.
Name of receiver:	Prof. Kamen Kanev