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1 Introduction

The Institute of Software Technology is the largest of the institutes of the faculty considering both the number of academic staff and the number of students taught. More than 30 colleagues in four departments (Departments of Software Engineering, Software Technology, Enterprise Management Systems, and Mathematics) take care of the educational tasks.

The nationwide unique competence centres, run jointly by multinational firms, cover the following areas within the key-role branches of information technology: general purpose operation systems and development tools (**Microsoft Competence Centre**), database management (**Oracle Competence Centre**), enterprise management systems (**SAP Competence Centre**). These competence centres guarantee the continuous knowledge-base flow and technology transfer between our institute and the leading members of e-business. This greatly contributes to the constant renewal of our education and the launching of up-to-date optional subjects.

2 Educational Profile

During more than 30 years of informatics engineer training at the John von Neumann Faculty of Informatics, the Institute of Software Technology has always been one of the strongest supports. Within the course students get acquainted with modern methods and tools of software development, gain routine in object oriented and visual programming techniques, acquire abilities to plan, create and modify databases. The academic tasks of the institute also include the teaching of mathematical subjects. After basic training students can achieve theoretical and

practical expertise in one of the timely branches of informatics within the frames of the specialization scheme (software technology, informatic and automated systems, database management, enterprise management systems), and optional subjects.

An outstanding mainstay of our institute is multidirectional talent-spotting. During basic training, interested students are given extracurricular mathematical education, due to which they have achieved several first prizes in the recent years, both individually and in teams at the Hajós György National Mathematics Contest organized for students of polytechnical institutions. Activity in the Students' Scientific Association (TDK) offers a unique opportunity for individual research and development work. Students participating in TDK projects solve and present interesting development problems with teachers' guidance. In recent years our students have reached roaring success at the bi-yearly organized National Conferences of Students' Scientific Associations (OTDK). In 2003 two first prizes, two second prizes, two third prizes and a special prize were brought home, whereas in 2005 three first, three second, one third and one special prize were awarded to our students.

3 Research and Scientific Activity

Research and scientific activity of the institute is extremely diversified, it incorporates several fields. The most relevant topics and results are presented in the following.

Computer Vision-based Mobile Robot Navigation

The aim of the research is to investigate problems connected with the working environment of mobile robots, for which information gained through image processing offers some help. The goals are proper navigation, path planning and obstacle avoidance. Research comprises several elements based on each other. The digitalized picture of a camera serves as base information, which is filtered with different image processing algorithms. One of the elements of the investigation is the analysis of these basic algorithms and their collective effect. Another utilization of the camera image is to scan the position of objects in the robot's environment [1], and the mechanism of the map-building.

PAL optic was used for the first time in the case of stepping robots for the simultaneous investigation of the environment of the legs. With this method it is possible to avoid obstacles nearby, and the legs can be moved more efficiently [2]. In familiar outdoor environment the position and orientation of the robot can easily be calculated of the physical characteristics of the objects by producing omnidirectional images [3]. Applying structured lighting, obstacles in front of the robot can be detected sufficiently fast, which allows real-time obstacle avoidance.

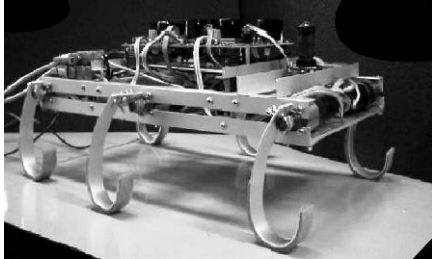
- [1] Vámosy, Z., Molnár, A.: Obstacle Avoidance for a CLAWAR Machine, In: Proc.of 2nd International Symposium on Climbing and Walking Robots - CLAWAR'99, Portsmouth, (Virk, Randall, Howard (Eds.)), Professional Engineering Publishing Limited, London, 1999, pp. 597-603
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- [3] Vámosy, Z., Tóth, Á., Hirschberg, P.: PAL Based Localization Using Pyramidal Lucas-Kanade Feature Tracker, In: 2nd Serbian-Hungarian Joint Symposium on Intelligent Systems, Subotica, Serbia and Montenegro, 2004, pp. 223-231

Mobile Robot Development

Research regarding autonomous robots aims to improve gaiting strategies, to increase mobility and stability, and tends towards operator-independent operation. In the case of gaiting strategies static and dynamic walking strategies are examined separately [1] from different aspects: efficiency, reliability and energy management. Within the field of autonomous operations, research is focused on moving and task fulfilment partly in known, partly in unknown circumstances. The aim of the investigation is to compare simulation results of certain path planning models (GVD, wave-backpropagation, regulatory system, neural network) with results given by real robots.

Stability is a crucial point of view in the development of walking robots. Different dynamic and static strategies have been elaborated through the investigation of walking robots, which also covered energy management. Energy consumption of walking has been examined as a function of time, based on which the development of new constructions of low consumption has started. During the development of operator-independent operation a stressed aspect has been the total autonomy of the robot, where energy is supplied and controlled aboard.

Some experimental mobile robots have been constructed and presented at national and international exhibitions and fairs. The built robots are also used for practical examination of solution methods of path planning and navigational tasks.



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Special Retrieval Systems

Queuing systems, where customers arrive at a server, and after getting serviced leave the system can be found in several areas of everyday and technical life – primarily in informatics – and constitute an important branch of mathematics.

The aim of the research is to elaborate the analytic mathematical description of such mass-service systems, where waiting time of customers can only be the multiple of a certain cycle-time T . This type of systems can be found for instance at the landing of aeroplanes or the optical buffers of telecommunication networks, for which different arrival and waiting-time distributions lead to different mathematical problems. A generalization of the problem is the investigation of systems of more than one type of customers (so-called systems of relative priority). Our aim, where it is possible, is to underpin theoretical results with simulation done with the help of some computer algebra system.

Within the project we focus on relative priority cases of systems described above based on simpler cases already described. Regarding the different service-time distributions of systems serving two different types of customers, generating functions of transition probabilities, ergodicity conditions, stationary and limit distributions are to be determined. Both continuous (uniform, exponential and their combinations) and discrete (uniform, geometric and their combinations) service time distributions are considered. Numerical investigation is also carried out to support calculations.

Thus far we managed to give the exact mathematical description, necessary and sufficient conditions of ergodicity for those relative priority systems serving two types of customers, where service time is continuous, uniformly or exponentially distributed, and where these are combined. [1], [2]. These systems have been simulated with the help of computer algebra system MAPLE [1]. In the case of continuous uniform distribution some simplification conditions were assumed for

convenience reasons, but we have managed to extend the theory to cases without these assumptions. In the discrete case generating functions of transition probabilities have been determined with distributions mentioned above and in the case of three different collision-treatment discipline. Functions of the expected value of the queue-length have also been determined, and ergodicity conditions were given in some of the cases. Similarly to the continuous case, theory has been supported by numerical investigation. [3]

Another direction of the research is represented by the so-called vacation systems, where some part of the busy period is not taken up by the service itself, but – due to some maintenance or preparation for service – by idle periods, vacations. Although for these systems classical methods can be applied, they end in extremely complicated results. Therefore, using another approach the equilibrium distribution is given with the help of recursive formulae. As far as the vacation is concerned, two different types are considered, at the beginning of service, at the end or the combination of these are examined. Results are generalized for systems accepting mass-arrivals. [4]

From the results of the project the defense of a doctoral dissertation is expected in the very near future.

- [1] P. Kárász – G. Farkas: Exact Solution for a Two-Type Customers Retrieval System. *Computers and Mathematics with Applications* 49 (2005) 95-102
- [2] P. Kárász: Special Retrieval Systems with Requests of Two Types. *Theory of Stochastic Processes* 10 (26) 2004, No 3-4, pp.51-56
- [3] G. Farkas – P. Kárász: Investigation of a Discrete Cyclic-Waiting Problem by Simulation. *Acta Acad. Paed. Agriensis, Sectio Mathematicae* 27 (2000) 57-62
- [4] P. Kárász: Equilibrium Distribution for Bulk-Arrival M/G/1 System with Vacation. (submitted to *Journal of Mathematical Sciences*)

Face Detection, Face Recognition

The primary aim of the project [1, 2] is to examine the combination of face detection and face recognition techniques to see how it is possible to increase the efficiency of detection and recognition. The source of the information to be processed is a live camera image. In the course of face detection human faces have to be spotted in a camera image, or if a series of video images are processed, then tracking of faces and optionally the determination of their orientation is also a part of the task. One of the applied algorithms assumes that the shape of the face is elliptic and uses Hough's transformation for detection [1]. Another approach can be classified in the group of appearance-based techniques, whereas the third one applies searching for skin colours. As these methods work in different ways, it is feasible that they complement each other well. Where one of them is not efficient enough, the other one can give appropriate results, and vice versa. Another task

connected with the detection of faces is the determination of the orientation of the head, which can be achieved by the observance of the relative position of the eyes, the nose, the mouth, the hair or other characteristics. An extra task of the program is tracking, i.e. if a face is found in the image, then it is followed and paid attention to until it leaves the volume traced by the camera.

Another far-flung purpose of the project is face recognition, for which it is essential that the face is close enough in the image, and thus, characteristics can be retrieved with high precision. On the one part the system uses the method of eigenfaces as a holistic approach technique, using its supplement versions developed in the meanwhile. The eigenface method is an effective and simple solution to face recognition, which is based on the most effective retrieval of relevant information of face images. In other words the principal components of faces are to be found. Then the recognition process is as follows: the characteristic vector gained from the normalized face image is projected onto the space of base vectors determined by face images stored in the database, and then the stored face of closest characteristic vector is found. The system also includes a property-based method as another face recognition technique. Face images are convolved with filters, which are built up with Gabor-wavelets of five different frequencies and in eight directions. Characteristics retrieved this way are to be classified.

- [1] Bors, B., Horváth, R., Safranka, M., Vámosy, Z., CERBERUS Project, Human Verification: a Biometric Approach, In: IEEE International Conference on Computational Cybernetics, Siófok, August 29-31, 2003, on CD
- [2] Kövér, T., Vigh, D., Vámosy, Z.: MYRA – Face Detection and Face Recognition System, In: 4th Slovakian-Hungarian Joint Symposium on Applied Machine Intelligence, Herl'any, Slovakia, 2006 pp. 255–265, ISBN 963 7154 44 2

Intelligent Knowledge Evaluation

Development of an Intelligent Knowledge Evaluation Module through an Example Chapter of Mathematics

Research has been done through the Centre of Intelligent Knowledge Management and Innovation since summer of 2005. With the topic lecturer István Vajda has been enrolled in Debrecen University, Doctoral School of Mathematics and Computer Science in the autumn semester of academic year 2005/06.

Firstly, exercises in the assignments of mathematical subjects in the IT engineer course have been categorized. The base of categorization is formed by about 30 different written assignments of the previous three years, in which equal parts are taken up by mid-semester tests, end-of-semester examinations, and comprehensive examinations closing up mathematical studies. Statistical analyses are primarily concerned with one-semester subject Linear Algebra.

The aim of categorization – based on the written assignments already done – to determine task solution models, for whose analysis the system has to be prepared.

Basic expectation is that the system be able to recognize correct solution sequences and evaluate them. To prepare for this, categorized solutions of the exercises are split into elementary parts. An elementary part of the exercise is the least unit (atom) that can be evaluated by the system, whose output data (text, formula, figure, etc) have been classified with respect to syntactics. In the evaluation of an exercise a key role is given to what atoms it contains, but their connection structure is just as important, as well.

Another aspect of the research is to analyze (primarily mathematics oriented) examinations systems, with special attention to the applied data input methods (formula, figure, etc), and the intelligence of the automated evaluation [2]. With these experiences the facilities of the module will be defined precisely: expectations to students/examinees and teachers/examiners client modules will be formulated in the near future.

- [1] Dr. György Anna, Kos Viktor, Schmuck Balázs, Dr. Sima Dezső, Szöllősi Sándor, Vajda István: *Intelligens vizsgakiértékelő rendszer*, IX. Országos Neumann Kongresszus Győr 2006. június 27-29.
- [2] Vajda István, dr. György Anna: *Elektronikus vizsgáztatás matematikából, Módszertani kérdések és lehetőségek*, Matematika, fizika és számítástechnika oktatók XXX. Konferenciája, Pécs, 2006. augusztus 23-25.

Development of a Module Evaluating Short Textual Answers

The aim of the research is to develop a module, which evaluates short, typically 4-5-sentence answers by aspects given by an examiner in advance. The project has run within the frame of the Centre of Intelligent Knowledge Management and Innovation since the summer of 2005. Besides this, the research serves as a doctoral topic for Sándor Szöllősi under the supervision of Dr. Dezső Sima in Pannon University, Doctoral School of Informatics.

As a first step, we have searched literature, and beyond the comparative presentation of knowledge evaluation systems we have pointed out the relevant trends of the present time, in order to be able to take them into account in the course of the present development.

To compare systems we have formed a unified system of aspects, which was used for the evaluation of the systems. To review the system of aspects the tool of design space was used.

We have found that knowledge evaluation systems can be approached from two different aspects: by the facilities they provide or by the way they are implemented. The aim of the published articles [1], [2] is to compare knowledge evaluation systems encountered in the literature with the help of the design space tool. Using relevant planning points of view and realization techniques we have

established the design spaces of facilities and the implementation of knowledge evaluation systems. By projecting possible combinations of planning aspects and planning alternatives onto each other we have received the spanned design spaces, in which we have positioned knowledge evaluation systems found in the literature. By analyzing realized systems it is possible to present the generations of knowledge evaluation systems, and to perceive determinative development directions.

Out of the trends concerning the facilities of knowledge evaluation systems it has to be emphasized that on the one hand the complexity of the evaluated exercise types and the extent of the automation of evaluation is constantly increasing, and on the other hand although several solutions to evaluate long essays have been found regarding active exercise types, the examined systems do not offer appropriate methods to evaluate short texts.

Out of the trends concerning the implementation of knowledge evaluation systems it has to be emphasized on the one hand that by the spread of internet usage platform-independent systems accessible through the global network come into the limelight more and more, and on the other hand regarding safety, authentication becomes more and more important, which can be considered as the Achilles' heel of the systems.

- [1] Sándor Szöllösi, Dezső Sima, Balázs Schmuck: The Design Space of the Services of Knowledge Assessment Systems, Proc. 7th International Conference on Information Technology Based Higher Education & Training (ITHET), Sydney, Australia, 2006, pp. 392-399
- [2] Balázs Schmuck, Dezső Sima, Sándor Szöllösi: The Design Space of the Implementation of Knowledge Assessment Systems, Proc. 7th International Conference on Information Technology Based Higher Education & Training (ITHET), Sydney, Australia, 2006, pp. 408-414

Content-based Image Retrieval

In general terms there are two methods used for searching image databases. One of them is textual search, which is based on the fact that key words are stored together with images. The other one is content-based search, where the indices of images are composed of the self-contained characteristics (e.g. colour, shape, pattern) of the image.

The main direction of our research is to examine the generating of so-called property vectors applied for content-based image retrieval, and to create new algorithms.

In the course of previous research, two things were investigated. One of them was to determine how efficiently it is possible to search databases by the global colour characteristics of the image. The other one was to determine that if the image is split into connected, homogeneous segments, how efficiently it is possible to

search databases by the colour characteristics of the individual segments. In the latter case it is necessary to adjust several parameters while generating the segments. Research is still in process to determine these automatically [1, 2, 3].

At several applications, colour itself is not enough to recognize objects in an image database, but very often the first information which is noticed of an object is still its colour. Hence, identifying colour regions can be a useful pre-filter algorithm with many applications, due to which colour-based image segmentation is a well active research topic.

Searching for colour regions can be carried out by clusterizing the colour histogram of the image generated in a certain colour space. Histograms, however, depend on the partition subtlety of the colour space, i.e. on how many buckets the colour space is divided into. Determining the number of buckets is a difficult problem, which requires a large number of experiments. At every experiment an expert has to evaluate by sight if the number of buckets is chosen appropriately. We are currently working on developing an algorithm that chooses the number of buckets automatically. The algorithm is based on the perception that connected regions of similar colours in an image observed by the naked eye are the same as the connected regions in the grey-toned version of the colour image. Consequently, regions generated with bucket numbers have to be compared with grey-toned regions.

The results of the research have been utilized in education, as well. Connected with colour-based retrieval the institute organized the Intensive Programme on Computer Vision summer school in August this year, whose main topic was colour usage in image processing and computer vision. More than sixty students from our faculty, a German, a French and two Finnish universities attended the summer school.

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- [2] Sergyán, Sz., Csink, L.: Consistency Check of Image Databases. In: Proc. of 2nd Romanian-Hungarian Joint Symposium on Applied Computational Intelligence, Timisoara, Romania, May 12-14, 2005, pp. 201-206
- [3] Sergyán, Sz.: Special Distances of Image Color Histograms. In: Proc. of 5th Joint Conference on Mathematics and Computer Science, Debrecen, June 9-12, 2004, p. 92

Intelligent House Project

Tools, which enable electric networks in buildings to be controlled by computers, to gather measured data and to be managed from a distance, are affordable nowadays. The infrastructure based on the so-called EIB technology contains intelligent switches, interlopers, blinds controllers, heat detectors, etc. The electric

network constructed this way and integrated into the network incorporating audiovisual equipments and the infocommunications network can serve as the base infrastructure to provide intelligent facilities.

The aim of the project is to develop a solution which can incorporate maintenance, supervision, management, optimization of energy consumption, building protection, safeguarding and fire service by distant management through the internet.

We have handed in a joint R&D application with other institutes for funds by NKTH.

Scientific Administration in the European Union from the Aspect of Applications

The European Council has declared the necessity of creation of knowledge-based economy on its Lisbon meeting on March 23-25, 2000. To reach this it is necessary – among others – to build up the infrastructure of knowledge, to support innovation and to reform the education system. And at last but not least substantial financial resources.

The aim of the research is

- to review prime questions of scientific administration of the European Union from the aspect of applications,
- to analyze statistical indicators, with which it is possible to keep track of the course of realization of knowledge-based economy,
- to review the changing of indicators analyzing reasons and consequences,
- to examine the volume and the change in the utilization methods of capital expended on research and development from the aspect of the fulfilment of the Lisbon Strategy,
- to reveal the main indicators of the operation of knowledge-based society, with special attention to publication and citation activity, to specialization by disciplines, and to other measurement possibilities of the efficiency of research and development,
- to review the regulations of innovation, to examine the utilization of results of research and development, and the role of risk capital.

Moreover, the research is also concerned with the informatic background of application processes, making suggestions to facilities of a complex application system. By the realization of the planned system it will be feasible to create applications of higher quality and to judge applications electronically created and handed in at a higher standard. At the same time, by increasing the transparency of the whole process a fairer judging system can be introduced.

All these can result in the betterment of the application system, and if it is put through, then both applicants, judges and callers of applications will profit from it, and hence, preparing this essay was not in vain.

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- [2] Yahoui, H., L. Csink: HU: Magyarország (Hungary), in: (Under the coordination of J. M. Thiriet & M. J. Martins) - Monograph: Towards the harmonisation of Electrical and Information Engineering Education in Europe" - Ed. EAEEIE, August 2003, 350 pages, (ISBN, book version: ISBN 972-97738-2-3, ISBN: CD-ROM version: ISBN 972-97738-3-1), pp. 106-113
- [3] Csink, L.: European Research and Development from a Financial Aspect. Studia Iuridica Caroliensa 1., Budapest, 2006, pp. 9-20