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CT, USA

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To my wife and sons.

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Preface

This book includes Volume I of the proceedings of the 2006 International Conference on Systems, Computing Sciences and Software Engineering (SCSS). SCSS is part of the International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CISSE 06). The proceedings are a set of rigorously reviewed world-class manuscripts presenting the state of international practice in Advances and Innovations in Systems, Computing Sciences and Software Engineering.

SCSS 06 was a high-caliber research conference that was conducted online. CISSE 06 received 690 paper submissions and the final program included 370 accepted papers from more than 70 countries, representing the six continents. Each paper received at least two reviews, and authors were required to address review comments prior to presentation and publication.

Conducting SCSS 06 online presented a number of unique advantages, as follows:

- All communications between the authors, reviewers, and conference organizing committee were done on line, which permitted a short six week period from the paper submission deadline to the beginning of the conference.
- PowerPoint presentations, final paper manuscripts were available to registrants for three weeks prior to the start of the conference.
- The conference platform allowed live presentations by several presenters from different locations, with the audio and PowerPoint transmitted to attendees throughout the internet, even on dial up connections. Attendees were able to ask both audio and written questions in a chat room format, and presenters could mark up their slides as they deem fit.
- The live audio presentations were also recorded and distributed to participants along with the power points presentations and paper manuscripts within the conference DVD.

The conference organizers are confident that you will find the papers included in this volume interesting and useful.

Khaled Elleithy, Ph.D.
Bridgeport, Connecticut
June 2007

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The 2006 International Conference on Systems, Computing Sciences and Software Engineering (SCSS) and the resulting proceedings could not have been organized without the assistance of a large number of individuals. SCSS is part of the International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CISSE). I had the opportunity to co-found CISSE in 2005, with Professor Tarek Sobh, and we set up mechanisms that put it into action. Andrew Rosca wrote the software that allowed conference management, and interaction between the authors and reviewers online. Mr. Tudor Rosca managed the online conference presentation system and was instrumental in ensuring that the event met the highest professional standards. I also want to acknowledge the roles played by Sarosh Patel and Ms. Susan Kristie, our technical and administrative support team.

The technical co-sponsorship provided by the Institute of Electrical and Electronics Engineers (IEEE) and the University of Bridgeport is gratefully appreciated. I would like to express my thanks to Prof. Toshio Fukuda, Chair of the International Advisory Committee and the members of the SCSS Technical Program Committee, including: Abdelaziz AlMulhem, Alex A. Aravind, Ana M. Madureira, Mostafa Aref, Mohamed Dekhil, Julius Dichter, Hamid Mcheick, Hani Hagras, Marian P. Kazmierkowski, Low K.S., Michael Lemmon, Rafa Al-Qutaish, Rodney G. Roberts, Sanjiv Rai, Samir Shah, Shivakumar Sastry, Natalia Romalis, Mohammed Younis, Tommaso Mazza, and Srini Ramaswamy.

The excellent contributions of the authors made this world-class document possible. Each paper received two to four reviews. The reviewers worked tirelessly under a tight schedule and their important work is gratefully appreciated. In particular, I want to acknowledge the contributions of the following individuals: Yongsuk Cho, Michael Lemmon, Rafa Al-Qutaish, Yaser M. A. Khalifa, Mohamed Dekhil, Babar Nazir, Khaled Hayatleh, Mounir Bousbia-Salah, Rozlina Mohamed, A. Sima Etner-Uyar, Hussein Abbass, Ahmad Kamel, Emmanuel Udoh, Rodney G. Roberts, Vahid Salmani, Dongchul Park, Sergiu Dumitriu, Helmut Vieritz, Waleed Al-Assadi, Marc Wilke, Mohammed Younis, John Zhang, Feng-Long Huang, Natalia Romalis, Hamid Mcheick, Minkoo Kim, Khaled Rasheed, Chris Panagiotakopoulos, Alex Aravind, Dinko Gichev, Dirk Mueller, Andrew Vincent, Ana Madureira, Abhilash Geo Mathews, Yu Cai, Spyros Kazarlis, Liu Xia, Pavel Osipov, Hamad Alhammady, Fadel Sukkar, Jorge Loureiro, Hemant Joshi, Hossam Fahmy, Yoshiteru Ishida, Min Jiang, Vien Ngo Anh, Youming Li, X. Sheldon Wang, Nam Gyu Kim, Vasso Stylianou, Tommaso Mazza, Radu Calinescu, Nagm Mohamed, Muhammad Ali, Raymond Wu, Mansour Tahernezhadi, Trevor Carlson, Sami Habib, Vikas Vaishnav, Vladimir Avdejenkov, Volodymyr Voytenko, Vygantas Petrauskas, Shivakumar Sastry, U. B. Desai, Julius Dichter, Hani Hagras, Giovanni Morana, Mohammad Karim, Thomas Nitsche, Rosida Coowar, Anna Derezinska, Amala Rajan, Aleksandras Vytautas Rutkauskas, A. Ismail, Mostafa Aref, Ahmed Abou-Alfotouh, Damu Radhakrishnan, Sameh ElSharkawy, George Dimitoglou, Marian P. Kazmierkowski, M. Basel Al-Mourad, Ausif Mahmood, Nawaf Kharma, Fernando Guarin, Kaitung Au, Joanna Kolodziej, Ugur Sezerman, Yujen Fan, Zheng Yi Wu, Samir Shah, Sudhir Veerannagari, Junyoung Kim and Sanjiv Rai.

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Bridgeport, Connecticut
June 2007

An Adaptive and Extensible Web-based Interface System for Interactive Video Contents Browsing

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Abstract **-** With the growing popularity of mobile devices (including phones and portable media players) and coverage of Internet access, we tend to develop the need of consuming video content on the move. Some technologies already allow end-users to watch TV and listen to news *podcasts* or download music videos on their devices. However, such services are restricted to a provider's selection of pre-formatted and linear content streams. Hence, we propose a web-based interface system that supports interactive contents navigation, making it possible for end-users to "surf" on video content like they are used to on the Web. This system is extensible to any specific domain of video contents, any web-enabled platform, and to any browsing scheme. In this paper, we will explain the architecture and design of this system, propose an application for soccer videos and present the results of its user evaluation.

Keywords: architecture, multimedia, content, browse, hypermedia, navigation, video, semantic, XML, pipeline

I. INTRODUCTION

Nowadays, most of us carry latest-technology mobile devices, such as mobile phones, PDA, pocket game consoles and portable media players, allowing to play video contents wherever we go. Along with the increasing coverage and bandwidth of wireless Internet access, today's consumers expect a richer, easier and more rewarding experience from their video-enabled devices to find, select, retrieve and consume video content on the move. The popular solution of cellular network providers is to propose a restrictive range of videos to download and/or access to certain TV channels. But this approach is very restrictive as these providers "push" their own content instead of leaving the consumer browse any content from any source on the Internet.

While streaming any video from the Internet is becoming possible on mobile devices like on desktop computers, their technical and ergonomical constraints bring new issues to consider. Firstly, according to [1], usage of mobile devices is not as exclusive as using a desktop computer at home. Mobile users can be distracted at any time by their context, hence they want an adaptive and flexible way to access the information they are expecting at a time. Secondly, mobile devices are technically limited: battery life, memory capacity, computing power, screen size, input interfaces, etc… Hence, the browsing experience and the display of contents must be adapted to ensure their usefulness on the mobile device. Thirdly, wireless access to the internet is too expensive for users to afford wasting long and bandwidth-consuming connections as they could at home using unlimited broadband Internet access or TV.

In order to bring the multimedia web to our mobile devices while satisfying these constraints, we need to adapt the retrieval of multimedia content for these specific platforms and their usage. Our approach is to allow users to browse inside the video content without having to transfer it integrally on the device and to personalize the content. This is made possible by video indexing, as long as a browsing interface can be generated from the resulting indices, providing direct links to access its most relevant segments.

In this paper, we propose a web-based interface system relying on a SEO-indexed video library to bring rich and personalized video content efficiently (by focusing on the information that matters for the user) and adaptively (to the platform's constraints) at anytime (on demand) and anywhere (on the move or at home) to the average end-user (with ease of use). As we are aware that new devices and new types of video contents are constantly appearing on the market, this system is adaptive to new devices and extensible to new video domains. Moreover, its modular architecture makes it possible to integrate new components allowing browsing content in an intuitive, precise and enjoyable manner.

This paper is structured as follows: Section 2 describes our previous work and the proposed application of the system; Section 3 specifies the workflow of the expected application; Section 4 outlines the architecture of the proposed interface system; Section 5 explains the design of the dynamic interface generation; Section 6 describes the implementation of our application on the system; Section 7 discusses the success of our approach by evaluating the application; and finally, Section 8 and 9 describe the conclusions and future work.

II. APPLICATION AND PREVIOUS WORK

As an application of such a system, we have proposed navigation on soccer matches with adaptation to user preferences [2]. We have identified use cases which mobile soccer enthusiasts would benefit from. The idea is to browse

K. Elleithy (ed.), Advances and Innovations in Systems, Computing Sciences and Software Engineering, 1–6.

soccer matches on the move after having recorded them at home. Users could then use their mobile device (e.g. during their daily bus journey) to browse the highlights of a match in a constrained/noisy environment, browse the latest exciting events concerning one's favorite players, list matches with interesting specificities, etc…

For this application, we need to extract some valuable metadata (structure and semantics) from the soccer videos recorded on TV. Inspiring from MPEG-7, we have proposed a video indexing scheme and developed tools permitting to segment and semi-automatically analyze soccer videos in order to generate these indices from TV-recorded soccer matches [2]. The extraction process is out of the scope of this paper, but we will summarize the SEO indexing scheme.

SEO is a semi-schema and object-relational based indexing scheme allowing a flexible and efficient way of annotating and indexing video content in XML. This work has been focusing on soccer videos essentially but the same paradigm can be used for different domains as well. Moreover, it is based on MPEG-7 concepts and ideas, which have been widely-accepted as the video description standards by video professionals and institutions. A *SEO* index consists of the following components:

- *Segments*: A segment is an individual spatio-temporal range of a video document that contains indexable contents such as whistle, slow motion replay, and close-up on players' face and near goal area.
- *Events*: An event is a special type of video segment that contains a particular theme or topic such as a soccer goal and foul. It usually embeds annotations and possibly linking to objects.
- *Objects:* An object can be a person, a place, or any other material or immaterial entity that is involved with an event.

Thus, any video item (e.g. a soccer match) contains a definition of its belonging segments, events and objects.

In the SEO model, access to content is brought by the use of domain-specific queries (expressed in the XQuery language) that generate hierarchical summaries from the XML metadata. Some of those queries are depending on the user's preferences in order to personalize the results.

III. Workflow of the Soccer Application

In order to ensure interactivity and intuitivity for end-users, we have designed the system as a website, allowing users to browse the content by jumping from page to page using hyperlinks. Moreover, this paradigm is easily portable to devices that have limited input capabilities (e.g. few keys, stylus) and can be supported on mobile phones using the WAP technology.

The interface system is session-aware, that means that it keeps the context for each connected user and adapts the content according to his/her preferences. As shown on Figure 1, connecting on the system leads to a login page. Once authenticated, the user is brought to the homepage which proposes links to queries and video segments for registered domains and latest matches, as shown on Figure 2. For each match, a keyframe and some metadata (e.g. place and date of the match) are displayed. At all times, the user can go back to this page or to the User Preferences management pages shown on Figure 3. These pages allow the user to select his/her favorite players, event and segment types for each sport, using 2-list interfaces.

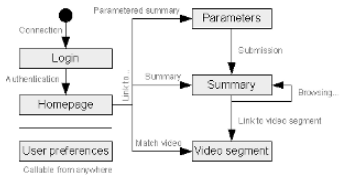

Figure 1: Workflow of the soccer application

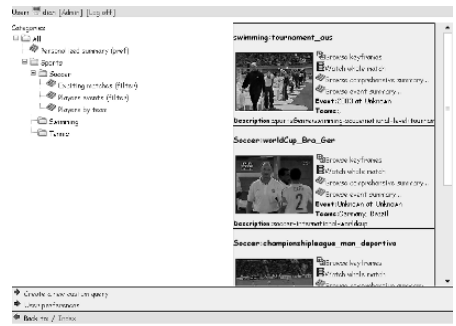

Figure 2: Homepage on PC

Figure 3: User preferences management pages

Two types of queries are proposed on the main page: (i) domain queries return summaries which scope a given domain only (e.g. soccer), whereas (ii) media queries return summaries which scope a given video (e.g. a match). Some queries are parameterized, making it possible for the user to customize the results. As seen on Figure 4, when the user selects such one, he/she will be invited to fill in a form of

parameters (a) before displaying the resulting summary (b). This form is already populated in order to propose predefined (and existing) options to the user instead of letting him/her type the corresponding information. The summary is an interactive page containing a hierarchical browsing pane at the top and a details pane at the bottom showing data about the currently selected item. Depending on the type of item, links to video segments or to other summaries can be proposed.

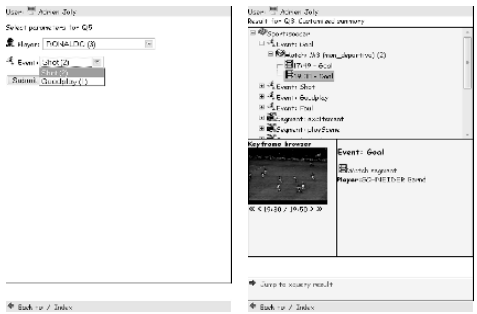

Figure 4: (a) Parameters form and (b) summary

More details about this application and its user evaluation are given in Sections VI and VII. We are now describing the architecture and design of the interface system on which relies the soccer application.

IV. System Architecture

In order to easily support many kinds of client devices by generating and delivering adapted user interfaces to each of them, we decided to adopt a web-based architecture that consists in "light" clients using a web browser to interact with an applicative server called the *Retrieval Server*. Figure 5 depicts the architecture of the proposed system.

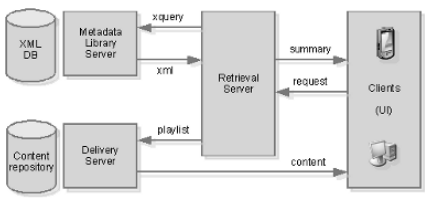

Figure 5: Architecture of the system

Because the metadata library is heavily solicited by this system, access to the metadata has to be handled by a XML database server that ensures reliable and efficient retrieval using XQueries [3]. For that purpose, we have chosen to use eXist [4], a popular and robust open source solution.

The actual delivery of video content must be handled by one or several streaming server(s), according to the type and format of content and the final application. We chose not to focus on streaming issues, hence the proposed system was designed to support any streaming server by extension.

A. Design of the retrieval server

Our system is expected to be extensible to new domains, browsing schemes, platforms and delivery servers. In order to satisfy these specifications, the *Retrieval Server* was designed with the layers listed on Figure 6: (i) the *data access* layer contains the queries that feed the system with data from the metadata library, (ii) the *representation* layer defines the templates that transform raw metadata into their human-readable representation, (iii) the *user interface* layer proposes components that implement platform-specific browsing schemes, (iv) the *services* layer handles the calls for delivery of summaries and content to the user that will be actually processed by (v) the *servers* layer.

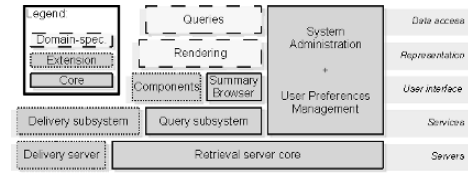

Figure 6: Extensibility of the retrieval server

As depicted on Figure 6, the layers (i) and (ii) can be extended with domain-specific queries and rendering templates. New browsing schemes and platforms can be supported by extending the layer (iii) with components. And content delivery servers can be plugged by adding a handler to the layer (iv) services.

B. Implementation of the retrieval server

The *Retrieval Server Core* located on the layer (v) is a J2EE application based on Java servlets which handle general web logic (e.g. sessions). On the layer (iv), the *Query Subsystem* consist in servlets implementing the GUI (Graphical User Interface) generation engine which drives the data flow from the metadatabase to the final user interface. This will be explained further in Section V. On the same layer, the *Delivery Subsystem* can be extended by servlets to give access to the content from specific delivery servers. In the current implementation of the system, we use the HTTP server as a *Delivery Server*, providing direct download access to content. Hence we implemented two servlets: the first returns URLs to keyframes which are identified by the video identifier and the timestamp, and the second returns URLs to video segments. Both layers (iii) and (ii) rely on XSL transformations. This will be explained further in Section V. At last, the layer (i) consists in XQuery files.

V. Dynamic GUI generation pipeline

In order to generate summaries adaptively to an extensible pool of queries, domains, browsing schemes and client platforms, the GUI must be dynamically generated. As our queries return XML data that must be processed to generate platform-adapted HTML summaries, we chose to follow the "XML/XSLT pipeline" approach presented in [5]. This

approach consists in processing the XML input data with different XSLT transformations in order to obtain platform-adapted documents at the end of the pipeline. Furthermore, because the numerous extensible layers result in many different chain combinations, the pipeline has to be generated dynamically. In order to achieve this, the GUI subsystem generates the pipeline by building a graph in which transformations are connected according to their specified input and output formats.

Browsing Schemes are defined as GUI components that transform high-level results of queries into platform-adapted interactive summaries allowing the user to browse the contents. The system natively includes a generic GUI component called the *Summary Browser*, which consists of a hierarchical browser composed of a *tree pane* and a *content pane*, as seen previously on Figure 4. It is generic since this tree can match the structure of any XML output from the queries. In this browsing scheme, users can select nodes in the tree of results to display their corresponding metadata and content (e.g. details, keyframes and other related data). For example, if a query returns a set of soccer matches, clicking on a match will show the location and date of that match, some keyframes, hyperlinks to match-specific queries and to the whole match video.

Note that a "*Keyframe Browser*" is natively included in the system as another GUI component. It enables the user to browse the keyframes of a segment.

A. Case of the Summary Browser

The generation of a summary using the *Summary Browser* component is a particular scenario of the pipeline. As it is the only browsing scheme natively included with the system, we will now describe the process of generating a summary from the results of a query.

As depicted on Figure 7, this process consists in 3 transformations:

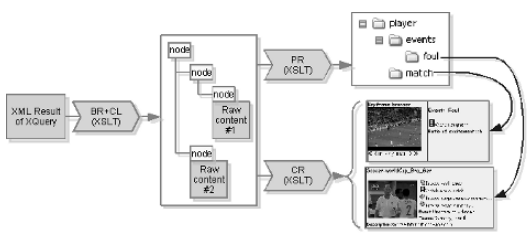

Figure 7: Data flow from the XML query result to the final HTML page using the Summary Browser

1. **Browsing document Rendering (BR) with Content Location (CL)**: This query-specific XSL transformation builds up the structure of the summary that will be shown on the final HTML page for browsing from the results of the query. The output of this transformation respects the input format of the *Summary Browser* component; it is a high-level XML format with no platform-specificities. Moreover, this transformation calls a generic "content location" transformation that will embed the content (e.g. reference to keyframes and textual details) associated with nodes of the tree structure, in order to leave their rendering for later. This transformation permits to separate the structure from the content while keeping linkage information using identifiers for late binding.
2. **Page Rendering (PR)**: This transformation renders the final platform-adapted DHTML page from the high-level tree structure resulting of the previous transformation. This page contains a *treeview* component and the scripts driving the browsing logic for the final summary. This transformation is actually the instantiation of the *Summary Browser* component.
3. **Content Rendering (CR)**: This transformation is a second pass on the output of the BR+CL transformation. It extracts the embedded content elements generated by the *Content Locator* and delegates their rendering to domain-specific templates defining the representation of those elements in the expected output format (HTML).

Then, the rendered content is integrated to the page (by merging them) to obtain the final platform-adapted summary that will be returned to the client. The DHTML code of the page drives the browsing interactivity, content being bound to their corresponding tree nodes thanks to the identification applied by the CL transformation.

The main strengths of this design are that: firstly, we abstract the platform specificities in the first transformation, as it only defines the way to structure the results of a given query in a high-level format. Thus, it is easy to add support for new client platforms or change the GUI layout by implementing different versions of the *Page* and *Content Rendering* transformations only. Secondly, the rendering of content is delegated to domain-specific templates. Hence, it's easy to add support for new domains; the main transformation engine remains unchanged. Thirdly, the separation of the tree and the linked content makes it possible to implement a "PULL" version of the *Summary Browser* that would download content on-demand from the server instead of downloading everything ("PUSH" of the contents from the server).

B. System configuration model

This section will describe the configuration model which the extensible GUI generation pipeline relies on. This model defines the entities that the system deals with in order to generate adapted interfaces dynamically. It is stored as a XML document in the database. Extending the system consists in merging extensions in this common system configuration XML tree.

As depicted on Figure 8, in the *system* configuration tree are defined *domains* and *platforms*. For both of them, instances are hierarchically linked using a reference to the *parent* identifier. In the domain hierarchy, each *domain* node inherits the *queries* that are defined for its ancestors. In the *platform*

hierarchy, each *platform* node inherits the *transformations* that are defined for its ancestors.

A *domain* is defined by:

- *Queries* are proposed on the main page to provide summaries that scope on the domain,
- *Media-queries* are defined like *queries* but are proposed for each video items of the corresponding domain (e.g. the "event summary" and "comprehensive summary") and,
- Its *renderer*: a XSL *transformation* that renders the metadata and associated content from the SEO components (segments, events and objects) that are defined for this domain and returned by the queries.

A *Query is* defined by:

- Its *presentation* consisting in XSL *transformations* that will convert the XML result of the query to the input format of the rendering component that will be used to generate the final interactive summary. Note that different transformations can be proposed, depending on the *target* platform.
- An optional *form* consisting in a *query* and its *presentation* (defined as above), for parameterized queries only. The query will ensure the retrieval of data that will be used to populate the form generated by a XSL *transformation*.

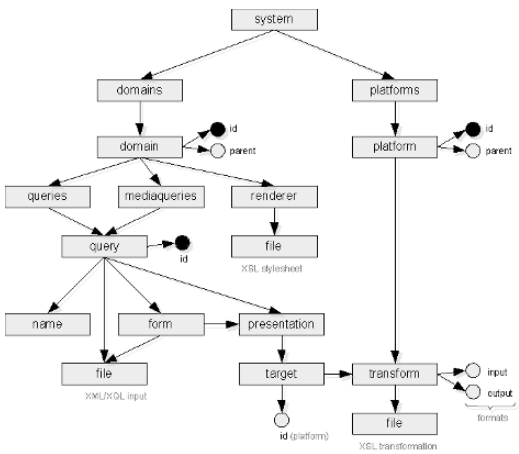

Figure 8: System configuration scheme

Platforms are defined as a set of platform-specific XSL *transformations* for given input and output *formats*. Each transformation is actually the implementation of a GUI component (like the *Summary Browser*) that will generate the final user interface from formatted query results. The platform hierarchy enables the GUI generation engine to elect higher-level (and thus, less precisely adapted) platforms for the case where a perfect match between a required *target* platform and an existing platform definition could not be found. As an example, we can consider the following platform hierarchy: *pfm.pc, pfm.ppc, pfm.ppc.vga, etc*, where *pfm* denotes platform; *pc* corresponds to Personal Computers (desktop), *ppc* stands for Pocket PC and *vga* is a special kind of *ppc* with a high-definition screen. If we are using a Pocket PC client with VGA screen, but that no version of the *Summary Browser* has been implemented specifically for VGA screens, the standard Pocket PC version will be used instead.

The *Format* identifiers are used to match inputs and outputs in order to build transformation graphs automatically. Like platforms, formats are also identified hierarchically, where the descendants specialize their ancestors, giving more flexibility for the GUI generation process. Note that, contrary to *platforms*, *formats* are not explicitly declared. They are implicitly defined by their hierarchical identifier. As an example, we can consider the following format hierarchy: *fmt.browser, fmt.html.basic, fmt.html.v4,* where *fmt* denotes format, *browser* denotes the "*Summary Browser*" input format, and *html* format could be *basic* or advanced (*v4*) depending on the target web browser.

A *transformation* file is specified given its *input* and *output* formats. During use, the system will build the transformation pipeline required to render the GUI as a chain of transformations in which the inputs are optimally corresponding to the outputs for the given platform.

VI. Implementation with Soccer Videos

The system has been implemented and deployed on Tomcat as a web application. As seen on Figure 9, the *Summary Browser* GUI component has been implemented in DHTML (HTML + JavaScript) for both modern browsers on PC and Pocket Internet Explorer on Pocket PC.

In order to evaluate the system, we have implemented the "soccer" domain (queries and templates) and added 3 SEO-indexed soccer matches in the video library. This application supports 6 summaries, including 2 which are parameterized, and 1 which is based on user preferences. We will now describe the summaries Q1, Q2, Q3, Q4, Q5 and Q6.

Q1. Comprehensive Summary: This summary lists the « play-break tracks » of a given match. Each track consists in a "play" and a "break" segment, the "play" phase being interrupted by an event (e.g. foul, goal…). A "play" segment describes the cause of an event whereas a "break" segment describes its outcome.

Q2. Events Summary: This summary chronologically lists the events happening in a given match.

Q3. Players by Team: This summary lists all video segments in which a players appears as part of one of his teams, for every player of any team.

Q4. Player Summary: After selecting a player, this query returns personal and strategic details (e.g. position) and event

segments related to this player. Segments are grouped by event type and match.

Q5. Exciting Matches: This summary provides a list of matches filtered by their custom number of goals and fouls.

Q6. Personalized Summary: Basing on the user's preferences, this summary shows the latest video segments related to his/her favorite players, types of events and segments.

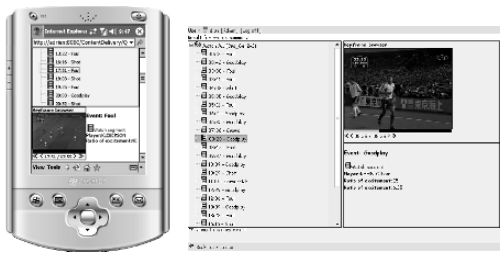

Figure 9: Web-based Video Retrieval System Accessible for Desktop and Mobile Devices

VII. User Evaluation

To prove the effectiveness of our proposed interface system, we have conducted a user evaluation on the soccer application relying on this system with a group of 53 university students. The aim of this survey is to gather users' feedback on the effectiveness, intuitiveness and enjoy-ability of the system for this application. Each criterion is measured uniformly by quantified "strongly agree, agree, disagree, and strongly disagree".

As shown on Figure 10, an average of 90% of the surveyed users agreed with the effectiveness, intuitiveness and enjoy-ability of the system for the proposed soccer application, and about 15% of them strongly agreed. The most appreciated summaries were Q2 (Event Summary) and Q6 (Personalized Summary).

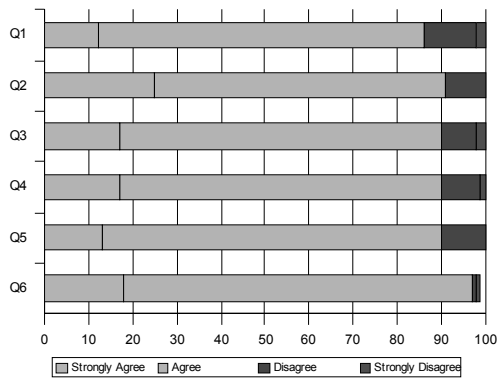

Figure 10: User acceptability of summaries

VIII. Conclusion

In this paper, we have proposed the architecture and design of an extensible video retrieval and browsing system. The architecture is intended for use with a XML-based video content indexing scheme, and we have shown its effectiveness with SEO-indexed soccer videos. The design is highly modular, allowing adaptation to various domains, browsing schemes and any web-enabled platform/device.

The major contributions proposed in this paper are: (i) the extensible multi-layered architecture of the system, (ii) the *Summary Browser* as a hierarchical browsing scheme allowing to browse the results of virtually any query in a rich and user-friendly manner, (iii) the graph-based GUI generation pipeline, and (iv) the system configuration scheme including domain description and platform adaptation.

Our approach expands the hyper-navigation paradigm that is used on today's websites (pages made of text and images) to video content in order to browse it in a non linear manner. Moreover, our evaluated implementation demonstrated that such an approach is realizable and effective.

This system could be the platform for new services brought to end-users for video hyper-navigation and summarization. It is suitable for many specific applications that could bring profit to content providers by selling more content and/or by proposing highly-targeted advertising to their clients.

IX. Future Directions

As the architecture and design of the system proposed in this paper has already shown its robustness in the scope of its application in a soccer video library, we propose some future directions to improve it further: (i) add new browsing schemes (e.g. using thumbnails or chronological representation), (ii) add new data rendering tools (e.g. charts), (iii) consider user's location and environment for delivery of targeted and adapted content, (iv) add user community and exchange features (e.g. forums, and tagging), and (v) support custom query creation.

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Design and Implementation of Virtual Instruments for Monitoring and Controlling Physical Variables Using Different Communication Protocols†

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Abstract – **In this Project were developed software components (Java Beans) which have the capability of communication through different communication protocols with hardware elements interconnected to sensors and control devices for monitoring and controlling different physical variables, conforming a hardware-software platform that obeys the virtual instruments design pattern. The implemented communication protocols are RS232, 1-Wire and TCP/IP with all of its annexed technologies like WiFi (Wireless Fidelity) and WiMax (Worldwide Interoperability for Microwave Access); also these elements communicate with a database and have the capability of sending text messages to cell phones through a GSM modem. For the development of software were used the object-oriented programming paradigm (OOP), Java programming language, LINUX OS and database server MySQL. As hardware, were used sensors and control devices in a 1-Wire network, a TINI (Tiny InterNet Interfaces) embedded system and a PIC (Peripheral Interface Controller) microcontroller.**

Key words: **Virtual Instrumentation, Java, Monitoring, Control, Communication Protocols.**

I. INTRODUCTION

The virtual Instrumentation (VI) is a concept introduced by the National Instruments (NI) company. In 1983, Truchard and Kodosky of the NI, decided to face the problem of creating a software that would allow to use the personal computer (PC) as an instrument to make measurements, as result of this, they obtained the software denominated Laboratory Virtual Instrument Engineering Workbench (LabVIEW). Thus, the VI concept is conceived as "an instrument that is not real, it's executed in a computer and has its functions defined by software" [1].

A traditional instrument is characterized for performing one or several specific functions that cannot be modified. A virtual instrument is a hardware-software combination through a PC that fulfils the same functions of a traditional instrument [2]. Besides the VI are very flexible and their functions may be changed by modifying software. For the construction of a VI, it's required a PC, a data acquisition board and appropriated software.

This article describes a way to design and implement the necessary software to create virtual instruments with the property of being capable to communicate in a transparent way with the outside (to acquire data) through different communication protocols, such as: RS232, 1-Wire, TCP/IP, WiFi, WiMax, among others. This kind of software (Java Beans) allows the VI to be implemented in many kinds of applications like remote monitoring and control of physical variables and distributed automatism [4], [5],[6],[7].

II. MATERIALS AND METHODS

For the design and implementation of VI there were used the object-oriented programming paradigm (OOP), UML software modelling language (Unified Modelling Language) with ArgoUML tool , Java programming language of Sun Microsystems, IDE (Integrated Development Environment) NetBeans 5.0 of Sun Microsystems too and database server (DB) MySQL 5.0. All of them are free distributed.

The dynamic polymorphism, implemented through inheritance, is applied in the VI design in a way that allows the extension of the instruments in a transparent way and with an efficient code reutilization. The classes responsible of the communication are totally disconnected of the instruments code; this makes possible the adaptation of any new communication protocol with minimum effort. The VI are made fulfilling all the demanded requirements of Java language for them to be Java Bean components, accelerating control boards development through an IDE.

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K. Elleithy (ed.), Advances and Innovations in Systems, Computing Sciences and Software Engineering, 7–11.

The developed VI are put under tests using communication through serial ports and inlaying them into 1-Wire sensor networks through the TINI embedded system of MAXIM / DALLAS Semiconductors [3], allowing remote monitoring and control through Internet. For this task, there were designed and implemented VI boards for remote monitoring and control of physical variables (temperature, relative humidity, luminosity) of a greenhouse dedicated to the production of flowers.

III. RESULTS

Virtual Instruments Software

The project establishes a main mother class which is the base of the virtual instruments. This class has all the fundamental methods that each virtual instrument should have like the method in charge of the instrument's thread and the data acquisition method, besides it defines the basic variables required to draw the object in an adequate and standard way for all the child instruments. The designed mother class is denominated *InstrumentoVirtual*, it extends *JComponent* and it's abstract.

The methods responsible of the alarm and to adjust the measurement scale are abstracts and should be defined by the child classes (this depend whether the instrument handles or not alarms or measurement scales, like the particular case of an on/off switch). The method in charge of repainting the objects on the screen is defined, but has to be rewritten by each child class due to the different characteristics of each instrument.

By having the Java Beans as the main idea of the project, all variables that directly affect the performance of the final element like variables in which are defined the colors of the final object, the measurement scales or the specific communication protocol that the particular Java Bean will use, should have its methods *set* and *get* to modify the variable and to give the actual value of it.

For the acquisition of data that will be shown on the screen, each protocol has its own capture method, nevertheless all these methods have the same name (*setLectura*), in other words, the method is recharged. The *setLectura()* method is responsible of creating the object that makes possible the communication. This method is recharged for the different protocols (RS-232, TCP/IP, 1-Wire, among others) desired to use. Each communication protocol is encapsulated in a class responsible of the configuration of all the parameters for an adequate communication. Therefore, in the *InstrumentoVirtual* class there are four different *setLectura()* methods where one of them is the main and it's the one that is going to be executed by defect by the child class that will be born from *InstrumentoVirtual*. This method has a switch/case block that decides the kind of connexion that has been defined for the child instrument. If for any reason it hasn't been defined the kind of connexion, the program assigns the connexion option to database. The connexion definition is made by *selectConexion*, which is an *int* variable in charge of telling the switch/case block the kind of connexion the user has defined for the specific object.

The group of methods in charge of communication are completely defined on the *InstrumentoVirtual* class because each object of a child class should have the capability of using any communication protocol, depending of the characteristics of the particular system that is being developed with software.

There's also a child class of *InstrumentoVirtual*, which is abstract too, this class is called *InstrumentoVirtualLinealCircular,* and has the only purpose of making possible the implementation of circular geometry objects (like for example a manometer). The implementation of a particular class for circular geometry objects is due to the complexity on the measurement scale transformation, the animation on data visualization and the transformation of the data acquired by the instrument to be correctly drawn on circular geometry.

The performance idea of the program for a specific Java Bean of the virtual instrumentation project, for example the thermometer is the next one: The element is drawn and the instruction to begin the thread that governs the Java Bean thermometer is executed. This thread remains constantly running, and to avoid PC recharging on the same process, there's a variable *tiempoMuestreo*, which indicates the thread to sleep for an entire *tiempoMuestreo* after executing the assigned routine, optimising in that way the program performance. Therefore, for velocity exigent programs, these threads may sleep less than 20 milliseconds, and being actualizing data, or in cases like the serial port, each time the data arrives an interruption of the thread's dream is generated, paying attention to the serial port and acquiring the data without any lost. After the thread has slept for a defined time and if there isn't any problem, the thread executes all its routine again, repainting the object on the screen, actualizing the lecture value to the last taken data and returns again to its dream.

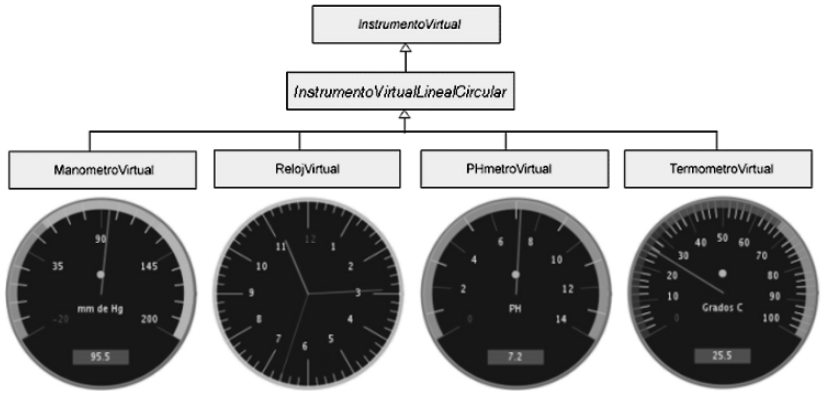

Fig. 1: Virtual Instruments and its inherency.

Fig.1 illustrates some of the designed VI: a thermometer (*TermometroVirtual*), a manometer (*ManometroVirtual*), a phmeter (*PHmetroVirtual*) and a clock (*RelojVirtual*). It can be clearly seen they inherit from *InstrumentoVirtual* class or from the *InstrumentoVirtualLinealCircular* child class, depending of the specific instrument geometry.

Fig. 2 shows the structure of *InstrumentoVirtual* class and some of its child classes, like *PHmetroVirtual* and *TermometroVirtual* in detail. There is shown the great complexity of the mother class in comparison of the simplicity of child classes, this clearly shows the huge potential of OOP and one of its great characteristics, the inheritance.

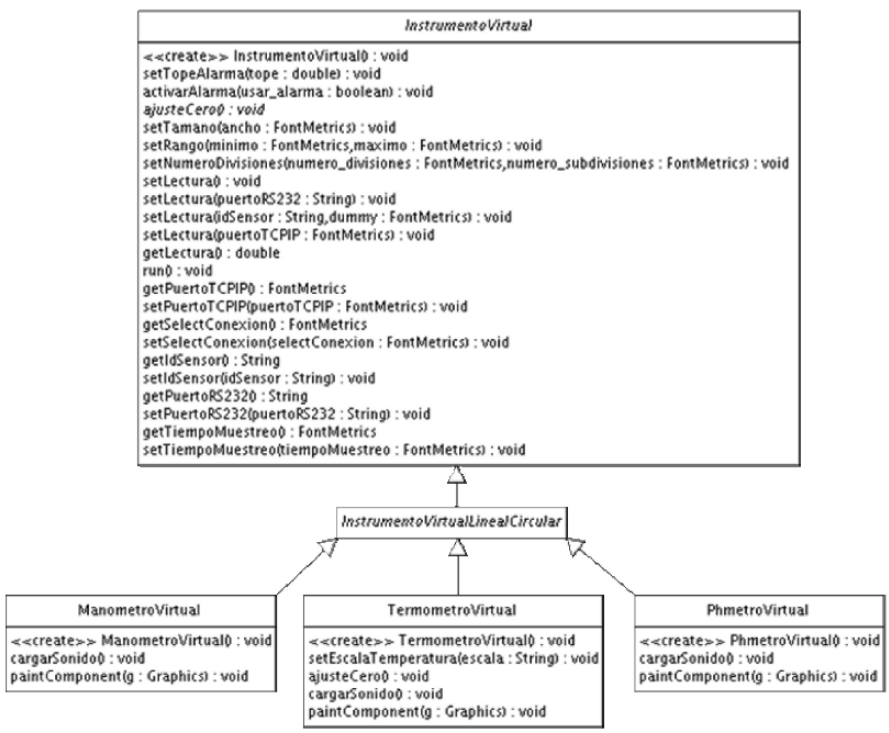

Fig. 2: Small UML diagram that show the huge differences between mother and child classes.

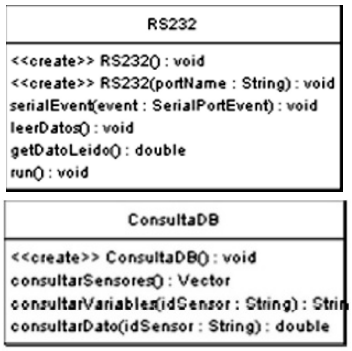

Fig. 3: Some classes in charge of communication protocols. RS232 is the class that manages the RS232 communication protocol. ConsultaDB is the class that manages the database connexion

Fig 3. shows two of the classes that manage the different communication protocols. As explained before, notice that these classes are totally disconnected of the virtual instruments code.

Implemented Hardware

Due to the fact the designed VI handle different communication protocols; there were implemented two different hardware assemblies to carry out all the pertinent tests.

A) Greenhouse Remote Monitoring and Controlling System.

The greenhouse remote monitoring and controlling system used in this project is a hardware-software platform whose principal idea is the monitoring and control of the physical variables of a greenhouse through Internet. For this a new type of embedded system called TINI was used, which has a lot of potentialities like being able to program it with JAVA language and to support a lot of communication protocols, like TCP/IP, RS232, CAN, 1-Wire, among others. The TINI embedded system is in charge of the sensor/control devices network (this network uses 1-Wire communication protocol which is a communication protocol specialized on sensor networks), the sending of data to a central server and the reception of different kinds of requests from the server. The central server saves data into a database and allows it visualization. Fig. 4 shows a general scheme of the entire system.

A very important fact is that communication between TINI embedded systems and the server may be made in several ways: through a wire connexion using TCP/IP communication protocol or through a wireless connexion using WiFi or WiMax connexion devices. Moreover, it's worth to notice the TINI's great capacity of data acquisition from different communication protocols and to hand it over in TCP/IP data packages; this gives great flexibility to the system.

The joint between the system and the VI may be made in two ways: The first one consist in that the data arriving from the sensor/control devices network are saved on database, therefore the VI directly communicate with the DB for acquiring their respective data and showing it on the screen

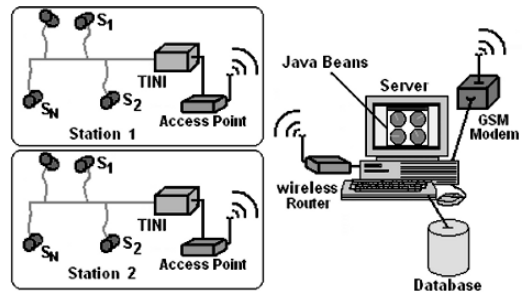

Fig. 4: General scheme of the greenhouse remote monitoring and controlling system.

The second way consist in the direct data acquisition made by the VI, in this way each VI handles a connexion with the TCP/IP port, only receives the data of concern (data sent specially to the VI to a specific virtual port) and shows the receive data on the screen. In this way, there's not necessary a DB.

B) Acquisition board – RS232.

On the development of the project, there was made a board set up by a PIC 16F877 microcontroller, a LM35 temperature sensor and a MAX-232 device (this one was used to transform PIC TTL voltages to RS232 communication protocol required voltages), which is in charge of acquiring the temperature sensor data and sending the acquired data, by way of RS232 protocol, to a server in which they are directly captured by a VI element. An important fact is that the board has the capability of acquiring data from eight sensors, however in this case, there's the limitation that only one VI occupies the serial port and denies the other seven VI to read the port and therefore to present data on screen. This problem may be resolved by an agent responsible of taking possession of the port and saving the arriving data on DB, in this way the VI would directly connect to DB without any lost of information.

The problem of occupying a physical PC port by a VI doesn't apply on TCP/IP communication protocol because this protocol handles "virtual" ports, whose (in theory) may be infinite (they are truly limited by the working PC). All these ports have the same physical input channel which is never occupied for particular software, unlike it happens on serial ports.

C) GSM MODEM – Alert SMS Messages.

The third implemented hardware device is a Samsung X486 cell phone which is used as a GSM MODEM for the delivery of alerts in form of SMS messages. For this purpose, there were used AT commands to handle the cell phone as a GSM MODEM; all this process is carried out by serial communication with the device. All the VI have the capacity of using this MODEM, however, a limitation of this system is that the MODEM may only be used by a VI at the time (due to the limitations of serial ports, explained before).

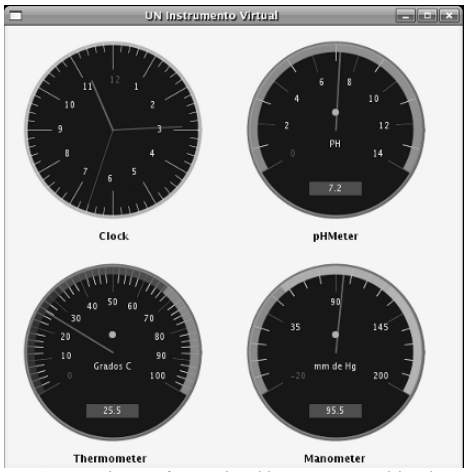

Fig. 5: An image of some virtual instruments acquiring data

The complete system was proved using four VI acquiring data from different communication protocols (Fig 5): two of them connected directly to the DB, another one acquired its data directly from the TCP/IP port (1414 port) and the last one connected directly to the serial port (ttyS0). Each one of these VI presented the acquired data on screen in a very satisfactory way. Furthermore, the GSM MODEM was connected to the USB port, being registered as a serial port identified as ttyUSB0. The data sent to the VI were modified in a way that alerts would be thrown; these ones were satisfactory sent as text messages by the module that handles the GSM MODEM.

IV. Discussion and Conclusions

As a result of this project, there were obtained virtual instruments capable of acquiring data in an autonomous way using different communication protocols like RS232, TCP/IP, among others. The carefully used software engineering for the VI design allows them to be easily adapted to different situations and, in this way, having instruments that may be implemented on monitoring and control software development for the small and medium national companies in a fast, economic and reliable way.

The manufacture applications require software to be reliable, of high performance and great adaptability. The virtual instruments designed and implemented as described in this article, bring all those advantages through the integration of characteristics such as alerts, security and network management. The great adaptability of this technology allows its incorporation in different kinds of environment like a house, a laboratory, a forest, a greenhouse or an industry.

Virtual instruments bring significant advantages on each stage of the engineering process, from the design and investigation to the manufacture test.

One of the biggest advantages of software is the great versatility it has due to its implementation on Java language, which allows it to have a successful performance on diverse operating systems. Furthermore, being Java and all its used tools (for design and development) of free distribution, it's very possible the implementation of this kind of systems at a very low cost.

V. Recommendations and Development Fronts

If there are introduced more sophisticated graphics visualization systems, statistical analysis and distributed network implementation into virtual instruments, they will bring capacity for robust company applications. By having well structured software, the VI may have intelligence and decision making capabilities.

Actually, the Scientific and Industrial Instrumentation Group of National University of Colombia Sede Medellín, is working on the design and implementation of VI on distributed wireless sensor networks, using the autonomous sensors MICA Mote of the University of California, Berkeley.

This technology will allow the realization of fundamental investigations for the Nation, like the monitoring of physical variables of forests and monitoring of civil structures.

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Online Decision Support System for Dairy Farm

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***Abstract* – online decision support system for dairy farm was created for helping Lithuanian dairy farmers, scientists, dairy technology producers, students and other peoples interesting in dairy business. It enable they use newest information and technology for planning own business**

I. INTRODUCTION

Dairy business is one of underlying branch of Lithuanian agriculture. In creation or development dairy farm it is very important optimally select livestock breed, feeding ration, technology for livestock keeping, milker system and other equipment. All of them must secure good quality and biggest quantity of produced milk, low producing cost and biggest profitability.

With new information technologies we have more possibility using mathematical models for optimization economical and technological parameters of dairy farm.

In dairy farming sector of Europe countries are used some computer based models for creating feeding ration subject to individual cow productivity, cows breed and other factors. Commonly those models are created for feed, which are produced by models owner.

By this time in Lithuania wasn't created multipurpose mathematical models for dairy farm. Such models will be useful for farmers, scientifists, students and dairy adviser. It could be effective to make decision in selecting cows breed, feeding ration, livestock keeping and milking technology. It will be very helpful for all in dairy business.

Goal and subject of investigation was creating multipurpose mathematical model of dairy farm. Model is based on data bases which are accessed by World Wide Web. Data bases could be renewed and updated online by administrator grants for information suppliers. These suppliers are feed producing companies, dairy technology suppliers or scientists and agriculture advisers. Users of this information would be farmers, students and other men's interesting in dairy business.

Mine goal of creating online decision support system for dairy farm are:

1. Stimulate using information technology and mathematical models in dairy business for modeling and prognoses economical processes.
2. Make ability for scientific research and discoveries immediately apply in practice.
3. Improve information attainability.
4. Cheeping consulting cost.

Keywords: mathematical modeling, agriculture, dairy farm.

II. METHODOLOGY OF RESEARCH

Methodology of research are based on mathematical modeling of technological processes by using statistical methods and mathematical equations, estimated correlations in scientific research and POWESIM software

III. RESULTS OF RESEARCH

In creating of dairy farm, modernizing or expanding it mine question are time for getting dividends of madden investments

In this mathematical model are evaluated such kind of expenses:

KISKG – variable expenses in farm for producing 1 kg of milk;

KTIK – expenses for one cow kept in farm, Lt/cow;

IKR – part of expanses for producing 1 kg of milk;

PRDM – average milk yield in farm per year kg/year, calculated by equation;

$$PRDM = PRDN \cdot MK \cdot 365. \quad (1)$$

PRDN – milk yield from one cow, kg.

After evaluation costs of feed, energy, labor and other expenses we estimate milk cost, i.e. total expenses for producing 1 kg of milk

$$ISKG = BPSKAIN + KISKG, \text{ Lt/kg}. \quad (2)$$

Process of investment in model from financial point of view, could be divided in two separate processes – capitalization and getting constant income from cumulated capital. Those processes are even in particular time interval. Both processes in time could have different distributions. In model distribution in time form (especially profit) are very

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important, because money flows are planed on end of every year

In separate sectors of model are formed necessary investments for project implementation requirement. Investments usually are written in project fund requirement and sources table, in which are information how much and for which purpose necessary money for project implementation. Main part of project outlay is for long-term means (building and maintenance expenses). Necessary fund for project implementation in model consist of:

1) Long-term means = { FAV;MIKN}, sum of expenses for farm buildings (FAV) and milking equipment (MIKN).

2) Circulating capital = ISKGP, sum of expenses milk producing.

3) Unexpected expenses ((1)+(2))*0,01, it is 1% from sum of expenses for long-term means and circulating capital.

$$\text{Necessary fund} = (1) + (2) + (3) + \text{GLVK}, \qquad (3)$$

GLVK-price of cow.

In this model object of analysis are payment flows which characterize both processes. Models elements of flow are described by profit and investment.

Net profit – it is total profit collected until end of year after all necessary payments are done. These necessary payments include all real expenses for produced production.

Profit flow element (R_t) in model could be estimated in such way:

Calculating most important economical parameter – profit. Profit can be raised by increasing production volume and decreasing outlay. For this reason in model are set coefficient of soled milk from all produced (PPK), i.e. proportion between produced and soled milk. Then soled amount of milk per year will be calculated (PRK):

$$PRK = 365 \cdot PRDN \cdot PPK \qquad (4)$$

In this model part, after determination price of raw milk (SUPK), we can calculate incomes for soled milk (PA):

$$PA = PRK \cdot SUPK \qquad (5)$$

Profit (P) is calculated by subtract outlay from incomes:

$$P = PA - S, \qquad (6)$$

Outlay can be calculated:

$$S = ISKG - PRK \qquad (7)$$

ISKG – outlay for producing one kg milk.

After subtracting taxes (IMK) from profit (P) we will get net profit (GRPL):

$$GRPL = P - IMK \qquad (8)$$

Then, after estimation net profit for every year and depreciation expenses (AMR) we get total profit flow element for every year:

$$R_t = GRPL_t + AMR_t, \quad t = \overline{0,n} \qquad (10)$$

R_t - Total profit flow in t year;

$GRPL_t$ - Net profit in t year;

AMR_t - Depreciation expenses in t year.

In this model for evaluation of efficiency of investments are used index of pay dividend time. This index is calculated by compare in time moment sum of incomes and investments (I_t). Our investigated process of investment is presented like continuous flow of payments in every year.

Time of investment pay dividends in this model are calculated like time interval in which investment become equal net profit after subtract all outlay for producing milk, i.e. sum of investment will be equal in same time (n) sum of incomes:

$$TI + \sum_{t=0}^{n} I_t = \sum_{t=0}^{n} R_t \qquad (11)$$

TI – sum of all means used for project implementation.

Time interval (n) in which equality show us period of investments start to pay dividends.

Sum of investments ($\sum_{t=0}^{n} I_t$) can be calculated in this way:

a. we determine sum of loan;
b. determine interest rate, %;
c. determine project term in years, n;
d. By number of year's n and interest rate (%), we find paid sum with interest rate for creditors in every year (Lt.). This sum (RGSUM) are calculated by equation (12):

$$I_t = \frac{PASK \cdot \frac{i}{100} \cdot \left(1 + \frac{i}{100}\right)^t}{\left(1 + \frac{i}{100}\right)^t - 1}, \quad t = \overline{0,n} \qquad (12)$$

i – Interest rate, %;

t – Number of year for project implementation;

PASK – sum of loan;

I_t - t – paid sum for creditors every year.

Period (n) after which investment start to pay dividend are calculated:

$$TI + \sum_{t=0}^{n} I_t - \sum_{t=0}^{n} R_t \le 0 \qquad (13)$$

Period after which investment start to pay dividend are calculated by summing discounted interest rate and continuously played credit return in every year until sum become equal investment sum.

IV. CONCLUSIONS

1. Created multipurpose mathematical model of dairy farm can be used in Europe Union, because it takes account of EU law for environment and other requirements.
2. Created model can improve IT using in agriculture, stimulate using new research data in practice and increase information attainability for dairy business.

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Decision Making Strategies in Global Exchange and Capital Markets

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Abstract. **The main objective of this paper is to present the investment decision management system in exchange and capital markets – the Double Trump model. The main problems being solved with this model are named as quantitative decision search problems. Computer-imitational methods are also analysed as the main solving means for the mathematical models viewed as stochastical programming tasks in order to reflect the problems characteristics. Attention is paid to the revealing of the analytical possibilities of the decision management system and to decision methods identification, analyzing such non-traditional problems of financial engineering as three-dimensional utility function maximization in the adequate for investment decisions reliability assessment portfolio possible set of values, searching for investment decisions profitability, reliability and riskiness commensuration concept and mathematical decisions methods. Solving of the problems named above ensures sustainable investment decisions development in capital and exchange markets.**

I. Introduction

Strategy, in cybernetics opinion, is any rational rule determining certain actions in any decision making situation. Formally, strategy is the function of the information obtained, which takes values in all possible set of alternatives at the given moment. This rule must include the whole decision making period and all possible situations.

Determined rules and situations are named as simple strategies. Their using result is usually described as strategy implementation or non-implementation. Strategies, which compose simple strategies' possibilities probability distributions, are named as mixed strategies, and about their realization we can say by these categories: by mean, with probability 1, by probability, etc.

Nowadays strategy's category more often goes together with the adjective "sustainable". There is no difference - is it a global atmosphere pollution reduction problem, or is it a small firm energy supply problem. And this is explained not only in terms of intellectual development, but also in terms of behaviour economy. Naturally, with the beginning of the broad exploitation of the category "sustainable strategy", its contents vary a lot. However, almost unambiguous trend is noticed – sustainable strategy more often is described quantitatively, i.e. by finding quantitative indicators allowing to identify strategy sustainability. There is no doubt that the core grating for sustainability grounding is the reliability of the analysed strategy's separate elements or their certain combinations.

Investment strategy is the set of investment decisions. Implementation of these decisions allows investor to get the best profitability and reliability composition. Here the possibility reliability is a very important factor and towards its evaluation the idea of adequate investment decisions reliability assessment portfolio was directed.

The sustainable investment decisions, or simply investment in currency and capital markets strategy, can be called such a strategy, which allows to secure not lower than market generated profitability, as well as invested capital value increase. Considering exchange and capital market riskiness degree and risk variety, the attempt to develop such a strategy can seem as intention to swim through the Atlantic ocean with simple boat. So, the real solution of such complex problem as sustainable investment strategy development is possible only with the adequate means for this problem solving.

Adequate portfolio, retaining profitability and risk commensuration possibilities reveals also profitability and reliability, as well as reliability and risk commensuration possibilities. Space of adequate portfolio values is the set of survival functions, constructed on every level of riskiness. This allows estimating how many units of profitability need to be denied in order to increase reliability by one unit. However, space of adequate portfolio values is the space of izoguarantees. This allows not only to commensurate profitability and risk, but also performs reliability and risk commensuration. Actual utility function provides a possibility for an investor to perform these actions individually, i.e. considering investor's own willingness to undertake certain risk level.

Recall that efficient investment decisions' in the exchange market strategy will further be perceived as the mix

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of the actions and means, which would allow to select such invested or speculative capital management, which would guarantee advantage over all the existing investment means of respective duration and risk in the market.

Double Trump model, as investment possibilities analysis', goal formation and decision-making means, has an adequate structure:

- exchange rate forecasting subsystem;
- goal formation and achievement means subsystem;
- decision-making in exchange market model system characteristic identification and its quantitative decision-making methods subsystem;
- efficiency evaluation of the decisions being made and efficient decisions possibilities and conditions assessment.

II. The Structure and Characteristics Of The Double Trump Model

The main principles of an adequate forecasting system

Further we will illustrate the main utilization principles of a one-step currency rate and stock price forecasting system. The core of the forecasting system consists in the probability distribution selected parameter regression dependence of the forecasted index value at a (t+1) moment on the probability distribution certain parameters value of the index under analysis at a t-th and previous moments:

$$y^{t+1} = f\left(x_1^t, x_2^t, ..., x_n^t; \Theta(0,t)\right) \quad (1)$$

where in general we can say that:

y^{t+1} - probability distributions of the forecasted currency rate or stock price possible values at (t+1) moment;

x_i^t - *i*-th factor's possible values probability distribution's vector at a t-th and previous moments;

$\Theta(0,t)$ - the resultant of the influence of the other factors on the factor under analysis at (t+1)-th moment;

f - regression.

Practical results of the forecasting system application

One of the authors of this paper [3] developed the new decision management system for exchange and capital markets – the Double Trump model. A wide experiment was performed with the model, which gave valuable results.

The essence of the Double Trump model is that the two currencies were selected as the basic – EUR and USD, while in general there were analysed 7 currencies: EUR, USD, GBP, CHF, CAD, AUD, JPY [5], [8].

The rebalancing of the portfolio, i. e. the selection of an optimal portfolio, is carried out step by step. The scheme of every step of portfolio management strategy looks like this:

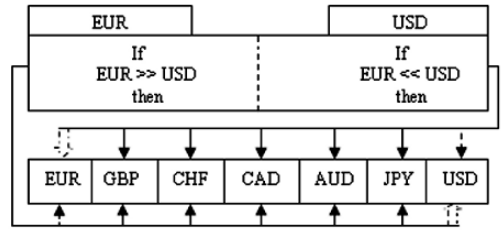


Fig. 1. Double Trump (EUR and USD) portfolio decision management in currency (EUR, GBP, CHF, CAD, AUD, JPY, USD) market model

- we choose EUR and USD as trump currencies;
- make prognoses of the EUR/USD, EUR/GBP, EUR/CHF, EUR/CAD, EUR/AUD, EUR/JPY and USD/GBP, USD/CHF, USD/CAD, USD/AUD, USD/JPY rates, or evaluate them on the basis of gathered FOREX historical data;
- If the EUR exchange rate increases (>>), then EUR is considered to be the trump currency, the diversification of a portfolio is performed on the basis of prognoses of EUR and exchange rates of other currencies. If EUR<<USD, the USD is chosen as the trump currency.
- After we have chosen the trump currency, we choose the currency portfolio which makes it possible to maximize the profitability of the subject at the end of each step, in the particular case – which makes it possible to maximize the purchasing power of the portfolio both in euros and dollars (Fig. 1).

Peculiarities of proposed forecasting system and its comparison with methods of technical analysis

As one can see from the presented model structure (Fig. 1), the preparation of our system of decision making in exchange markets formally begins with selecting the methods of currency rate forecast. Since in this system, as in technical analysis, a particular research object is historical currency rate indices, the suggested methods of forecast should be compared with the forecasting methods already in use in technical analysis, which are numerous and various. Here, next to traditional methods of forecast used in all areas of activities (various traditional models, regression models, moving averages models, etc.), the principle of pattern identification is also intensively used. The essence of the latter method is that particular patterns are being tried to identify, according to which the changes of future indices should repeat changes of historical data [5], [6].

Knowing that the set of technical analysis forecasting models is wide and diverse, it would be negligent to specify the summarized characteristics of this set. Therefore, even though many technical analysis forecasting methods are theoretically suitable for currency rate and stock price forecast and have a long-time practice of utilization not only

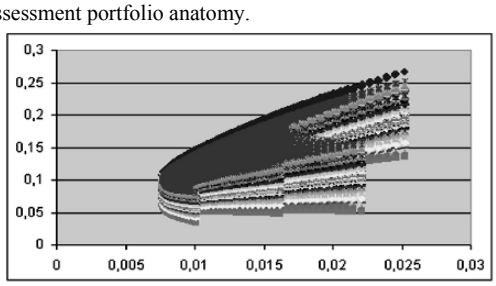
in this area, we have to admit that they do not satisfy all the main attributes necessary for forecasting methods. Adequate forecasting system should poseess the following characteristics:

- **Adaptivity.** A currency rate forecasting method must be adaptive, i.e. it should help in considering in each point of variation of currency rate both the set and importance of the factors, as well as the functional dependence of currency rates and the factors, when the factors themselves and the forms of interdependence of these factors are being modified.
- **Flexibility.** The forecasting methods of currency rates and stock prices must be flexible, i.e. they must be applicable in every forecasting system.
- **Consistency.** Actions and results in the forecasting method must be clearly separated, i. e. they must be consistent. It is very important when determining and using the analytical interrelation between the result and the factor as well as among the factors themselves.
- **Correctness.** The diagrams of reliability zones could be a good illustration to explain the correctness of the models.
- **Accuracy.** The dislocation of the historical parameters in confidence zones indicates that the behavior of the currency rates and stock prices not only is compatible with the consistent patterns of the behavior of stochastic variables in their confidence intervals, but also these confidence intervals have much greater confidence levels.
- **Reliability.** Employment of one or another method of forecast should allow to measure quantitatively the reliability of the obtained results.
- **Constructiveness.** Forecasting methods must be constructive, i.e. they should allow selecting the most probable values of forecast variables or processes.

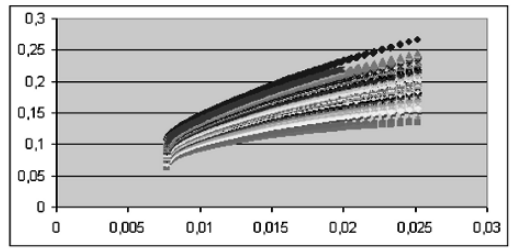
III. Development Of Adequate Portfolio For The Investment Decisions Reliability Assessment

Anatomy of adequate portfolio

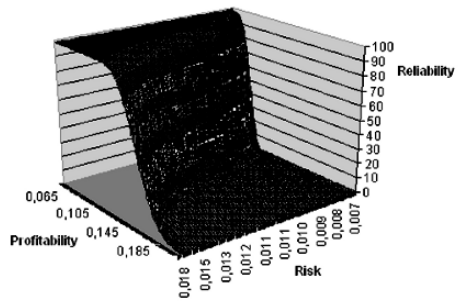
In order to reveal the portfolio of investment decisions reliability role mechanism in details, we will briefly take a look over adequate investment decisions reliability assessment portfolio anatomy.



a. Bunch of "quintiles (percentiles) – standard deviation" portfolios



b. The confidence zone of adequate portfolio



c. Three-dimensional view of the investment portfolio

Fig. 2. Elements of the adequate portfolio

Fig. 2 present adequate portfolio for investment decisions reliability assessment. "Mean – standard deviation" portfolio (modern, or Markowitz portfolio) is a portfolio formed for independent values, having normal probability distributions [1], [2]. Next, a bunch of the possible values of all possible "quintiles – standard deviation" portfolios (Fig. 2, section a) is formed. More precisely speaking, not all the quintiles were used for this bunch, but only percentiles. In turn, the efficiency zone - all portfolios' "quintile – standard deviation" set of values for each quintile efficiency lines is presented in Fig. 2, section b. Fig. 2, section c presents the three-dimensional view of the investment portfolio.

There is no doubt that investor is interested not only in quantitative indicators of investment profitability possibilities, but also in guarantee of each possibility, i.e. the probability investment efficiency (return). In case of modern stock portfolio, the guarantees of investment profit possibilities are usually not discussed, although in case when portfolio returns possibilities probability distribution is a normal one there is a direct possibility to evaluate these guarantees, if mean value and standard deviation are known [5].

Fig. 3 (left side) shows set of values of the adequate portfolio and utility functions' (right side) interaction possibilities searching for the most useful portfolio values for the subject whose interests reflects the utility function.