ДЕРЖАВНИЙ ВИЩИЙ НАВЧАЛЬНИЙ ЗАКЛАД
«УЖГОРОДСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ»
(м. УЖГОРОД, УКРАЇНА)
КОШИЦЬКИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ
(м. КОШИЦЕ, СЛОВАЦЬКА РЕСПУБЛІКА)

ISSN 2218-5348

МІЖНАРОДНИЙ НАУКОВИЙ ВІСНИК

Випуск 1 (12)

Матеріали Міжнародної науково-практичної конференції
«Науковий парк як універсальна регіональна структура інноваційної діяльності»
(м.Ужгород, Україна – м.Кошице, Словацька Республіка, 3 березня 2016 р.)

Ужгород – Кошице
2016

УДК 001:378

Вісник містить наукові статті і тези доповідей, проголошених та обговорених на Міжнародній науково-практичній конференції «Науковий парк як універсальна регіональна структура інноваційної діяльності», проведеній Ужгородським національним університетом спільно з Кошицьким технічним університетом (Словацька Республіка) 3 березня 2016 року в рамках наукового проекту «Інноваційний університет – інструмент інтеграції в європейський освітній і науковий простір».

Видання здійснено за підтримки Міжнародного Вишеградського фонду.

STATE UNIVERSITY
«UZHHOROD NATIONAL UNIVERSITY»
(UZHHOROD, UKRAINE)
TECHNICAL UNIVERSITY OF KOŠICE
(KOŠICE, SLOVAK REPUBLIC)

ISSN 2218-5348

INTERNATIONAL SCIENTIFIC HERALD

Edition 1 (12)

Materials of International scientific and practical conference
"Science Park as universal regional structure of innovative activity"
(Uzhhorod, Ukraine – Košice, Slovak Republic, March 3, 2016)

Uzhhorod – Košice
2016

UDC 001:378

The Herald contains scientific papers and report theses, enunciated and discussed at the International scientific and practical conference "Science Park as universal regional structure of innovative activity", held on March 3, 2016, by Uzhhorod National University together with the Technical University of Košice (Slovak Republic) as part of implementation of the research project "Innovative university – tool of integration to European educational and research area".

The publication is issued with the financial support of the International Visegrad Fund.

PILOT SUB-PROJECTS: INNOVATIVE-INCUBATION LABORATORY FOR APPLIED RESEARCH IN THE FIELD OF TECHNOLOGIES, APPLICATIONS AND SERVICES

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This article presents results of research activities under project University Science Park TECHNICOM for Innovation Applications Supported by Knowledge Technology in ICT activity. There are three partial activities presented – Dramify, Fixer and Smart Metering project. All those projects results in real applications and products ready to be deployed in market. Dramify project preliminary results are quite promising with success rate above 80% for all presented methods except sentiment analysis. Fixer is under long term performance/stability testing. Smart meter is implemented to fifty end user households within local energy distributor power network. Research and development is covered by Computer Networks Laboratory at Technical University in Košice.

Introduction

Computer Networks Laboratory since 2013 participates in national research project University Science Park TECHNICOM for Innovation Applications Supported by Knowledge Technology in Activity 3.1. Pilot projects in the field of information and communication technologies. Several research goals are defined by project and this article presents recent state of art.

Dramify project

Audiobooks are popular for people travelling longer distances in public transport, for the ones living active life with no time to read books, the blind and visually impaired readers, etc.

Although there are several online stores and libraries like *Gutenberg - The Audio Books Project*[1] or world's largest audiobook and spoken word provider *Audible*[2], they still rely on skilled narrators or volunteers and thus the audio content is limited. There are also portals where volunteers may take a part in audio book narration like *LibriVox*[3] or Amazon platform *ACX*[4], which gathers authors, publishers and narrators in common marketplace and matches them

[1] Gutenberg - The Audio Books Project:
https://www.gutenberg.org/wiki/Gutenberg:The_Audio_Books_Project
[2] Audible: http://about.audible.com/
[3] LibriVox: https://librivox.org
[4] ACX: http://www.acx.com/

based on experience, previous results and requirements. *LibiriVox* suffer of no audition process, hence the quality is not guaranteed and people can pretty much submit whatever they want.

Services like *NaturalReader*[5] or *Kindle's* built in TTS reader can read the whole pdf, ePub or document in other formats in one voice. Although the quality of voices is quite high, final impression is far from great. After a couple of minutes the reading alloys into coherent murmur and becomes boring for the listener.

There were also some attempts to create a similar service like Dramify, e.g. patent submitted by P. Agarwal et al. [1], project *ChulaDAISY* by P. Punyabukkana [2], or intelligent audiobook reader imitating puppeteer in Slovak language created by M. Rusko et al. [3]. None of them were transformed to a real service, though.

Dramify combines cutting edge TTS technology with unstructured text processing techniques and machine learning. The service is able to detect main characters, figures out their gender and detects what character tells which parts of the text. Based on this information the most suitable TTS voice is selected. To make final user experience even closer the narrated audiobook, the service identifies sentiment of direct speech and modulates voice accordingly.

The solution is currently in a state of a prototype, with extensive testing on a broader set of e-books aiming at improving classifiers to increase the success rate and better handling of corner cases.

The goal is to provide a service that can decrease the cost of audio book production while being able to create audio book on-demand in a quality close to human narration.

FIXER project

Fixer solves the problem encountered in manufacturing industry where every error in the process means financial loss. Fixer's algorithm is able to orientate in the operating space by transforming the coordinate system using optical flow and marker tracking. With the ability to know the exact relative position of the tool (for example screwdriver) to the piece being completed Fixer is able to track if the worker is following the predefined manufacturing process. If an anomaly is detected for example the worker spiked a step Fixer immediately shuts down power to the screwdriver and alarms the worker thus the error is actively prevented. This algorithm was developed and tested on videos from real life production environment.

SMART METERING project

Mechanisms for the monitoring and management of essential activities like turning the lights on or off, measurement and temperature control or remote control of the home electronic appliances is nowadays covered by the intelligent home technologies. Aging of home electric appliances is manifested in every

[5] NaturalReader: http://www.naturalreaders.com/index.html

household. This can lead to increased electricity consumption, anomalous behavior, failure of electrical appliance or introducing the various noises to the mains of the household. Goal of the Innovative Smart Energy Analytics is to create hardware/software environment which is able to measure the power consumption from the single point of the household (mains) utilizing the high-frequency samples with the prediction of the home appliances behavior and anomaly detection.

Dramify project - Processing

Backend of the system is implemented primarily using NLTK *(Natural Language Toolkit)* library in *Python* [2]. Unstructured text from e-book is firstly divided into a list of sentences thanks to NLTK's internal unsupervised algorithm built on abbreviation words, collocations, and words that start sentences. Secondly, the sentences are tokenized into words above which all statistics are calculated.

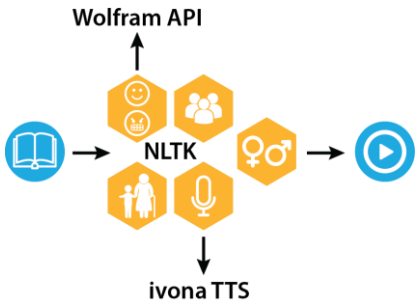

Figure 1. High-level diagram of Dramify architecture

Main characters identification

The tool identifies the set of four or five main characters using statistics and dictionary of well-known names. This approach is combined with method based on distribution of words that start in caps. Words that occur frequently in beginning of sentences (for instance pronounces like *"what"*, *"where"*, etc.) are filtered out. Distribution method covers non-standard names mainly from science fiction or fantasy novels, like *"Gnadalf"*, *"Frodo"* and similar. Smaller number of identified main characters is sufficient, since currently available TTS systems or services do not offer a higher number of English TTS voices.

Gender assignement

Gender plays a crucial role when assigning a proper TTS voice. Each of main characters selected in the previous step is assigned a proper gender, calculated by the following procedure:

- The majority of characters are identified from a dictionary, given by mapping of known names to corresponding gender from NLTK corpora.
- When a name is not found in the dictionary, a Naive Bayes classifier is used to choose male / female label. The classifier is trained on a last syllable of known dictionary names.

- In combination with classifier we calculate statistics of occurrence of pronouns *"his", "her"* presented close to main characters' names in text. This significantly increases right gender assignment from the classifier.

Age group assignment

The tool identifies just three age groups: child, adult, elderly. A character is classified into one of the age groups based on the most common adverbs located close to character's name in text. For this purpose we use extensive dictionaries of adverbs divided into three groups.

Direct speech assignment

Direct speech is not marked in every book the same way. One author uses double quotes, while other only single quotes, and some authors skip quotes at all. Dramify tackles this problem by a set of filters and replacement rules, where all various forms of direct speech labeling is transformed to one common.

Sentiment analysis

For sentiment analysis we utilize HTTP calls to *Wolfram Alpha API* [5] and their algorithm for sentiment classification. Wolfram provides just three categories: positive, neutral, and negative. While working in a scope of sentences, we add additional two categories given the sentences' punctuation in order to refine the voice modulation.

Sentiment analysis is still part of the research, since presented approach does not provide sufficient results for every book. Currently we are testing broader scope as paragraph or a subset of sentences around investigated direct speech to improve the results.

Text-to-speech

Transformation of text to audio is done by multi-lingual speech synthesis cloud service *Ivona* [6]. The service offers 15 English voices (9 US, 3 UK, 2 Australian and 1 English Indian). Payload of the HTTP request is in JSON format, but data to transform might be in SSML, where it is possible to set characteristics like: pitch, emphasis, rate, volume, age (child, teen, adult, senior) etc.

Dramify project - Results

In-depth testing was realized on a set of 50 novels downloaded mainly from *Project Gutenberg*[6]. Among the selected books were: *Alice in Wonderland*, *Five Weeks in a Balloon*, *Anna Karenina*, *Hobbit*, etc. Similar books' structure (preface, Gutenberg notes, table of contents, etc.) helped us to filter unimportant parts outside of main content to be processed. Dramify does not cope well with these pats of book yet.

Main characters were identified in 90% by dictionary method and only in remaining 10% cases was used the distribution method. As we can see, the majority of characters has well=known name. Overall, 95% of main characters were identified correctly.

[6] Project Gutenberg: https://www.gutenberg.org/

Age group assignment was tested in three different settings, where statistics were calculated for a specific number of adverbs before/after character's name. The results are

- 1 word: 80,6%
- 2 words: 83,2%
- 3 words: 77,6%

From the above we concluded to use 2 words before/after character's name.

Gender identification works well for all main characters detected by dictionary method, since gender is known for them. Naive Bayes classifier and method based on pronouns provided similar results in the interval of 75% – 80%.

The lowest success rate was acquired in sentiment analysis. It is given by more factors: sentiment analysis of Wolfram API is imperfect; and analysis just one to three sentences in a given context is not sufficient enough in all cases. Often even the reader doesn't know proper sentiment aimed by author.

FIXER project – Implementation

Hardware components

We have developed several types of markers to determine the workspace margins and in-space orientation - both visible and IR spectrum markers and using both un-modulated and modulated light. Thus we have many possible combinations of markers - that can be tweaked to cover any possible situation we might encounter in the industrial usage such as different light conditions, reflective materials, software execution speed etc.

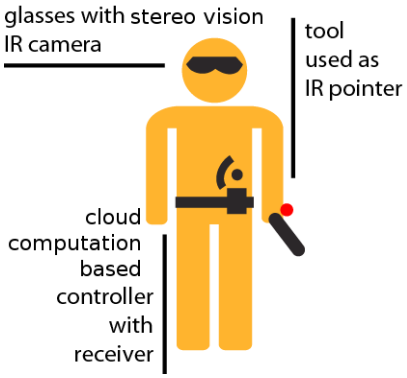

Figure 2. HW equipment required for workers verified by FIXER.

The actual best prototype use infra-red diodes with fully automated synchronization with camera capturing frame rate. This is the main advantage in environments with many other infra-light sources. IR markers are the only one requirement to install in workspace area.

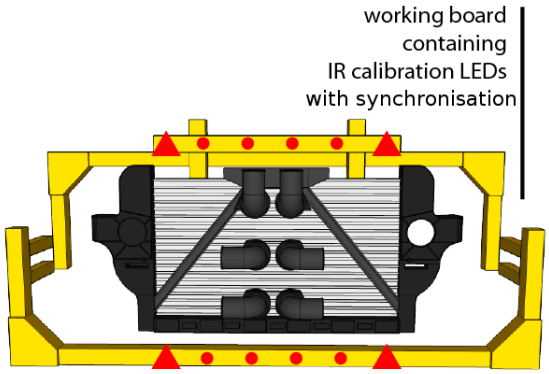

Figure 3. HW equipment required for workspace controlled by FIXER.

On the worker side, the main three HW elements are developed and required. The main source of information's from worker's area is the camera with infra-light filter fisheye lenses.

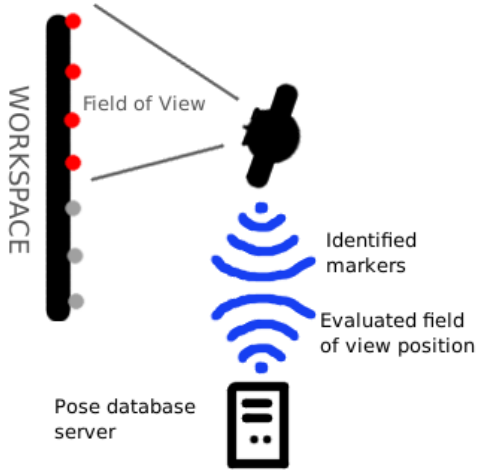

Figure 4. Estimating actual field of view position using detected markers and possible view combinations database.

Our simplest prototype use only one camera, but there is possibility to use two cameras with stereoscopy space depth estimation. The second element is the cloud-based controller, which takes video stream from camera and evaluates the marker position in currently captured image. Finally we have developed the marker, which is used to track the working tool.

Evaluation software

Evaluation software consists of:

1) stored position sequences for each assembled part
2) stored possible views of workspace
3) pre-process software
4) anomaly analysis and pose evaluation server/cloud

Fixer's algorithm computation is based on calibration markers and screwdriver position. Linearization is used to transform matrix of detected markers position to reference image and it's done by pre-computed transformation matrix. This transformation matrix is depended on workspace and used camera. After linearization process the pre-process software analyze the input image from camera, detect workspace markers, working tool markers and their positions.

These positions are then carried out onto evaluation server. This server identifies the detected markers comparing their positions to positions database and computes the actual field of view to real world transformation matrix. Now the real position of worker and his working tool is known. Comparing with expected position, if anomaly or other failed position detected, system will automatically send the warning response to worker and turn off any working equipment (tools).

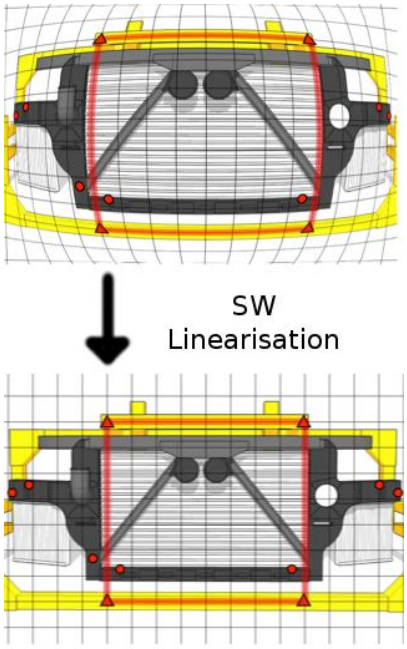

Figure 5. Linearization of optically-deformed input image from fisheye lens based camera using pre-calculated mathematical camera model.

Learning is done manually by trained worker who defines (step by step) sequence pattern in system initial state (typically after first system setup). Thanks to semi-cloud technology, there is no need to update each FIXER unit separately. When one or more changes are applied in workflow process, system will automatically change its behavior in all workers' units.

FIXER project – Results

From the hardware perspective - we have shown that it is possible to construct an optical filter for the camera lens specifically detecting modulated infra-red-diode markers thus removing any possible optical interference. A belt-

mounted computation unit and cloud base examination server and database were developed and long term performance/stability is beginning tested. Next steps will focus on combining our SW and HW elements and tweaking the system in live production environments. First tests displayed some weakness. The most common are system led reflections; lens flare cases and other IR based systems interferences. In hardware part we work now on auto-synchronal led modulation to remove false positives from system marker detections. Software site is now tested with two camera systems to increase the orientation and position examination precision.

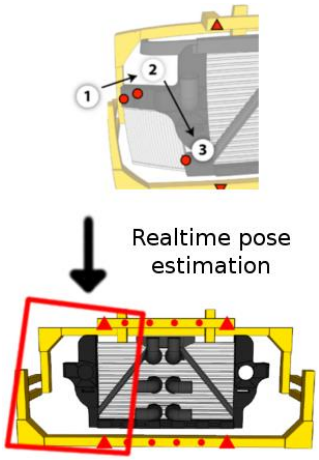

Figure 6. Example of the position determination in workplace based on area margin markers (red circles and triangles) and the previous known positions (numbers in circles).

SMART METERING project

Each of the home electronic appliance is from the power consumption point of view characterized by indicators like power consumption in active/standby state, leading edge of the current at the moment when the equipment has been recently started, tail characteristics when the appliance is going to be switched off or when switching between the operational modes of the appliance.

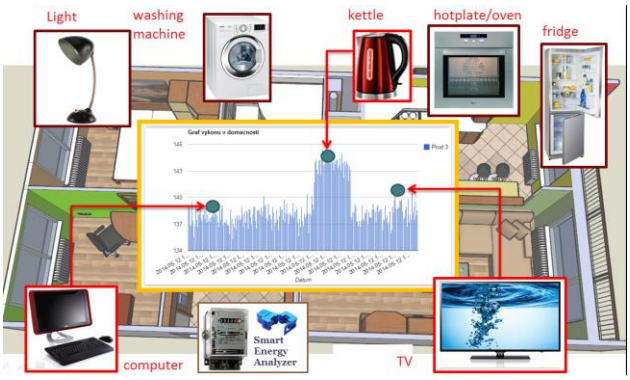

Figure 7. Example of the high-frequency samples measured at the single point of the household (mains).

With the high-frequency samples at the single point of measurement it is possible to identify home electronic equipment by its characteristic behavior. Figure 8 is showing example of the high-frequency sample measured at the single point of the household (mains) which allows to identify individual electronic equipment. Goal is not only to create a per-equipment report of the consumed power but rather to detect anomalies which are happening due to the appliance malfunctioning or simply due to the human error – e.g. lights has been turned on but individual forgot to turn the light off. Figure 2 is showing gap in the energy profile of the household indicating malfunctioned device or untypically long activity.

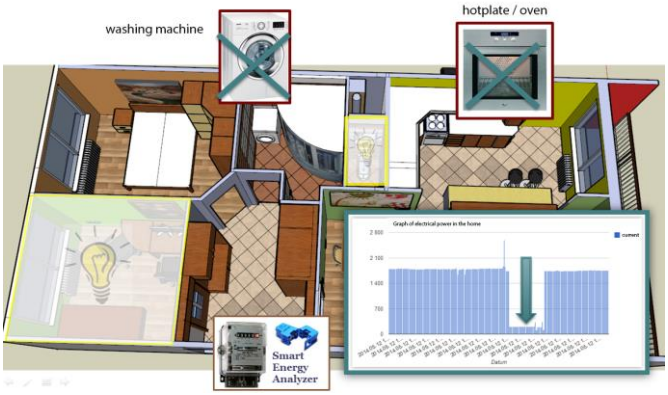

Figure 8. Example of the device failure in the energy profile of the device.

There are number of possibilities how to transmit the information from the measurement process to the cloud for the further analytics. One of the ways which has been experimented in the proposed solution is to use the Internet connection of the customer using the Power Line Communication module. Goal was to develop hardware/software solution which is capable of bi-directional communication even when it resides behind the router with the network address translation technique. Figure 3 is showing the way solution was designed. It consists of the following components:

- Home gateway (router) which allows to connect via TCP to the cloud server
- Powerline communication module which is using Ethernet technology
- Source of the measurement (e.g. power meter capable of high-frequency sampling)
- Microcontroller to communicate with the power meter with the TCP/IP support

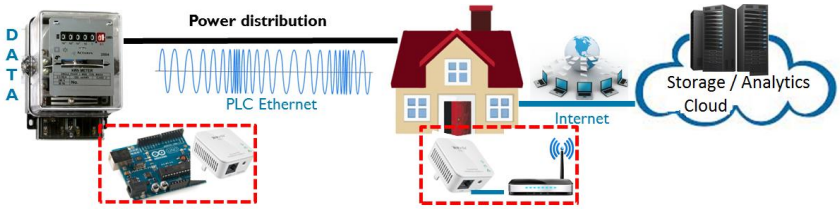

Figure 9. Network architecture to access storage server via the customer internet connection

Atmel based microcontroller has been used as the communication module which is using TCP/IP to communicate with the storage/analytics cloud via the two-way communication channel and 485 serial line to communicate with the power meter using DLMS protocol. Communication module is equipped with the 4 wires – 2x power line, 2x 485 serial interface. Figures 4 and 5 are showing the module and it's mounting under the cover of the power meter.

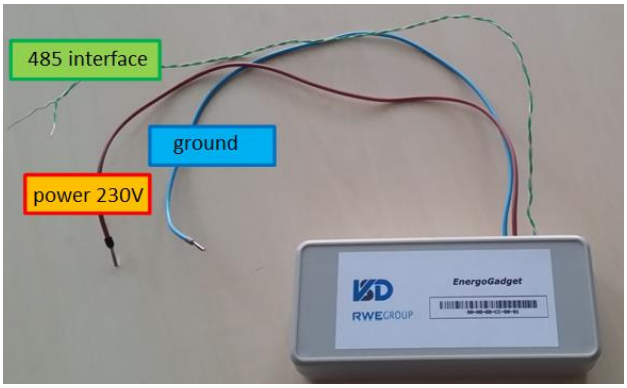

Figure 10. Communication module

Customer connection to the internet is connected via the power line communication (PLC) module which is connected to LAN port of the home router. This allows us to get connected over the customer's ISP and export information to cloud.

Figure 11. Mounting of the communication module

Figure 12. Connecting PLC module at the customer site

Software solution is using DLMS protocol [7] to communicate with the power meters to gather energy profile characteristics which are subject of the further analysis. Figure 7 shows essential GUI interface to monitor the power meters and their total power consumption.

Figure 13. Graphical User Interface for power meters monitoring

Graphical user interface supports visualization of active energy in time as well as energy profile and user's availability statistics.

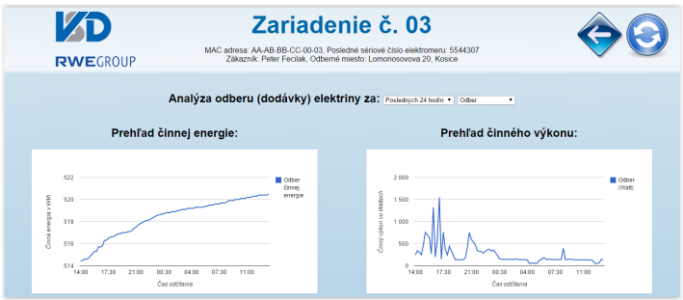

Figure 14. GUI visualization

From the graphical representation of the power energy curve it is possible to identify heavy and quiet energy moments of the household. Figure 9 shows

standstill moments of the household (e.g. sleeping), morning hygiene, and heavy energy moments like cooking or afternoon ironing.

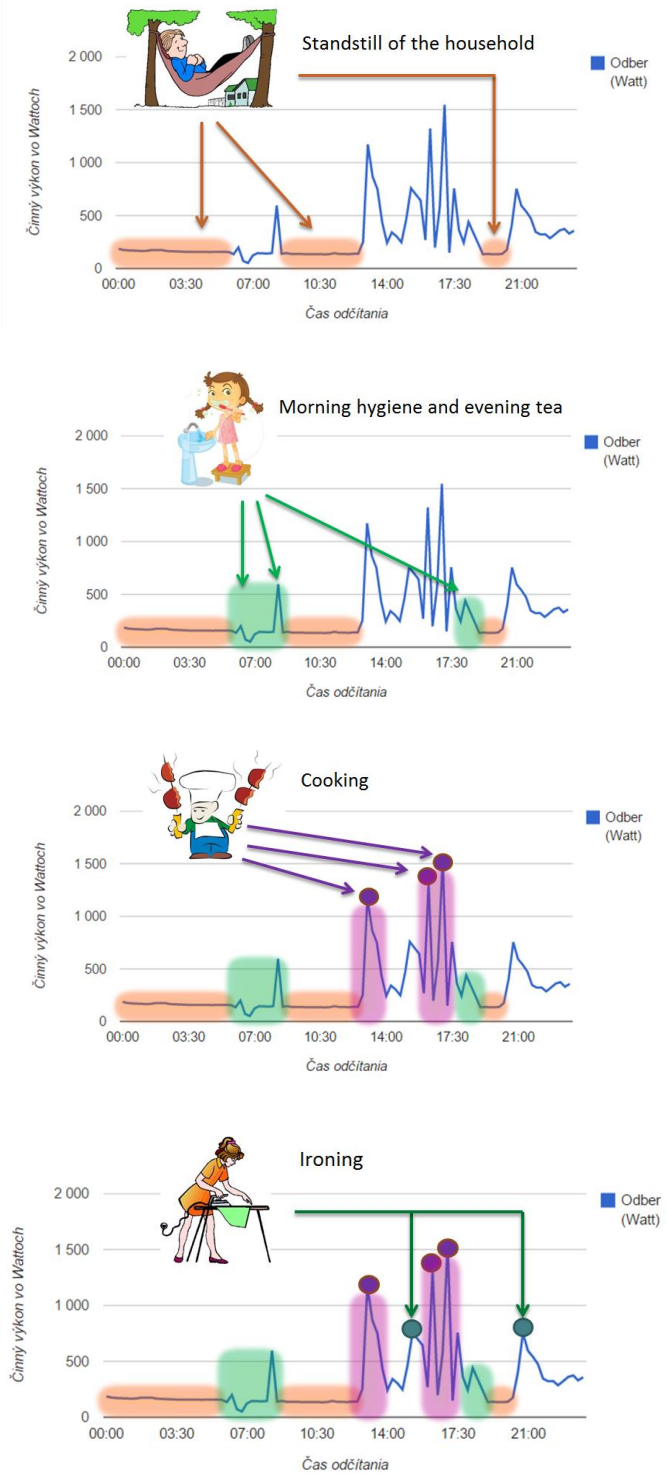

Figure 15. Details of the energy profile of the household

Machine learning supports the process of home appliances identification. Anomaly based approach is used to notify the customer in cases where the behavior is significantly different than what was measured during the period of

normal operation. Figure 10 shows two energy profiles of the same appliance – fridge. Figure 10 shows on the left normal behavior when the compressor is being turned on and off periodically and case of the anomaly on the right-side – e.g. when door has been left open on the fridge.

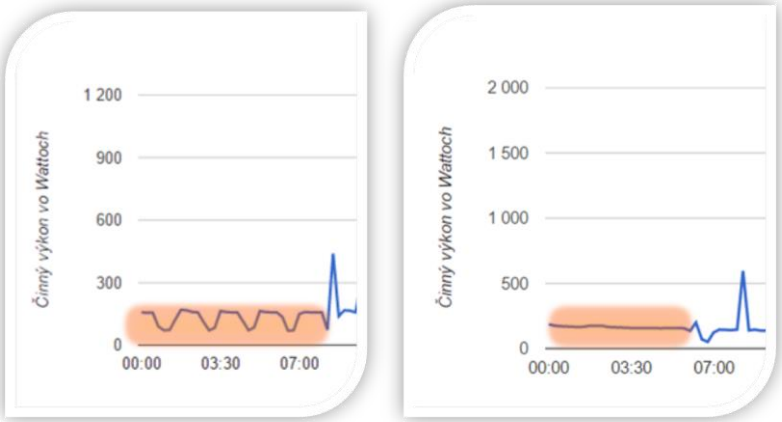

Figure 16. Anomaly detection / malfunctioned home appliance (fridge in this example)

Conclusion

Paper presents state of art in three projects – Dramify, Fixer and Smart meter developed under TECHNICOM project. Results shows big potential for next research and development. Next steps in Fixer will focus on combining our SW and HW elements and tweaking the system in live production environments. In hardware part Fixer team work on auto-synchronal led modulation to remove false positives from system marker detections. Software site is now tested with two camera systems to increase the orientation and position examination precision.

Dramify team is working on detecting the context of every scene, which will provide us required information to add background noise and thus create a more immersive experience. To increase the success rate of assigning proper character voices we plan to utilize cognitive systems such as IBM Watson, which rates veracity of hypotheses provided in natural language. The goal is to provide more features and improve detection techniques, so the service can provide comparable user experience as narrated audio books.

Smart meter team is working on increasing of system stability and better detection and recognition algorithm of connected devices. Improvements are also planned in hardware gadget implementation.

Acknowledgment

Paper is the result of the Project implementation: University Science Park TECHNICOM for Innovation Applications Supported by Knowledge Technology, ITMS: 26220220182, supported by the Research & Development Operational Programme funded by the ERDF.

REFERENCES

1. P. Agarwal, P.B. Benjamin, K.K. Yee, N. Joshi, "Automated Generation of Audiobook with Multiple Voices and Sounds from Text", Patent Application Publication, Pub. No.2 US 2009/0326948 A1, December 2009.
2. P. Punyabukkana et al., "ChulaDAISY: An Automated DAISY Audio Book Generation", Proceedings of the 6th International Conference on Rehabilitation Engineering & Assistive Technology, Tampines, Singapore, pp: 9:1-9:4, 2012. ISBN: 978-981-07-2663-8
3. M. Rusko, M. Trnka, S. Darjaa, J. Hamar, "The dramatic piece reader for the blind and visually impaired", SLPAT 2013, 4th Workshop on Speech and Language Processing for Assistive Technologies, pp. 83–91, Grenoble, France, August 2013.
4. "Natural Language Toolkit" accessed: August 2015. [Online]. Available: http://www.nltk.org/
5. "Wolfram Alpha API" accessed: August 2015. [Online]. Available: http://products.wolframalpha.com/api
6. "Ivona Text-to-Speech" accessed: August 2015. [Online]. Available: https://www.ivona.com/
7. O. Hersent, D. Boswarthick, O. Elloumi, DLMS/COSEM, in The Internet of Things: Key Applications and Protocols, John Wiley & Sons, Ltd, Chichester, UK. 2011. ISBN: 9781119994350

ЗМІСТ

Наукове видання

МІЖНАРОДНИЙ НАУКОВИЙ ВІСНИК INTERNATIONAL SCIENTIFIC HERALD

Випуск 1 (12)

Свідоцтво про державну реєстрацію друкованого засобу масової інформації КВ №20546-10346Пр, видане Міністерством юстиції України 15.01.2014 р.

Відповідальний за випуск І.В. Артьомов
Упорядник А.І. Гусь
Коректура: Т.М. Алексєєва, Л.І. Середа
Технічне редагування: М.І. Іванова, О.І. Гурчумелія
Комп'ютерна верстка та дизайн обкладинки А.І. Бродич

Підписано до друку 30.03.2016 р.
Ум.друк.арк. 29,2
Гарнітура Times New Roman
Формат 60х84/8 Зам.№28
Тираж 300 прим.

Оригінал-макет виготовлено
в редакційно-видавничому відділі ДВНЗ «УжНУ»
88015, м. Ужгород, вул. Заньковецької, 89,
E-mail: dep-editors@uzhnu.edu.ua

Віддруковано ПП А.А. «Демидов»
88000 м. Ужгород, вул. Митрака, 25

М-72
Міжнародний науковий вісник: збірник наукових статей за матеріалами Міжнародної науково-практичної конференції «Науковий парк як універсальна регіональна структура інноваційної діяльності», Ужгород-Кошице, 3 березня 2016 року /ред. кол. В.І.Смоланка (голова), І.В.Артьомов та ін. – Ужгород: ДВНЗ «УжНУ», 2016. – Вип. 1(12). – 254 с.
ISSN 2218-5348
УДК 001:378

International Scientific Herald: collection of scientific papers on materials of International scientific and practical conference "Science Park as universal regional structure of innovative activity", Uzhhorod-Kosice, March 3, 2016 / ed. count. V. Smolanka (Chairman), I. Artjomov and others. – Uzhhorod: SU "UzhNU", 2016 – Ed. 1 (12). – 254 p.