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Semantic Architecture for Sensors

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Semantic Architecture for Sensors [1]

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Abstract. Technological progress in recent years and the increase of Internet of things (IoT) in our daily life brought a huge flood of data that can only be handle, processed and exploited in real-time with the help of Information and Communication Technologies (ICT). The ICT is one main element in order to achieve more efficient and sustainable an environment resource management, while the needs of the citizens are satisfied, creating new applications to improve citizen's quality life. The creation of new systems that allow the acquisition of context information, automatically and transparently, and give that information to decision support systems are important aspects for information societies. In this paper it will be presented the usability and importance of sensors to get information from our environment in order to know what and when happen changes around us as well as the importance of ontologies in the structure and organization of the systems, to acquire new knowledge.

Keywords: Sensors, Ontologies, FP7-ICT, Projects ICT

JEL codes: D83, O31, Q23

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1.1Introduction

Technology is being used to improve citizen’s daily life. Through the creation and improvement of new technologies, the comfort of people is becoming better every day. This technological progress has made possible to extend the use of Information Technology and Communications (ICT) to new applications to improve our quality of life. This fact has become so important to our society that the investments on the ICT are increasingly, for instance, the budget related to ICT from the EU (European Union) on 2014-2015 was 703.5 million, the estimated total budget for the next year 2015-2016 will be 762.55 million and for 2016-2017 the estimated budget will be 807.65 million [1][2]. The EU has the objective of design, program and implement highly distributed and connected digital technologies which are embedded in autonomous physical systems. The ICT intends to make the systems more intelligent, more energy-efficient and more comfortable in order to make the citizens a better use of the resources to the cities. One example of this tendency is Internet of Things (IoT), which increases intelligence of the objects around us and connects them to the network to exchange data without requiring human interaction or have the capability to control these objects remotely, because everything is connected and connected to the network.

In this report it will be described some types and uses of sensors and the importance of using ontologies on complex systems. Following that, it will be represented a system which uses sensor’s technology and represent all the knowledge with one ontology. To show the importance of this developed system, it will be shown some European and American projects which uses the interoperability between these two concepts.

1.2Background Observation

In our society, information is becoming more important in order for us to have more comfortable and a better life. To acquire information for our surroundings, it is necessary to have information of environment around us, which is done by sensors, and it is necessary to analyse, save and give responses from that information which can be done with ontologies. On the next section, it will be presented some types of sensors and how they can communicate with their systems. It will also be presented what is one ontology and how they can be used in our community. Sensors and ontologies can be used for all the society on different places and conditions. For that reason it will be shown two different cases of sensors and ontologies, one case where they are used in a technological environment (cities) and other in a non-technological environment (forests).

1.2.1 Sensors

Sensors are used to provide a system with useful information concerning features of interest on the system's environment. A sensor is defined as a device that converts a physical stimulus into a readable output, and usually they are used to know the occurrence of an event or when to end an action. There are some types of sensors, and they can be:

- Mechanic: they detect movements, positions and presence, using mechanic resources. This type of sensors are very used in the industry to know if a structure reaches the end of his route (through one end limit switch);

- Magnetic: they detect the position of one piece or one part of a mechanism by putting one magnet to them. In the industry, where it is necessary to have quick responses, magnets are used because they have quick responses;

- Photoelectric: they use light and have very fast responses. In addition, they also don't have moving pieces that breaks or suffer detrition;

- Encoders: they are used to measure the position of a swivel axis and its velocity;

- Image: they are made from a big amount of photoelectric sensors that captures the shape, colour and other characteristics of one object. They are used, for instance, to detect defective objects on an assembly line;

- Measuring Optical: they are used to detect optical characteristics, such as luminance, contrast and colour.

- Thermal: they measure changes of temperature;
- Presence: they detect persons by their body’s temperature or forest fires through their heat;
- Ultra-sonic: they are used for detecting objects in long distances when the objects have the capability of reflecting this type of radiation [2].

Since there are many different types of sensors, it is normal for a controlled system to have more than one type of sensor to complement the others sensor’s information. These sensors are geographically dispersed in the environment and interconnected through a communication network. Although it is important to have large number of sensors, because they can bring new information and have better control on the system to be analysed, having a large number of sensors can bring problems of not having a real-time or near-real-time decision making as well as the capability of analysing and storing that amount of new data. The systems to respond to this problem are starting to emerge with the focus of being more efficient on sensor-based applications or improve sensor-based data management, sensor network configuration and sensor communication protocols [3]. This can be solved, for instance, by the use of single ontology.

1.2.1.1 Internal network connections

The internal network connections from sensors can be classified into a centralized or a distributed system. On the centralized system, the sensors are controlled directly by the gateway processor and the system relies on one clock. On a distributed system, each sensor has its own processor unit, clock and performs independently its functions. On the report [4] made in 19/09/2015 from the WIMEA-ICT project, there is a list of characteristics of a good network and how they are affected by **centralization** and **distribution systems**, or by **wireless** and **wired links**. The characteristics are:

- Scalability: possibility to expand the network of sensor nodes. Distributed systems are more scalable than centralized systems and there is a major problem if the system is centralized into one sensor node using wired connections. In that case, expansion requires physical intrusion from cabling and attaching the sensor node onto the frame.

- Reliability: the data that reaches the gateway must be the same as the sensor's measurement. The data can be corrupted because, in order to send the data from the network to the gateway, it is grouped as packages which can be lost along the way or the transmitting device can be faulty. To prevent these cases, the data can be retransmitted and/or adding redundancy by adding extra sensors. In a wired link, the node-gateway connection can undergo physical trauma and easily break causing failures. In both wired and wireless communications, it is possible to retransmit the data. In terms of redundancy, the wired system is worst due to the fact that logistical challenges are greater which is explained by the scalability item.

- Cost: generally distributed systems are expensive to set up, especially in time and energy, but the development effort required to achieve the same goal as a centralized system could be greater. About the links, a wired system can be more expensive because it has an extra cost of cabling and the labour to lay them. The wireless devices have an initial investment, but they are scalable which makes them much cheaper in terms of time, energy and money.

- Range: it is important to cover the longest range as possible. Long range connections using metal wire links have voltage loss due to cable length as well as optic fibre links have light signal loss. Wireless signals also have their signal attenuated has the signal is transmitted to longer distances. However, depending on the protocol in use, the wireless signals could travel longest distances with good reception at the gateway, with less capital investment than metal or optical fibre links.

- Power consumption: it should be as low as possible. In centralized wired connections, the power of the sensors can be turned off when the gateway enters a low power mode. Wireless sensor needs their own power supply which makes a disadvantage comparing to wired sensors.

- Security and data integrity: it is important that it cannot be possible to change data provided from the sensors. Wired links make that aspect possible while wireless links are more subject to external changes.

- Immunity to the environment: long wires from sensor nodes to the gateway act as radio antennas, picking up electromagnetic interference. There can also occur natural disasters like forest fires or floods that could lead to the destruction of the nodes and the gateway. The animals and/or humans can also destroy the cables of the sensor nodes. Regarding wireless connections, another problem would be the appearance of other wireless connections on the same frequency of the sensor's communications.

1.2.1.2 Existing solutions

Sensors in Smart Cities

With the development of new technological innovations, mainly ICTs, the concept of "Smart City" emerges as a means to achieve more efficient and sustainable cities. It is complicated to obtain a common definition of Smart City because cities are complex systems where massive number of interconnected citizens occurs and there are a big diversity of technological, social, economic and organisational problems. A common goal of a Smart City is, not only the use of ICTs to meet theirs objectives, but also to provide a new approach to urban management, in which all aspects of a city are treated with interconnection of all urban aspects, improving this way the quality of living of their habitants. For this reason the researches on [5] used the sensor Radio Frequency Identification (RFID) as one technique for identify the citizen's movements. With this kind of architecture, it is possible to make infrastructure planning, for example, in the transportation routes or the optimal positioning of the city's resources. The citizen's traceability was sent into one cloud service and then a centralized service provider would define the best service according to the data acquired from the cloud.

Sensors in Forest Fires

The predominant method to detect and forecast forest fires is using satellite telemetered data. This method consists on analysing satellite's images in order to detect pixels where the fire may exist. After that, the knowledge extracted from that image and auxiliary geospatial datasets are encoded to represent the new information in that image.

However, it has been proven that using wireless sensor networks (WSNs) to detect and forecast forest fires provides more quickly and higher information than using traditional satellite telemetered data. The WSNs are becoming more used nowadays because they can be deployed in different environments and their cost, size and dependence of micro-sensor technologies are decreasing. Researchers, regarding WSNs, investigate the best sensor combinations regarding forest fires, using the following sensors: light, air, temperature, air pressure, wind speed, wind direction, soil moisture, leaf wetness, relative humidity, rainfall, smoke, etc [3].

1.2.2 Ontology

Ontology is very used for knowledge representation and it is a description about domain concepts and their relations. It can differentiate kinds of objects (concrete and abstract, existent and non-existent, independent and dependent) and their relations or dependency. It can also be used to organize information in order to support information acquiring [6]. Semantic web is an extension of WWW, which gives an easy way to find, share, reuse and combine information. It allows people to store data, build vocabularies, and write rules for handling data, everything on the web. It has the objective to provide a better platform for knowledge representation of linked data to allow machine processing by adding logic, inference and rules systems to the web which allows data to be shared across different applications and everywhere [7].

Only a few studies, such as Semantic Sensor Web research, have been concerned about the limitations of raw sensor data streams by saving the sensor data with semantic metadata. This fact improves the spatial, temporal and semantic meaning and their potential interoperability and re-usability. The Semantic Sensor Web research also demonstrated the application of semantic reasoning rules in order to acquire new knowledge from semantically annotated sensor data [3].

1.2.2.1 Existing solutions

Ontologies in Smart Grids

The current electricity grid converts only one-third of fuel energy into electricity, without recovering the waste heat. To reduce even more its efficiency, almost 8% of its output is lost among its transmissions lines, while 20% of its generation capacity exists to meet peak demand only. To improve this situation, it is being developed the next-generation electricity grid, the “Smart Grids”. They respond to changing in the environment, improving energy efficiency and reducing carbon emissions. It is a power system that uses modern communications and control techniques to allow much greater robustness, efficiency and flexibility than ours power plants can’t [8]. The major technological advance in these systems is the two-way digital communication infrastructure. This brings some benefits because they will enable data interchange from the client to the utility, in order to know the amount of electricity necessary for the population and allow communications between the utility to the client, transmitting, for example, the electricity price to the client. For all these reasons, it is necessary to store and process large amounts of information, as consumption measures of millions of clients, price signals, grid events, transport network operation orders, alarms, and so on. On [10,11,12], researchers tested the integrity of using smart grid information with ontologies and proved that ontologies can efficiently handle, process and analyse in real-time flood of multi-directional data. With them the new information that can be obtained from the data can be distributed amount all the system components.

Ontologies in Forest Fires

On [3] it was used 180 sensor nodes in Stringbrook National Park region in order to calculate five different weather indices to identify the existence of forest fires. Fire weather indices can be categorized into five high level categories, from low to extreme, and correspond from a fire that can be easily controlled and there will be no risk to life, to a fire that will likely be uncontrolled and is fast moving having flames that may be higher than roof tops.

After each sensor acquired the data, it was stored on an ontology, which already contained 241 first-order logical rules created from other ontologies already made, to generate fire weather indices. With the information of this ontology, it was applied an Inverse Distance Weighting (IDW)-based neighbourhood region prediction algorithm, to visualise the fire weather indices for a specific region at a time period. With this architecture, each user could use Google earth to visualise, in real time or within a time period, fire indices for a specific region and could compare entire period, day-time and night-time average fire weather indices.

1.3Developed work

The developed system, represented on Figure 1 , has the purpose of suggesting the most appropriated music to one user, according to its current emotional state. It is used in a real-time environment, and according to the measures acquired by module “physiological measurements”, the system will search on an appropriate ontology, where all the knowledge is stored, in order to choose and play the most appropriate music to the user, according to its current feeling state. The physiological measurements exist, mostly, as medical devices with the purpose of verifying a patient’s health, but for this system, they will be used for infer emotional states, using its data acquired from the sensors connected to the user. The physiological sensors used on this system are: airflow (breathing), electromyography (EMG), electrocardiogram (ECG), body temperature, pulse, oxygen in blood and galvanic skin response (GSR). The signals from these sensors will be analysed with MATLAB software, in order to remove the signal noise and to apply the appropriate filters. Having one clear signal, it will be possible to infer about the current emotional state of the user using the ontology, searching the current emotional state and its corresponding solutions.

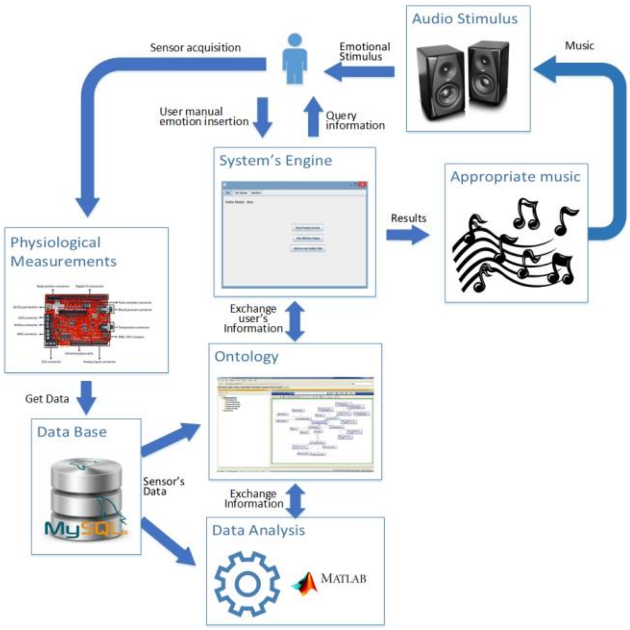

Figure 1: System architecture

This system has two phases of development. The first one will happen in middle February and it will be used for training the system, working with at least 20 different persons and measure its physiological measurements. They will be listening to one relax music, to create a base line for the signals, and then they will be listening to a rock music, opera music, pop music and finally house music. At the beginning and end of the music, it will be asked to the user to identify the current emotional state. With this experiment, it will be possible to understand what the changes are on the physiological measures used in and for future use, it will be possible to know what the emotional state is only using sensors connected to the body. The second phase will happen during the use of this system, by the capacity to learning from the previously acquired data and improving its solutions to improve the well-being of the users.

1.3.1 Current applications

Music plays an important role in our everyday lives, even more in the digital age. As Figure 2 shows, there is an increase for the downloading revenue for digital music of 3.3 percent annually from 2013 into 2018 [12]. It is possible to conclude that more people are listening to music and even more people prefer using digital music which is relevant for the use of the developed system.

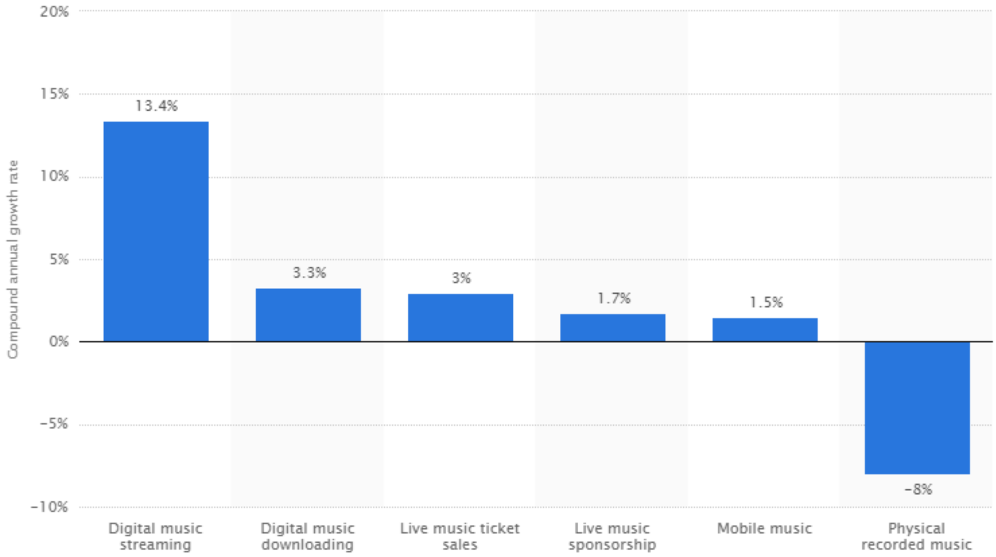

Figure 2 - Growth of the global music revenue between 2013 and 2018, by category [12]

Since the behaviours of the citizens are changing, there are an increase of online music platforms such as iTunes, streaming services such as Spotify, websites and TV shows such as VH1 or YouTube or the increasing of radio stations across the broadband, there are a music digital revenue from 2004 to 2014 of 6.5 billions of dollars, as can be seen on Figure 3, making this subject an economical interest for developing new attractions for the users.

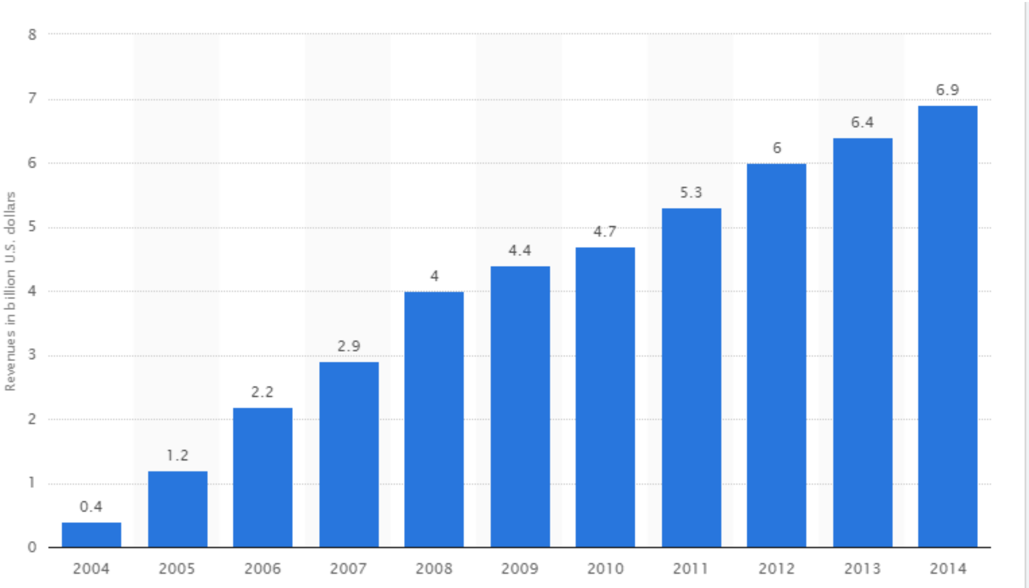

Figure 3: Global digital music revenue from 2004 to 2014 [13]

As the population's needs are listening more music and using more the digital music, this system was developed taking into account two different cases: having the possibility to control the most appropriate music for an individual (or group of persons) or for investigation purpose.

1.3.1.1 Controlling background music for a group use

Music is present is many public places we go. Trains, buses, elevators, restaurants or hospitals are some public areas that uses music as background music. And if it was possible to define that music according to the majority of the emotional state of the users of these spaces? Could this simple change make the citizens happier?

On [14] it was concluded that using music in a Smart Space had influence on reducing blood pressure, increased respiration (suggesting physiological responses to perception and enjoyment of music) and lowest mean of electroencephalogram (suggesting the physiologically important aspects of appealing music therapy during relaxation). Also experimental studies [15] showed that listening to positive music (the music had to be positively valenced [2]), when they try to improve their mood, was an effective way of improving happiness, experiencing greater gains in well-being, as measured by positive affect, subjective happiness and life satisfaction. The participants reported higher levels of happiness when listening to positive music while trying to feel happier, in a two weeks period. Imagining a public space where students or employees go for a coffee break, if it was possible to know the generic emotional state of the group of people, it was possible to play one music that could improve their feeling state and improve the citizens' quality of life.

With these studies, of the importance of music in our well-being, it is possible to confirm the utility for the public service of this types of systems. But, it is possible to know the feeling states of the citizens without physiological measurements, like sensors? The answer to that question is yes! The feeling state of one person cannot be only inferred by physiological measurements. There are used several modalities to interpret emotional states, because emotions affects almost all modes: audiovisual (facial expression, voice, gesture, postures, etc.), physiological (physiological measurements) and contextual (goal, preference, environment, social situation, etc.) states in human communication [16].

1.3.1.2 Controlling background music for individual use

Instead of viewing the applicability of this system for a group of persons, it can be used for an individual use. Many people individually listens to music while traveling, waiting or studying. It could be useful to choose the music according to the current feeling state of the user, instead of a random selection.

With the advance of technology and network communications, the use of mobile phones for listening music is increasing every day. Analysing Figure 4, which represents the use of internet for listening music, there are a huge increase of musical data acquired from the network, with global mobile audio streaming traffic from 2014 to 2019 having an increase of approximately 193 756 TB to 1 623 894 TB per month.

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[2] Valence describes how positive or negative an emotion is and ranges it from an unpleasant feeling to a pleasant feeling [31]

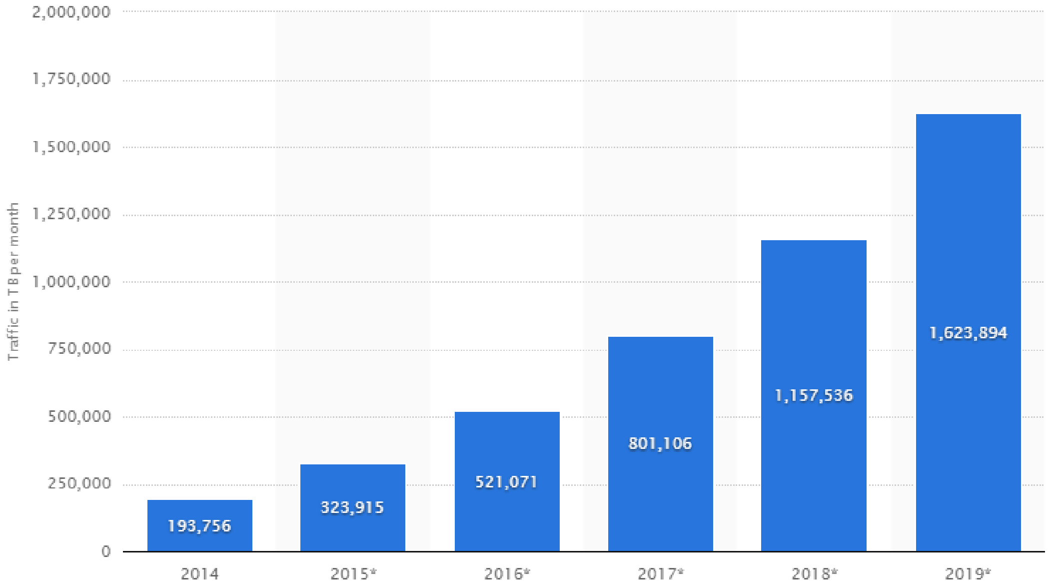

Figure 4: Global mobile audio streaming traffic from 2014 to 2019 (in terabytes per month) [17]

There are mobile phones that can extract health features and useful information through their sensors. With stride length (SL) and gait cycle time (GC), acquired from a tri-axial gyroscope from a mobile phone, it is possible to use them as biometric identifier for the user. There are already mobile phones that are capable of getting a readable ECG of their user. This information allows estimate the heart rate (HR), heart rate variability (HRV) and cardiac interbeat interval (RR) – with this information it is possible to infer about the users feeling state. Using their accelerometer, they are also capable of monitor the movement during the sleep, to determine which sleep phase the user is in, and according to that information, the cell phone will turn on the alarm on the lightest sleep phase, to help the user feel rested and relaxed.

Related to sleep quality sensing, other programs use the microphone of the smartphone to detect events that are related to sleep quality, including body movements, couch and snore [18]. Other study [19] analysed the influence of mobile phones while the users where using them to communicate with others. They use the information of the time of the mobile phone usage, phone and location data to give information of sociability and timing of calls, SMSs, emails, “screen on” to provide information of how often the users interact with phone during the day and the night.

1.3.1.3 Investigation use

The investigation use for this system was thought from the first phase of the development of this system. To understand the effects of music on our body and mind, it is necessary to measure it, through physiological sensors and see its information, and this is precisely what the system is capable of. One future work to be done with this system is the observation of physiological measurements of playing the same music but in different circumstances, for example, first is play only the music, then the music is played but with its videoclip, and finally the music is played with a totally different video.
The investigation of the music area is a situation that is increasing with the evolution of technology. This big global investment can be seen by the increasing between 2004 and 2014, the digital share of music revenues grew from 2.9% to 71%, represented by Figure 5.

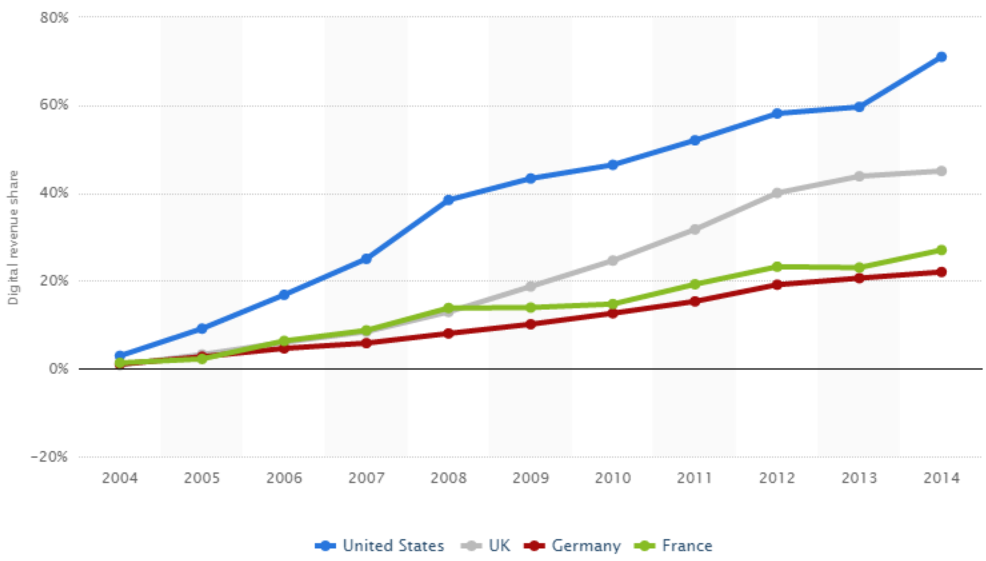

Figure 5: Digital share of overall music sales in United States, UK, Germany and France from 2004 to 2014 [20]

1.3.2 R&D in technology using music for our wellbeing

1.3.2.1 Europe – past, present and future

Since this system focuses on the well-being of persons and can be applied to society, there are monetary incentives for the investigation of these type of systems.

Under the FP7 programme, there were many projects related to music and using it for human wellbeing. The "Beat-Health" project (project number 610633 funded under FP7-ICT), was one example from that. This project intended to study the relation between music and movement for boosting individual performance and enhancing health and wellness. This fact can be seen when in gyms, when rhythm of music changes according to the objective of one class. A spinning class, for instance, usually has a variety of rhythms to make users feel like they are into a sprint, with a fast beat, or make people feel they are climbing a hill, with a slower beat. In this program it was developed an intelligent technological architecture to enhancing and recovering features of movement performance. Another project related to the developed system was the "Prometheus" project (project number 214901, funded under FP7-ICT). In this project researchers developed one framework to link fundamental sensing tasks to automated cognition processes. This goal was achieved using a network of heterogeneous sensors that monitor one environment or group of people, in order to understand human behaviour and different patterns. One example of that applicability is in the fields of security, to detect abnormal behaviour in real time, for instance, when a person is caring a luggage and drops it.

For the next year, regarding the activities of 2016-2017, the European Commission, for the ICT in Horizon 2020, will give the following budgets:

- SC1 – Health, demographic change and wellbeing: 124.2 M€. This sector is related to personalised medicine and the projects are related to active ageing and self-management of health, protection and methods of health data and coordination activities related to health and wellbeing;

- SC6 – Europe in a changing world – Innovative, inclusive and reflective societies: 70 M€. This social challenge includes activities related to public sector modernization.

For the next year, the two of the three focuses of the areas of the ICT working program will be:

- Internet of things;
- Smart and sustainable cities [21].

1.3.2.2 United States under National Science Foundation

Through the technological advances, there were an increase in size, diversity and complexity of data in virtually all aspects of human world. The system described in this paper could be on the National Science Foundation (NSF) division: “Division of Information & Intelligent Systems” more precisely on the sub-division: “Information Integration and Informatics - III”. The III’s sub-division of NSF is responsible for systems in order to handle massive volumes of data from disparate sources into useful information and new knowledge. To do this transformation, the United States foundation also uses semantic and ontologies to acquire new knowledge from the data, through the creation of new ontologies for specific information, sharing knowledge and inference with distributed sources. Their funded projects address several topics, as: data of unprecedented scale, complexity and rate of acquisition, by acquisition, storage and preservation, use and re-use of data, information and knowledge for decision-making and action. They have funded, each year, only for the sub-division “III”, up to 100 million Dollars (approximately 91 million Euros), to support more than 200 awards [22].

1.3.3 Projects related with this system

In this section it will be presented two projects which uses a similar architecture from the developed system. Firstly, the information from the environment is acquired by several sensors, next it is stored, analysed and finally the system gives information of the study case. To give that information, the system analyse not only the present situation but also the previously information acquired by the sensors, and with all this, it gives a perdition that can occur in the future.

1.3.3.1 WIMEA-CIT project - Automated Weather Station

WIMEA-ICT (*Improving Weather Information Management in East Africa for effective service provision through the application of suitable ICTs*) is an "Automated Weather Station (AWS) development and network densification" prototype. It was funded by Norad (Norwegian Agency for Development in Higher Education and Research for Development). The project is defined as a remote stand-alone automatic weather station and it aims to improve the accuracy of and access to weather information by the communities in the East African region through suitable ICTs [23] [24]. On this project, researchers created a prototype which consists of a network of wireless sensor nodes, each one measuring some environmental parameter and transmitting its data to a central gateway, using the IEEE 802.15.4 protocol communication in the 2.4 GHz range. This data is saved on the gateway into a file at a specific time intervals. The wireless sensor nodes consists in small boards with a microcontroller on it, and each one has its own name, address in the network and may have different sensors installed on it. The measurements of the sensors sent to the gateway are temperature, humidity, wind speed, wind direction and solar insolation, and the non-environmental information sent are power supply voltages and signal strength values. Each node is powered directly by supercapacitor batteries that are charged from solar panel through DC-DC converters. In this project the gateway in use is a Raspberry Pi B+. It is connected via serial interface to a sink node, that reads incoming frames and save them into a file. This file is human readable ASCII data and can be accessed over TCP using Ethernet. The data can be visualized in a graphical form on a webpage hosted by a webserver on the Raspberry Pi.

Until the last report, the researchers from this project were having some issues:

- Power issues: the current power supply for the node is solar panels, which are charging ultracapacitor batteries. But on East Africa it is frequent to occur vandalism, and people from there could destroy or steal the power equipment;

- Node enclosure: there are no case for the network of wireless sensor nodes and internal circuits to protect them from dust and water;

- Frame: the prototype doesn't have a frame which the gateway and some sensor nodes will be mounted [4].

With this project, there will be an increase station density by 70 to 100 stations across South Sudan, Tanzania and Uganda.

This project seeks an improvement of meteorology in that region, not only with the increasing the density of weather stations, but also with the training of the system, to model weather information to predict and analyse sensor's data, for weather forecast. Although these countries don't appreciate the installation of new technologies from other countries, for instance, the national meteorological services control all national weather data and have monopoly on giving forecasts [25], these project already have some sensors installed and it is possible to analyse the information from the sensors of the project on the webpage of the project [26].

1.3.3.2INTERSTRESS

The INTERSTRESS project (Interreality in the Management and Treatment of Stress-related disorders) was funded under FP7-ICT project and its total cost was 4.5 M€ and aims to design, develop and test and advanced ICT based solution for the assessment, treatment and prevention of psychological stress. First of all, it was necessary to objectively and quantitatively identify the symptoms of stress using biosensors and behavioural analysis. Secondly, decision support for treatment planning through knowledge previously acquired and detection algorithms. Thirdly, provision of warning and motivating feedback to improve compliance and long-term outcome [27].

This project uses a new concept for the e-health area – Interreality: integrating assessment and treatment within a hybrid, closed-loop empowering experience, in which behaviour in the physical world influences the virtual world experience and vice versa, always controlled by a therapist. It uses mobile and Internet applications, in order to employ 3D shared virtual world role-playing, and bio and activity sensors. This can be achieved through:

- 3D Shared Virtual Worlds – Interaction with one or more users with one another within a 3D representation, and can be immerse (in the health care centre) or non-immersive (at home) role-playing experience;
- Bio and activity sensors (from real to virtual world) – identity the emotional/health/activity status of user and influence his/her experience in virtual world (aspect, activity and access);
- Mobile Internet Appliances (from virtual world to real world) – direct link between social and individual user activity and user's life through a mobile phone/PDA [28].

On both virtual and real world, there will be always the recording of participant's behaviour and emotional status with biosensors and behavioural analyses.

With Interreality it is possible to suggest new experiences to users resulting in meaningful new feelings, which can be reflected upon and eventually changed through reflection and relaxation. This is one of the main goals of Interreality, because for the CBT (Cognitive Behaviour Therapy) protocol for stress management, imagination and/or exposure induce emotions, and meaning of associated feelings, can be changed by reflection and relaxation. The INTERSTRESS project focuses, for that reason, on modifying dysfunctional thoughts through a more contextualized experiential process. The individuals will be actively involved into a learning process, experiencing stressful situations reproduced in virtual environments and reflecting on the stress level in their daily life with help of advanced technology, such as smartphones or biosensors. With use of warnings and motivating feedback to improve self-awareness, compliance and long-term outcomes, participants receive feedback to improve their appraisal and copying skills [29].

On [30], it was tested the efficacy of Interreality paradigm, which is used ICT-based system for assessment and management of psychological stress, in comparison with Cognitive Behaviour Therapy (CBT). There were 121 participants involved from two different worker populations (teachers and nurses) and highly exposed to psychological stress. One group (61 subjects) received a 5-week treatment based on Interreality paradigm and another group (60 subjects) received a 5-week traditional stress management training based on CBT. Although both treatments were able to reduce perceived stress, only the group treated with Interreality reported significant reduction in chronic “trait” anxiety, with 12% success using Interreality and 0.5% success using CBT. Another relevant different was found regarding coping skills with a successful rate of 14% for Interreality over 0.3% for CBG in the Emotional Support Skill.

Analysing this project, it is possible to conclude the ICT can improve our quality of life if applied into the knowledge we already have. We already knew reflection and relaxation could reduce the stress, and the use of ICT with these factors can significantly reduce stress improving our daily life.

1.4Conclusions

The usage of sensors with ontologies is increasing with development of technology. Information is becoming self-dependent with analysing and decision making which are aimed for improving the quality of life of the citizens of our society. With the growing usage of sensors, in order to have more controllable and observable systems, there is an increase of flowing data that need to be read, analysed and saved, which can be done with ontologies. The research presented in this report shows that these two concepts are used in many different places and situations and the more they are used together, the more our society can benefit. One practical example are natural catastrophes. When we can predict with more accuracy the time and locals they occur and many things can be done with that precious information. With our current communication society, it is possible to acquire information from places that no human can go and analyse it, as if we were present there.

The big dependence of sensors with ontologies and their usage is very notable with the increase of funding and awards from EU, USA or Japan along the years. The importance of ontologies to create new knowledge is raising. Using ontologies, it is not only possible to exceed limited resources’ barrier: power, memory, computational capacity and communication bandwidth (observed in the WIMEA-ICT project), but it is also possible to re-use ontologies already made, creating this way a machine-interoperable semantics (observed in the Forest Fires example). The creation and development of a system that could analyse physiological measurements and see what, when and why they change, will promote new technologies for human’s wellbeing.

We live in a technological world and the more knowledge we can acquired from it, the more our society will use it our behalf.

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