ITEA3

Project Results

EmoSpaces

Detecting emotions in smart environments

EXECUTIVE SUMMARY

The goal of the ITEA project EmoSpaces was to develop an Internet of Things (IoT) platform to determine context awareness for affective services. In considering emotion as a source for improving IoT, breakthroughs have been generated in sensor fusion, home automation and social simulation.

PROJECT ORIGINS

Smart mobile platforms, wearable computers and internet appliances have had a huge effect on IoT, for which the global market will be worth approximately USD 14.4 trillion by 2020. Sensor fusion opens the door to context awareness, such as monitoring human-environment interactions, and research has shown the positive effect that emotions have on illnesses. In spite of this, emotion-based IoT services have received almost no attention and challenges remain for security and privacy, heterogeneous device management and analytics that can process such enormous sets of events. EmoSpaces set out to rectify this.

EmoSpaces (Enhanced Affective Wellbeing based on Emotion Technologies for adapting IoT spaces) has produced an intelligent IoT platform in which processing tools gather and analyse heterogenous data from smart environments, such as cameras or non-optical sensors. This is used to characterise the behaviour of users, with affective services then responding to established user profiles in line with their wishes. One example would be analysing data from wearable sensors to evaluate stress levels. EmoSpaces' technologies are incorporated into a holistic architecture to ensure adaptive use, effective transmission and accurate interpretation by stakeholders. To guarantee privacy, data from smart home systems travels through local networks without being transferred to cloud services.

TECHNOLOGY APPLIED

The EmoSpaces platform consists of technologies

The Emospaces platform collects identity, current emotion, localisation and activity information. Based on this info the system will deploy a content adaptation service.

for multimedia affect recognition based on sensing and smart devices, a big data platform for semantic sensor fusion and context-aware adaptation and automation of IoT environments. The basis for the platform is MQTT, an ISO standard publish-subscribe-based messaging protocol with which devices publish and subscribe messages to a central broker that then delivers messages to subscribers. The framework combines multiple input modalities using an MLP neural network. A Narrative Knowledge Representation Language (NKRL) reasoning engine was used to exploit a set of transformation and hypothesis rules, allowing the semantic emotional context of events to be inferred. Machine learning, artificial intelligence and computer vision algorithms also interpret scenarios using sensor data in order to extract the meaning of a past or current situation.

The consortium has integrated EmoSpaces' reasoning engine and algorithms into demontrators in various domains. Maidis has developed coaching services for diabetics and the elderly that analyse vital signs, exercise data and historical health records on the basis of probabilistic reasoning. The EmoCare Plugin then offers advice, sends information to a family member or alerts the doctor. VirTEA, meanwhile, is a mobile virtual reality application by Answare to help people with Autistic Spectrum Disorders (ASD) prepare for stressful situations; EmoSpaces' big data platform detects emotional patterns to train Autistic patients for unusual situations. In the entertainment domain, Arkamys has developed a music player able to select content and stream music around a domestic environment using the information obtained from optical and non-optical sensors that detect and analyse human presence,

emotions and activities. Finally, the EmoSpaces eLearning platform has been integrated into the open source learning management system Chamilo. A PHP plug-in detects the emotions of students as they take online courses and creates graphics which coordinators can use to improve the effectiveness of teaching.

MAKING THE DIFFERENCE

This project's versatility has translated into important technological, commercial and societal results. Firstly, the State-of-the-Art has been improved in several areas. For activity detection, only 50% accuracy was previously possible; with a demonstration that runs at 15 FPS with one minute of latency, EmoSpaces has reached 73%. This increases to 85% when object recognition is included. Another innovation has been the merging of both silhouette and facial recognition 'in the wild' (i.e. inferring emotion when subjects are poorly lit or moving). Facial recognition alone managed just 30% accuracy, whereas EmoSpaces has achieved 75%. For e-learning, training time has been reduced by 40-60% and has increased knowledge retention by 60%.

For most partners, commercial exploitation is now beginning. Answare has brought VirTEA to the market in Spain, where they anticipate a revenue of EUR 259,500 by 2021. This equals a 36% ROI. By selling over 300 headsets in 2019, they've already exceeded EmoSpaces' KPI of 50 interested companies and 100 users. Maidis has also published its healthcare services as an online portal and is working to commercialise this with insurance providers, further demonstrating the technology's adaptability to new domains. As 18 scientific and technical publications have already been produced and further dissemination is ongoing, external interest is set to grow.

For wider society, this project will have long-term effects on how we experience aging. This is particularly pertinent as total EU public spending on pensions, healthcare and education will increase by around 20% by 2060. Through EmoSpaces, elderly people can take advantage of services that they may otherwise be cut off from due to a lack of computer skills, allowing them to prolong their independent living and enjoy a better quality of life. By proposing the fusion of computer vision algorithms, emotional expression detection and IoT environments, the way forward has been paved for intelligent assistants that can proactively serve end-users.

MAJOR PROJECT OUTCOMES

Dissemination
- More than 18 publications: e.g. JCR Q1, Robotics and Autonomous Systems 2018, Journal of Wireless Communication and Mobile Computing 2018, Information Sciences 2019.
- Several presentation at conferences: e.g. 12th IEEE Conf. on Automatic Face & Gesture Recognition 2016, ICUFN 2017, IEEE ICTC 2017, UKC 2017, IEEE Systems Journal 2018, IEEE Transactions on Automation Science and Engineering 2018.

Exploitation (so far)
- VirTEA: mobile VR application to train ASD kids for unusual situations.
- URBANO: online e-RETAIL platform to measure the traffic of people and their emotional patterns.
- E-Learning EmoSpaces: platform to improve the learning phase through emotion detections.
- EmoCare: application devoted to the smart monitoring of patients with chronic diseases.
- Deployment of IoT platform for assisted living based on open standards (e.g. MQTT).

Standardisation
- ITU-T SG 13 ITU-T Y.4452 Functional framework of web of objects, September, 2016.
- ITU-T SG 13 ITU-T Y.2241 International Standard: Service framework to support web objects based ubiquitous Self-Directed Learning (uDL), September 2017.
- ITU-T SG 13 T17-SG13-C 0188 New appendix in Y, fsul: Appendix VI: Knowledge creation model in Web objects enabled uSDL, January 2017.
- Co-charing of: IEEP7007, Linked Data Models for Emotion and Sentiment Analysis Community.

Patents
- Data Transfer Method and Equipment using Data map among Devices, Reg. No: 2017-0508002.
- Diagnosis Method of Emotion Situation for user questionaire data, Reg. No: 2017-0120666.

Partners

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Project start
May 2016

Project end
September 2019

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