PERSONAL ASSISTANT BOT WITH NLP AND IOT

Abstract - *Smart systems use the new, previously unavailable data, which is collected through Internet of Things architecture and objects, to become smart and identify the needs of the system and the consumers without any external help. A key challenge for these rapidly growing smart systems of today is to provide effective home automation services to satisfy the increasing demands for an urban home assistant. Toward this goal, the Internet of Things (IoT) has great potential to overcome existing deficiencies in current home systems given its ability to embed smart technology into real-life urban contexts. The development in the field of Natural Language Processing (NLP) also mean, that we aren't too far away from a technology that will understand what we say, and have the ability to respond, in speech or action, without relying on hard coded command statements. In this paper, we show how this paradigm can be applied to the Home Automation domain and present a Home Automation System, an IoT enabled, chat bot system designed for urban homes. It provides several novel services and functionalities for home owners: 1)* ***conversational understanding*** *and 2)* ***monitoring capabilities****. We present the technical system behind this system and report on results from a self-made proof on concept that allows for a study of the feasibility of such a system*.

Keywords – NLP, Home automation, Chabot, Cloud Computing, Cloud Services

1. Introduction

The Home Automation System is meant to be a web/mobile application maintained by individual home owners. The system will provide functionalities like the ability to turn devices and appliances inside the house on and off, both remotely over the internet and through a simple voice command when inside the house. The system may be designed to allow owners to track information like the status of the refrigerator, moisture level of the plants, temperature of the home environment, etc. The Home Automation System is unique in the way that it combines the abilities and functionalities of **IoT, NLP and chat bots** where the data processing takes place in a **Cloud based system**. Multiple systems currently under development, focus on only one of these innovations, failing to recognize the benefits of combining all the systems. Together the systems are capable of functioning as a powerful virtual assistant that is powered by the home owner's voice, thus also adding a layer of security to the system.

1.1 Internet of Things (IoT)

The Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. It's a system of related and interconnected computing devices, mechanical and digital machines, and human beings that are provided with a unique identification code and the ability to transfer germane data over a network without requiring any form of external input or human-to-human or human-to-computer interaction. This form of constant connectedness and ease of sending information over the network by each individual node or 'thing' is what makes the concept of the Internet of Things truly revolutionary. This is because in principle, the presence of this new information allows us to fill in a vacuum that existed previously because of our inability to access or quantify such information. A simple example here, adds clarity about how the Internet of Things is slowly changing our lives by utilizing and leveraging previously unavailable in data in novel and powerful ways. Thus, the Internet of Things creates a virtual layer for your house appliances to interact over. It creates a context specific 'home' network that allows for easy access to all the relevant information these appliances are capable of providing. This network is then accessible to the human owner over the internet; the owner starts to realize the magic of Internet of Things, when he or she is able to communicate with their home from anywhere in the world.

He can ask his fridge for a rundown on the items it is holding, and the condition they are in, helping him then make better decisions when at the supermarket, or even just worry less when away from home for long period of times. Another user could access data from a thermostat and make sure the air conditioner is up and running fifteen minutes before she makes it home. A third user could set reminders on the television remotely. The possibilities, even at the simplest level are endless. So the first, startlingly simple benefit the Internet of Things is able to offer to us, is information and control, allowing for better and faster decision making from anywhere in the world.

1.2 Natural Language Processing (NLP)

Natural language processing is a field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages. As such, NLP is related to the area of human–computer interaction. Many challenges in NLP involve: natural language understanding, enabling computers to derive meaning from human or natural language input; and others involve natural language generation.
Modern NLP algorithms are based on **machine learning**, especially statistical machine learning. The paradigm of machine learning is different from that of most prior attempts at language processing. Prior implementations of language-processing tasks typically involved the direct hand coding of large sets of rules. The machine-learning paradigm calls instead for using general learning algorithms — often, although not always, grounded in statistical inference — to automatically learn such rules through the analysis of large corpora of typical real-world examples. A corpus (plural, "corpora") is a set of documents (or sometimes, individual sentences) that have been hand-annotated with the correct values to be learned.
The various phases in NLP are as follows:

1. Morphological and Lexical Analysis
2. Syntactic Analysis
3. Semantic Analysis
4. Discourse Integration
5. Pragmatic Analysis

1.3 Chat Bots

A chatterbot (also known as a talkbot, chatbot, Bot, chatterbox, Artificial Conversational Entity) is a computer program which conducts a conversation via auditory or textual methods. Such programs are often designed to convincingly simulate how a human would behave as a conversational partner, thereby passing the Turing test. Chatterbots are typically used in dialog systems for various practical purposes including customer service or information acquisition. Some chatterbots use sophisticated natural language processing systems, but many simpler systems scan for keywords within the input, then pull a reply with the most matching keywords, or the most similar wording pattern, from a database.

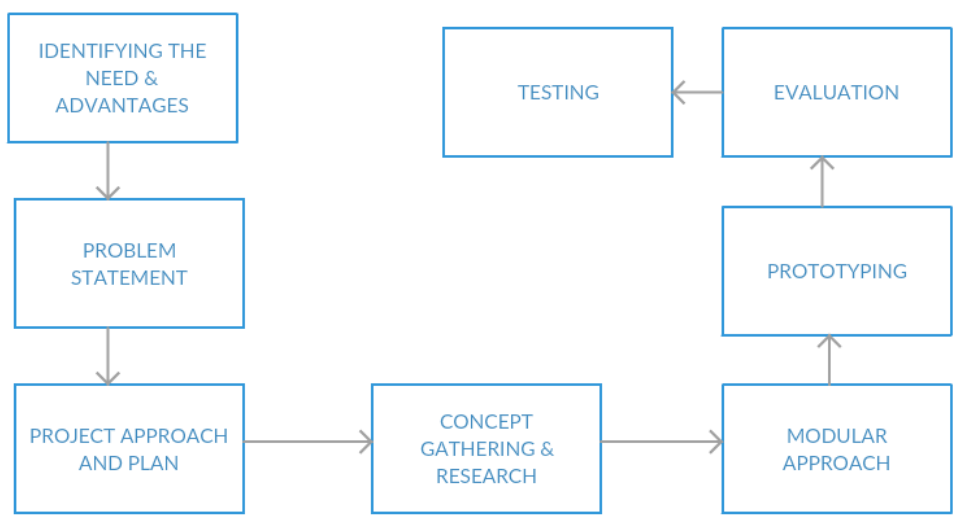
2. Methodologies

2.1 Engineering Process Model

The process model we will be implementing is **Incremental Model**. This is a method of software development where the product is designed, implemented and tested incrementally (a little more is added each time) until the product is finished. It involves both development and maintenance. The product is defined as finished when it satisfies all of its requirements. This model combines the elements of the *waterfall model* with the iterative philosophy of *prototyping*.

The incremental model allows to add functionalities to the project via Increments. It allows us to get a working model quickly and then evolve the model by adding increments.
After each iteration, testing is conducted. During this testing, faulty elements of the software can be quickly identified. Customer can respond to features and review the product for any needful changes.

Engineering Process:



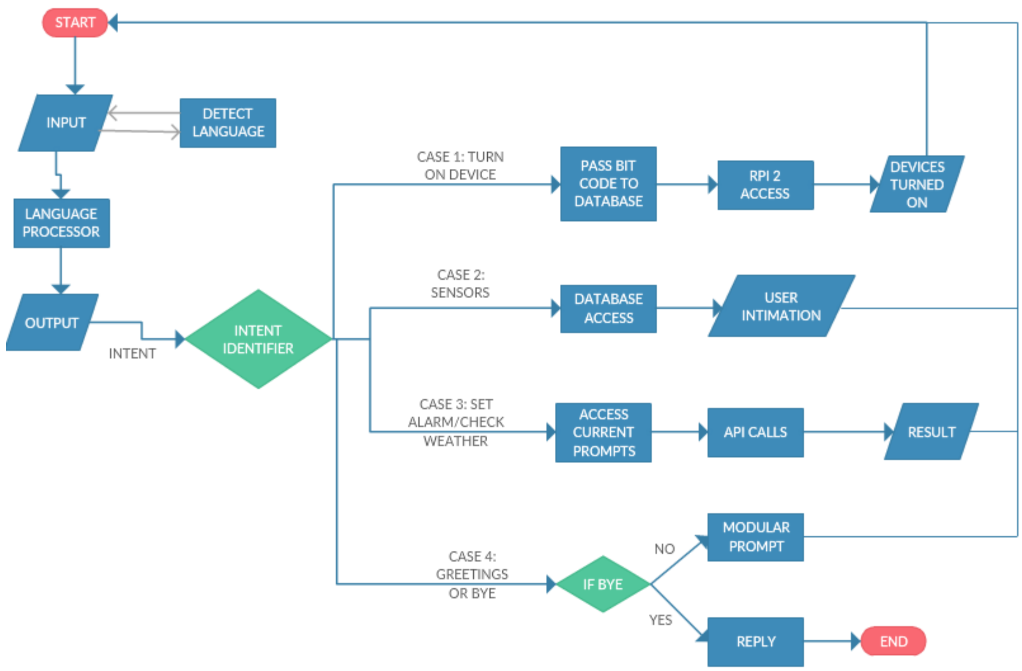
2.2 Functionalities

The system is basically built as a technology that assists the home owner to control almost every electronic component in the house – temperature, lights, air conditioning, coffee machine, alarm clocks, etc. The possibilities are endless. For instance – One could set an alarm to wake up early in the morning, based on this our system will switch on the coffee machine and water heater and heat up the bathing water to the appropriate temperature with respect to readings from the thermostat. Our system is better in the sense of communicating user needs to the home automation controller bot. Since this bot can make sense of conversations on the basis of context, home owners need not memorize hard coded commands to communicate. Let’s say the user is bored on a Saturday afternoon, and wishes to be entertained, it can just type out or speak out to the chat bot that “I am bored!” or “Entertain me!”. The ability of the bot to process

Natural Language permits it to translate the wish of the user to one of its predefined functionality such as switching on the television or the radio in the above case.

Apart from Home Automation, out system is also capable of providing home security. It may use camera feeds or biometric scanner at doors to allow entry only to the members of the family and keep out the intruders or robbers. In case the criminals do manage to break into the house, it can send SMS to the owner's phone instantaneously and notify the police or sound a burglary alarm.

Since our system carries out all processing tasks over the cloud, it can even be used to ask for restaurant suggestions, book travel tickets or hotels, book a cab, pay bills online and much more. Also, because of its NLP module, it can be used to search for music and display lyrics on TV, etc.



2.3 Product Functions

- Home automation
- Home Security
- NLP
- *Music Search Information*
- *Courier Tracking information*
- *Zomato food search*
- *Quotes*
- *E-bill payment*
- *Uber Cab order*
- *Bus reservation*

2.4 Constraints

- GUI is only in English.
- All homes require internet access.
- This system is working for single server.
- System is heavily dependent on internet service.
- Training of home owners required to use the system.

3. Discussions

3.1 Technologies Used

Software interfaces provide access to computer resources (such as memory, CPU, storage, etc.) of the underlying computer system.

- Client on Internet - Web Browser, Operating System (any)
- Web Server - Apache, Operating System (any)
- Data Base Server – Azure SQL Table, Operating System (any)
- Development End - Web Designing Tools (Django, Bootstrap, Java, JavaScript, HTML, CSS, XML, AJAX, MySQL), OS (Windows)
- Botframework
- Visual Studio
- LUIS for NLP
- Third Party APIs

Hardware interfaces exist in many of the components in the various I/O devices etc. The various hardware interfaces required are:

- Raspberry Pi 2
- Relay Board
- Devices
- Sensors
- Processor
- RAM
- Memory Usage
- CPU Usage

Minimum requirements:

CLIENT SIDE			
	Processor	RAM	Disk Space
Internet Explorer-6	Intel Pentium III or AMD 800 MHz	128 MB	100 MB

Table 2.2(a) Client side minimum requirements

SERVER SIDE	

	Processor	RAM	Disk Space
Web Designing Tools	Intel Pentium III or AMD 800 MHz	1 GB	3.5 GB
MySQL		256 MB	500 MB(Excluding Data Size)

Table 2.2(b) Server side minimum requirements

Recommended Requirements:

	CLIENT SIDE		
	Processor	RAM	Disk Space
Internet Explorer-8	All Intel or AMD - 1 GHZ	256 MB	100 MB

Table 2.2(b) Client side recommended requirements

SERVER SIDE			
	Processor	RAM	Disk Space
Web Designing Tools	All Intel or AMD - 2 GHZ	2 GB	3.5 GB
Internet Explorer-8		512 MB	500MB(Excluding Data)

Table 2.2(c) Server side recommended requirements

3.2 Hardware Used

The hardware system we use for simulation purposes only is Raspberry Pi 2. The Raspberry Pi is a credit card sized single board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZFS 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a builtin hard disk or solid state drive, but it uses an SDcard for booting and persistent storage. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language. The RPI 2 is the heart of our system and is provided internet connection via an Ethernet cable.

Fig 3.2 Raspberry PI 2

Fig 3.3 Ethernet Cable

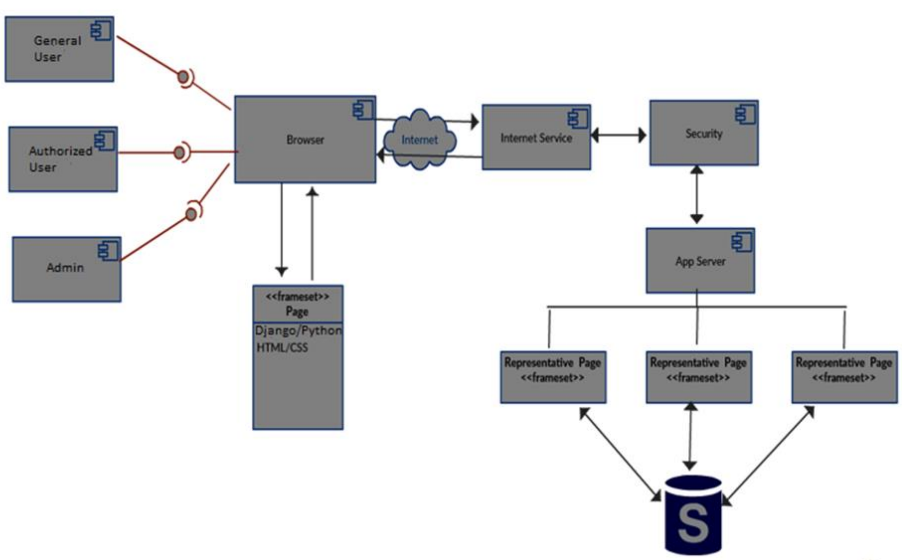
4. System Architecture

4.1 Chosen System Architecture

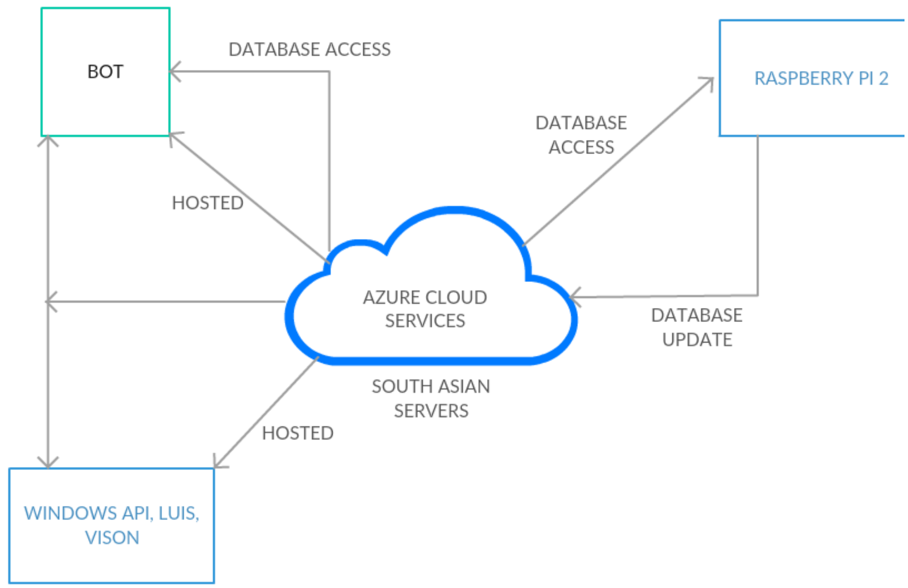
Client Server model is the chosen system architecture. Interaction happens with the server based on client request. The server is accessed only when a function is performed.

4.2 Component Design

Each component of the Cloud based Home Automation system is carefully designed to work well with each other despite using different types or classes of technologies used to build them. The end point or the point of contact is a bot framework API. It is solely responsible to take in all requests from users. The NLP component decodes the request from the user so as to try and understand which devices are to be used and how to use them so as to satisfy the user. Once it knows what needs to be done, it sends out messages to the respective device or sensor to act as actuators.

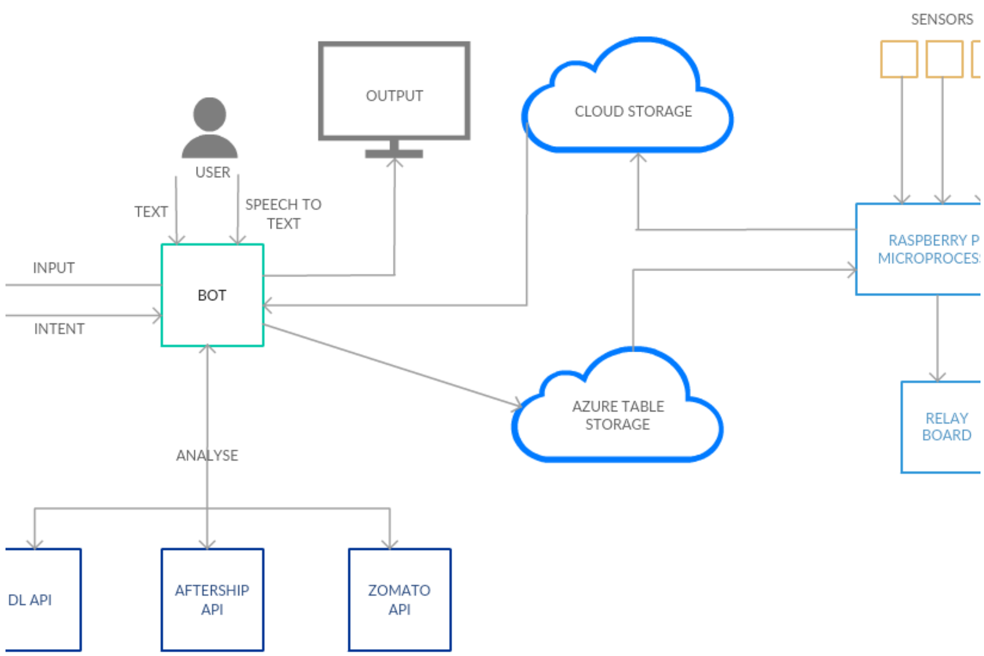


4.3 Model Interaction Diagram



4.4 Data Flow Diagram

The bot 'talks' with the user and takes the request as the input. It then passes on this request as it is to the NLP layer of the system that is hosted on the Azure Cloud platform. Here, the request is broken down into commands to be carried out to complete it. Next, the commands are sent to and stored in the Azure Mobile Database, also hosted in the Azure Cloud. The RasPI which acts as facilitator of all connected devices, synchronously and constantly keeps checking for updates in the Database. When a new command is detected it activates the device needed to carry out that command. After successful execution of the request, the RasPI goes back to the Database and erases the recently executed command.



5. Results and Future Scope

Future scope for the home automation systems involves making homes even smarter. Homes can be interfaced with sensors including motion sensors, light sensors and temperature sensors and provide automated toggling of devices based on conditions. More energy can be conserved by ensuring occupation of the house before turning on devices and checking brightness and turning off lights if not necessary. The system can be integrated closely with home security solutions to allow greater control and safety for home owners. The next step would be to extend this system to automate a large scale environment, such as offices and factories.

The results obtained from constructing such a home automation system that allows for conversational understanding are that they can improve the overall home situations of the owners and make life much simpler and easier especially in such fast paced metro-lifestyles. As for the technological implications and the results, we have succeed in arranging diverse technologies to enhance and extract the most viable features of each of them, especially – NLP, Cloud Services, Azure services over the internet, sensors and devices used in day-to-day life.

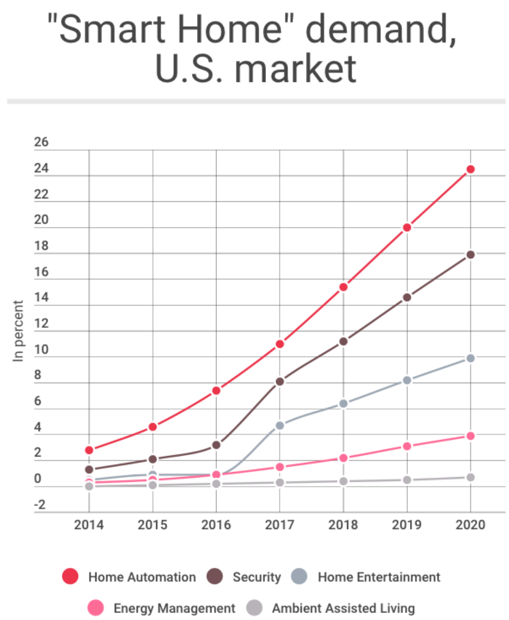


Fig 5.1 shows how technologies in our system have an exponentially increasing demand in USA markets.

6. Conclusion

Based on all the systems surveyed and their advantages and drawbacks, this paper presents the features to be possessed by an ideal system for home automation with remote access. An ideal system should be available from all over the world to a user and in real time. Only the Internet can ensure that access can be made available at all times. This will give rise to a standard access method for the home appliances using the Internet protocol. The user interface should be a web application that has an associated mobile application. So that people of all kinds can access the system. Such a system should also have the feature of being easy to install. Only then can automated homes become commercially viable. There should be a lot of thought put into the design of the user interface for these apps. Plug and play capabilities will be an added bonus for the system. Ease of adding a new device to an automated house will play an important role in taking forward the systems commercially.

7. References

[1] http://www.ieccr.net/comsoc/ijcis/

[2] Madakam, S. , Ramaswamy, R. and Tripathi, S. (2015) Internet of Things (IoT): A Literature Review. *Journal of Computer and Communications*, **3**, 164-173. doi: 10.4236/jcc.2015.35021.

[3] Jayavardhana, G., Rajkumar, B., Marusic, S. and Palaniswami, M. (2013) Internet of Things: A Vision, Architectural Elements, and Future Directions. Future Generation.

[4] http://postscapes.com/internet-of-things-history

[5] http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

[6] https://www.oreilly.com/ideas/ioth-the-internet-of-things-and-humans

[7] Gonnot, T., Yi, W., Monsef, E. and Saniie, J. (2015) Home Automation Device Protocol (HADP): A Protocol Standard for Unified Device Interactions. *Advances in Internet of Things*, **5**, 27-38. doi: 10.4236/ait.2015.54005.

[8] Ferguson, T. (2002) Have Your Objects Call My Object. Harvard Business Review, June, 1-7.

[9] http://www.internet-of-things-research.eu/pdf/IoT-From%20Research%20and%20Innovation%20to%20Market%20Deployment_IERC_Cluster_eBook_978-87-93102-95-8_P.pdf

[10] Kosmatos, E.A., Tselikas, N.D. and Boucouvalas, A.C. (2011) Integrating RFIDs and Smart Ob-jects into a Unified Internet of Things Architecture. Advances in Internet of Things: Scientific Research, 1, 5-12. http://dx.doi.org/10.4236/ait.2011.11002

[11] Biddlecombe, E. (2009) UN Predicts "Internet of Things". Retrieved July 6.

[12] Razzak, F. (2012) Spamming the Internet of Things: A Possibility and its probable Solution. Procedia Computer Science, 10, 658-665. http://dx.doi.org/10.1016/j.procs.2012.06.084

[13] Chen, X.-Y. and Jin, Z.-G. (2012) Research on Key Technology and Applications for the Internet of Things. Physics Procedia, 33,561-566. http://dx.doi.org/10.1016/j.phpro.2012.05.104

[14] Chorost, M. (2008) The Networked Pill, MIT Technology Review, March.

[15] Gershenfeld, N., Krikorian, R. and Cohen, D. (2004) The Internet of Things. Scientific American, 291, 76-81. http://dx.doi.org/10.1038/scientificamerican1004-76