SenseQ: Creating relationships between objects to answer questions of humans by using Social Networks

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ABSTRACT
Social Networks are a source of information very use to know what happen around us. While, the Internet of Things is a world that tries to measure everything by gathering data from sensors and interconnect different objects. Why not combine both? In this paper, we propose the creation of a system that gathers information from users' sensors, processes it and exposes this information to Social Networks through questions that users ask to the system. Users will be able to ask for data available in distributed sensors using a Social Network and our system will answer to the users also through the Social Network. In order to gather the data from sensors and combine them, we propose three different type of relationship between sensors: neighboring relationship, familiar relationship and work relationship.

CCS Concepts
• Information systems→World Wide Web→Web applications→Social networks

• Information systems→Information systems applications→Collaborative and social computing systems and tools→Social networking sites

Keywords
Social Networks; Sensors; The Internet of Things; Twitter

1. INTRODUCTION
Social Networks (SN) are very presents in our lives. Many of us share all aspects of their life on Social Networks like posting messages about what they are doing at that moment, sharing photos with friends, giving their opinion about other posts, and so on. Moreover, Social Networks are also used by business to promote their products or services and even, SNs are a new channel of communication between companies and clients.

Furthermore, Social Networks are also a source of data where users can search any type of information like the closing time of a shop, the restaurant's phone, the weather of a specific zone through the profile of an expert and so on. In this paper, we will present our proposal of a source of information accessible via Social Networks. The information that we want to provide is the data gathered by many sensors. Hence, we propose the combination of Social Networks and the world of the Internet of Things (IoT) to inform the user about any data available in our network of sensors.

Currently, there are many references to the Internet of Things around us. Some references could be the smartphones, wearables, tablets [1] or any other device with Internet capabilities. These smart devices are also called Smart Objects. The world of IoT allows the creation of many smart environments like Smart Homes [2]–[4], Smart Towns [5], Smart Cities [6]–[9] or Smart Earth [6], [10]. These new possibilities can exist due to the combination of different actuators, sensors or Smart Objects. Our proposal is based on a system that collects information from a sensor network to answer questions that users makes through Social Networks.

In this paper, we will present a proposal of integration of Social Networks and the Internet of Things in order to research how technologies of the Internet of Things can communicate with humans by using Social Networks.

The remainder of the paper is organized as follows. In Section 2, we introduce involved topics in this research. Section 3 shows our proposal, the system to answer questions of users by using sensor networks and Section 0 contains the conclusions of this paper and the possible future work that can be done from this proposal.

2. STATE OF THE ART
In this section, we will present a theoretical frame about the concepts involved in our proposal. These concepts include the Internet of Things, Smart Objects and Social Networks, because our proposal could be interpreted as a way of make queries to Smart Objects from the Internet of Things through Social Networks.

2.1 The Internet of Things

The term "the Internet of Things" (IoT) is defined as the interconnection of heterogeneous and ubiquitous objects between themselves [3], [11]–[14]. The concept includes not only the connection between objects also known as Machine-to-Machine (M2M) [15]–[17] but also the communication between humans (H2H) [17] and humans to machines (H2M) [18].

There are many researches that address the IoT in large range of fields. Researches related with our proposal could be researches address on the IoT and Social Networks.

The Social Internet of Things (SIoT) [13] combines the IoT and Social Networks obtaining a new generation of objects, the social objects. These objects are capable of interacting with other objects by themselves. They are able to discover services and useful information from other objects because all of them share their services and information in the network [19].

Using Social Networks in combination with the Web of Things has some benefits, for instance, the integration of Smart Objects in Social Networks that is proposed in [20]. They explored the possibility of integrate applications inside some Social Networks like Facebook in order to integrate Smart Objects in that Social Network.

Moreover, the combination of IoT technologies with the habits of using Social Networks helps people to familiarize themselves with the IoT according to scientists of Ericsson [19].

2.2 Smart Objects

In the definition of the IoT we mentioned the word objects. In the IoT the objects usually have any type of intelligence and therefore, they are called Smart Objects. The Smart Objects are objects with an embedded system that allows them to process information, communicate with other devices and perform actions based on other actions or events [3].

According to [3], [21], Smart Objects can be classified in three levels: Level of Intelligence, Location of Intelligence y Aggregation level of Intelligence.

Examples of Smart Objects can be smartphones, micro-controllers like Arduino [3], [22], [23] or any other object connected to the Internet and capable of handling information. The combination of the IoT and Smart Objects achieves that the network not only transports data but also is provided of intelligence and actions.

2.3 Social Networks

A way of integrate applications in our lives is adding social aspects to the applications. Good resources for that propose are Social Networks (SN). Many of Social Networks provide several Application Programming Interfaces (API) that allow reading or writing in timelines, receiving or sending private messages or updates, and so on. The convergence of the real world with SNs is an important piece of the Web 2.0 because SNs like Facebook or Twitter allow their users to communicate, exchange and share contents. Thus, creating applications that interconnect things and humans is also possible [20].

Currently, there are many available Social Networks to use for research purposes but we have chosen Twitter due to its way of work based on short messages composed by keywords, which are called hashtags. Furthermore, Twitter is suitable for this research although it has some limitations.

Social Networks are usually used to collect data about events or people, that can be useful for research purposes. However, we propose the use of Social Networks to give new information to users, instead of collecting data from them. However, users will have to ask for the information and our proposal will have to be capable of understanding the requests through natural language processing like in [24]. In [24], the authors use Twitter to extract information about traffic events using natural language processing.

We have chosen Twitter because of a concrete characteristic of this Social Network, it does not require reciprocation of its users' relationships [25].

In order to link the Internet of Things and Twitter we can consider some previous researches like [26] where the authors consider humans as another type of sensor, [27] where Twitter is used to detect Earthquakes, or [28] where the authors propose support decisions about the destination of tourism according to the posts of Twitter users.

3. PROPOSAL

We propose a system capable of answering questions that people would make through Social Networks using information from sensors connected to our system. Moreover, the sensors will have social capacities because they will be able to have friends in order to answer people's questions jointly. When a user will ask for specific information, the system will try to get the information from the registered sensors or from the relationship between sensors. For example, if a user asks for climate data the system will response with data from several sensors like temperature sensors and humidity sensors because these sensors have a friendship relationship based on the clime.

In order to explain our proposal, this section is composed by three different subsections: the registration of sensors, the socialization of sensors, the social interface and the connection of sensors to Social Networks.

3.1 Registration of sensors

Our system needs the registration of sensors that can gather the data required to answer the questions made by people. For that reason, we propose that users can register sensors in a web application with the parameters that allow us to identify the sensors properly. These parameters would be its location, its finality, its owner and the privacy state and some of them are used to refine the relationship between sensors as we will explain in subsection 3.2.

3.1.1 Location

The location will be a required parameter to register a sensor. The location will be composed by several locations because a sensor will be located in one place it will be reachable through different location levels. For instance, a sensor located in a university classroom would be reachable through different levels like "*University*", "*City*" or "*Country*".

This parameter will allow the system to know the neighbors of a sensor in order to allow the socialization between neighboring sensors as we will explain in subsection 3.2.

3.1.2 Finality

Another required parameter will be the finality. This parameter will indicate the role of the sensor. The finality will be composed by several finalities because a sensor could be useful for different proposes. For example, a sensor of temperature would be handy for knowing the temperature but it would be also handy for knowing the climate conditions alongside other sensors.

This parameter is also used to allow the socialization between sensors with the same finality as we will explain in subsection 3.2.

3.1.3 Owner

The sensor's owner will be another required parameter because the system will need the owner in order to store and retrieve the sensors. This parameter will not be introduced by the user but the system will assign the owner considering the user who registers the sensor in the system automatically.

This parameter is also used to allow the socialization between sensors whose owner is the same as we will explain in subsection 3.2.

3.1.4 Privacy state

The privacy is very important when we handle data obtained from sensors because we can use sensors that gather sensitive information like health problems. To ensure the privacy, the users will be able to specify different levels of privacy. Four privacy levels will be available in our system. Users will have to choose if their sensors are reachable by any user request, only by requests that include a specific location, only by requests made by its owner or a combination of the two previous levels.

Like the other parameters, this one is also used to allow the socialization between sensors but it is used not only to allow it, but also to avoid it as we will explain in subsection 3.2.

3.2 Socialization of sensors

The aim of our proposal is the creation of a network of sensors where they will have different types of relationships according to the parameters we exposed in subsection 3.1 in order to give certain information to user when it asks something through a social interface. Available relationships will be based on the four previous parameters and they will be: neighboring relationship, work relationship and familiar relationship.

3.2.1 Neighboring relationship

Through a socialization based on neighboring relationship, sensors will be able to know the nearest sensors. This type of relationship is used to set the different levels of privacy. One level of privacy will restrict the access to the sensor to only located requests.

For instance, if a user asks for the air quality of a building which is stored as location parameter of some sensors, the system will collect the information from sensors located in the building. Then, the system will combine all the gathered information and it will send it to the user.

3.2.2 Work relationship

The primary relationship of the proposed system is the work relationship. The aim of our proposal is answer the question that users ask through a Social Network, therefore, the system must have a way of recognize what the user want. This is the finality parameter that we explained in subsection 3.1.2.

The work relationship will not affect the privacy but it will affect the functionality of the system. When a user asks for a certain information, the system will search sensors whose finalities are suitable to answer the user's question taking into consideration all other relationships. Then, the system will combine all the gathered information and it will send it to the user.

3.2.3 Familiar relationship

The familiar relationship will allow the system to know sensors which share their owner. This type of relationship is also used to set the different levels of privacy. One level of privacy will restrict the access to the sensor to only requests from its owner.

An example is if a user asks for the humidity level without indicate a location, the system will collect the information only from sensors of the user which made the request instead of collecting the information from all public sensors that are suitable to answer the user's question. Then, the system will combine all the gathered information and it will send it to the user.

3.3 Social interface

One of our aims is the use of Social Networks to connect humans with sensors. We propose the use of Twitter as input interface through which the users will ask for information and the proposed system will answer.

Twitter is based on short messages composed by text and keywords that can represent users or topics. Our system will use these keywords to identify some parameters required to ask for information. The owner parameter will not be present in the text, instead it will be in the properties of the Twitter message because the owner will be the user of Twitter who makes the question. The rest of parameters will be find analyzing the text and hashtags. In order to identify the requested information, which is the finality parameter, the system will analyze the text and it will analyze the hashtags to find the location parameter.

Because of the use of Twitter, the system will have to store the username of sensors' owners. For that, users will have to sign up in the web application using their Twitter profile.

Examples of use could be the next:

- **Asking for the temperature in New York City**: The system will consult all sensors registered in New York City and it will combine the information to send the appropriate value.
  - *@user: @senseq What is the temperature of #NewYork*
  - *@senseq: @user The temperature of #NewYork is 23ºC*
- **Asking where it is raining using your sensors:** The system will consult all your sensors and it will respond with the locations of sensors that return that it is raining.
  - *@user: @senseq Where is it raining?*
  - *@senseq: @user It is raining in #Manhattan and #Jersey.*

As we can see in the previous examples, the proposed system will require techniques to analyze and understand natural language in order to obtain what the user is asking for.

3.4 Connection of Sensors to Social Networks

In order to understand how our proposal will work, it is necessary to suggest an architecture that could be interconnect sensors and Social Networks. We propose an architecture based on three layers: Object Layer, Backend Layer, and Social Layer.

3.4.1 Object Layer

The Object Layer will contain the Smart Objects in which sensors will be connected. Smart Objects provide to sensors the required autonomy to collect data and process them.

Besides, Smart Objects are usually capable of running applications, hence, we propose the creation of applications that connect Smart Objects with the next layer, the backend layer, in order to share the data collected by sensors.

3.4.2 Backend Layer

The layer which will manage the relationships between sensors, will process the data collected from sensors, will process the requests that arrive from the next layer, the social layer, and will create the messages that response users' requests using natural language.

This layer will be based on a Service Oriented Architecture in order to exchange information between the other layers. It will use the Social Network API to listen for messages whose target is the proposed system, and to publish the responses for those messages. In addition, this layer will communicate with the object layer using Web Services to collect the needed data to answer to the users' requests.

3.4.3 Social Layer

The third layer represents the Social Networks so it will not be a layer that depends on the proposed system. However, it is important because it is the interface that users will use to interact with the system.

This layer will be connected with the backend layer through the Social Network API so the backend layer will manage the communication.

4. CONCLUSIONS

In this paper, we propose a system that combines technologies of the Internet of Things and Social Networks in order to make easy the access to sensors data by users. Moreover, we propose three different types of relationships that filter the information that a user can access based on the location, the finality and the owner of each sensor. Finally, we explain how it the communication with the system through a Social Network, Twitter, by using public messages that contain hashtags and mentions.

From this work we will able to propose the next new future works:

- **Adding new relationships based on owner friends:** In this paper we talk about relationships between sensors, nevertheless, taking into consideration the relationships between users that use the system is another type of relationship that could be useful and we would to study to integrate in our system.
- **Establishing relationships between the system and users:** Currently, we only use the Social Networks as a method of communication, but we would take the advantages of the Social Networks to establish friend relationships in order to, for instance, give automatically recommendations to users based on previous queries.
- **External platforms:** Our proposed is a standalone system that it is not connected with other system and neither it allows the connection of an external system to retrieve information. As a future work could be the creation of an API so that other platforms or users can make queries to our system. Moreover, we could add to the system, platforms as source of information like Midgar [14], [29]. In this way, the system could use other platforms as a sensor and retrieve information from them.

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