A Human-Centred Business Scenario in SIoT – The Case of DANOS Framework

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Abstract. The Social Internet of Things (SIoT) provides a landscape with a huge business potential, which affects both the producer and the consumer, and opens new business opportunities for delivering products and services with increased user experience. Such a potential is predominantly dependent on the quality of objects' relationships established over time, which might determine the value of the interactions and the information exchanged between them. Accordingly, in this paper we discuss a business case over a novel human-centered framework, namely DANOS, which employs human personality traits as the primal influential factor of the behaviors and interactions of things in a network of objects.

Keywords: SIoT · Personality · Framework · human-centred model · Simulation

1 Introduction

Latest forecasts suggest that by the year 2021 there will be more or less 26 billion connected Internet of Things (IoT) units [3], portraying an intelligent network of things with a significant power, in terms of information availability, accessibility and shareability through its integrated nodes, and a highlighted potential for the business organizations [6]. A fundamental challenge towards that direction is for objects to be able to build strong and long-term relationships among themselves exchanging most apt information and services to the benefit of their users. Considering that such relationships could be established more effectively in a Social Internet of Things (SIoT) landscape [2], where things are able to create their own social networks, in this work we explore the potential of utilizing specific human characteristics in an objects' network for guiding their behaviours and actions as in the Human Social Networks (HSN) gaining e.g., on the navigability, scalability and trustworthiness. In this respect, we overview a real-life business consumer goods scenario using a novel framework in the area of SIoT, namely DANOS (Dynamic Anthropomorphic Network of Objects Simulator). It is based on a human-centered hierarchical model that maintains at its core human personality traits and drives the behavior and communication of objects while traveling autonomously in a space. Hereafter, we outline the main components of DANOS and present preliminary evaluation results showing more granular, stable and long-term relationships over time between the objects. As such, we expect higher accuracy on service requests, relevance on recommendations and enhanced user experience during information acquisition.

2 An Overview of the DANOS Framework

DANOS framework (see Figure 1) enables SIoT objects to create autonomous context-aware relationships and to share best-fit recommendations among them and with their owners.

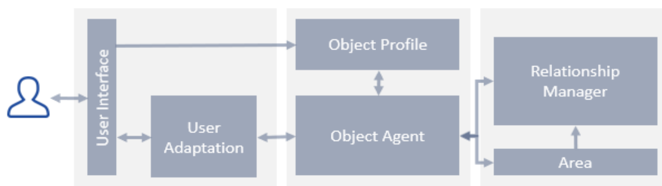

Fig. 1. Main Components of the DANOS Framework

The *user interface (UI)* (can be of any type, e.g., display on an object), maintains the communication with the user for collecting information and returning recommendations based on service requests. The *user adaptation (UA)* component is responsible for adapting the data to the user's preferences, e.g., adjusting recommendations on given user requirements. It includes various processes like locating specific information to create a service request, recording the interaction data between the user and his objects, extracting patterns (by applying, e.g., semantic reasoning) regarding his behavior, and ranking the collected information like recommendations proposed by other objects. The *object agent (OA)* component maintains the engine that facilitates the interaction with the DANOS network for requesting new friendships, gathering recommendations from friends, and registering its position in the *area*. It has an *object profile (OP)* which consists of all information that contribute to the creation of qualitative relationships between the objects, namely, *object specifics* (i.e., objects' specifications using various static attributes), *interaction specifics* (i.e., data that are generated through the objects' lifetime experience in the network, position in the area), and *user specifics* (i.e., characteristics, preferences, inherent human aspects (like personality traits) of the owners (users) of an object.) Once an object has inherited these characteristics during the initialization phase, it runs and interacts autonomously (through the OA detached from the user) in the network. Subsequently, the OA passes on the OP specifics to the *relationship manager (RM)* for calculating the similarity between two objects. The similarity calculation indicates if two objects will become friends while communicating in proximity in the area (we consider a *friendship* as an established relationship between two objects that share similar profile characteristics and can exchange information of common interest). In DANOS, one object may have a different opinion about another regarding the extent that they might fit based on their behavior. Hence, they might both want to become friends (full friendship), only one of them (partial friendship), or none of them (no friendship). Assuming that a friendship has been established, the OA receives various recommendations from similar objects to the targeted one, which is then prioritized, adapted and offered to the user (UA component).

3 A Real-life Business Scenario

The proposed framework adheres to a decentralized workflow process which we highlight through the simple business scenario below. DANOS focuses on two main subsequent SIoT process activities, namely, *new friendship acquisition* and *recommendation discovery* (currently under development) [1]. Peter has recently bought a new IoT fridge, joining the DANOS network. During the initialization phase his fridge inherits some of his preferences (e.g., he drinks lactose-free milk in the morning) and human traits (e.g., he is strong in *neuroticism* and weak in *openness* with respect to the scale of personality traits [4]), adapting a human-centered behavior (HCB) during communication with the other objects. Accordingly, his fridge will exhibit a HCB of not taking excessive risks when interacting with other fridges (e.g., will not risk to make friendships with other fridges that their profiles might be related but are not fully matched), since the particular combination of those personality traits refer to behaviors that are risk-avoidant – avoiding to take more risks for gains in decision-making [5]. As a newcomer object, Peter's fridge has no friends as yet, but it has to **find new friends** to get relevant recommendations to the benefit of its owner. Therefore, it creates a service request (UA) to locate objects-friends that will provide the best matching milk for his preferences, defined as a service name with specifications (in this case as $MilkService_{[lactose-free,organic]}$). Carrying this information, the fridge travels (OA) into the virtual area of DANOS network autonomously to the position $MilkService_{[lactose-free,organic]}$ and requests the RM for creating new friendships with the surrounding objects. The RM forwards the friendship request to all fridges which have subscribed in the same vector space $[lactose - free, organic]$, and for each responding object it calculates the similarity with Peter's fridge, considering the OP specifics (e.g., personality traits, list of friends or runs, power supply status, energy class), as discussed earlier. If the similarity is above a dynamically calculated threshold, the objects become friends and share their information or recommendations irrespective of the time or space they travel. Next, Peter's fridge **asks its friends for related recommendations** to find the best-fit milk for him. Its friends provide a number of suggestions based on the interaction data and patterns generated between their owner and the (milk) product (e.g., the frequency of drinking milk during a specific time during the day, dietary preferences), which it has to rank by assigning weights. For this job, it considers its owner's preferences, semantic interaction patterns (e.g., between previous products (milk) and the object (fridges)), as well as previous experience regarding the received recommendations by its fridge's friends (e.g., how successful they have been in the past). Finally, the fridge presents Peter with the top milk recommendations (UA) through the UI and observes his satisfaction for future recommendations on incoming requests.

4 Preliminary Evaluation Results

To evaluate the quality of the recommendations provided by the objects, we first need to understand the quality of the relationships established between them while travelling in DANOS. Hence, we simulate the friendship generation process of 30000 requests from 2000 objects over time (average of 15 request per object). We are using a generic area to define the context vector as $Area_{x,y}$, where $\{x, y \in N | 0 \leq x, y \leq 10000\}$. All objects travel randomly in this context area 25,5 times on average during the lifetime of the simulation. For the vector space, we divided the area into 10000 cells, where friendships can only be established in the same cell. In total, there were 3228 friendships established between the fridges (1135 full, 1173 partial and 892 no friendships – see Figure 2). The threshold was calculated dynamically in time (the value was optimized across various training simulations) and stabilized around 0.63. In case of Peter's fridge, it travelled 25 times (searching for the specific kind of milk), with a total distance of $x = 1335, y = 1440$ and has visited 22 different cells in the area, establishing 3 full-friendships with an average similarity metric of 0.76, 4 partial-friendships with 0.52 and 2 no-friendships with 0.51.

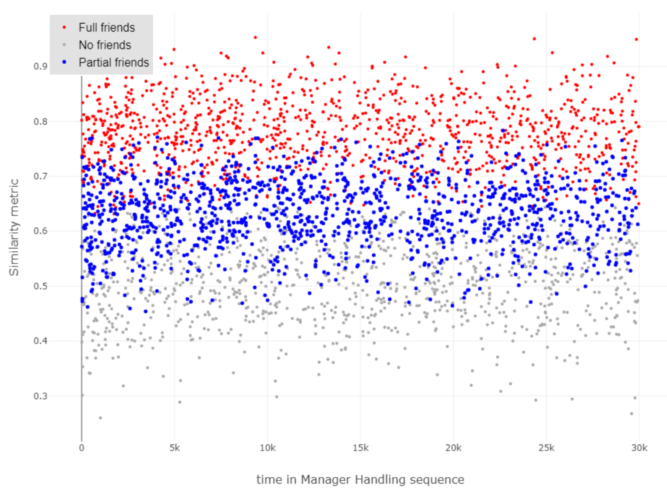

Fig. 2. The 3 Types of Friendships Established between Object Pairs Over Time

5 Conclusion

In this paper we overviewed a business consumer goods case through a novel human-centred SIoT framework DANOS. We outlined its main components and decentralized workflow, and emphasized on the generation of relationships between the things over time while travelling autonomously in a virtual space. We found that the quality of the friendships established may generate best fit recommendations on given requests to the benefit if the owner-user.

References

1. Atzori, L., Iera, A., Morabito, G.: Siot: Giving a social structure to the internet of things. IEEE communications letters **15**(11), 1193–1195 (2011)
2. Atzori, L., Iera, A., Morabito, G., Nitti, M.: The social internet of things (siot)–when social networks meet the internet of things: Concept, architecture and network characterization. Computer networks **56**(16), 3594–3608 (2012)
3. Gartner: Gartner Says the Internet of Things Installed Base Will Grow to 26 Billion Units By 2020. Available online at https://www.gartner.com/en/newsroom (accessed 06 November 2018) (2018)
4. Goldberg, L.R.: An alternative" description of personality": the big-five factor structure. Journal of personality and social psychology **59**(6), 1216 (1990)
5. Lauriola, M., Levin, I.P.: Personality traits and risky decision-making in a controlled experimental task: An exploratory study. Personality and individual differences **31**(2), 215–226 (2001)
6. Manyika, J.: The Internet of Things: Mapping the value beyond the hype. McKinsey Global Institute (2015)