

## Internet of Things based Data Driven Storytelling for Supporting Social Connections

Qiong Wu\*, Zhiqi Shen\*, Cyril Leung<sup>†</sup>, Huiguo Zhang\*, Ailiya\*, Yundong Cai\*, Chunyan Miao\*

*\*Joint NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY)*

*School of Computer Engineering  
Nanyang Technological University  
Singapore*

*{wuqi0005,ZQShen,HGZhang,AI0001YA,YDCai,ASCYMiao}@ntu.edu.sg*

*<sup>†</sup>Department of Electrical and Computer Engineering  
The University of British Columbia  
Canada  
cleung@ece.ubc.ca*

**Abstract**—The empty nest syndrome has become a significant modern social problem. Recent research has enhanced physical health monitoring for the elderly in smart home environment. However, the social needs of the empty nesters have been less supported in smart home designs. A compelling story about the elderly can make the adult children emotionally attached to their elderly parents and establish a healthy social connection between them. In this work, we propose a data-driven story generation system based on the Internet of Things (IoT). IoT based techniques enable the real time collection of the elderly's environment data through various sensors located in the home. The story generation system can weave the information mined from the sensor data into a story with high persuasive and emotion arousing power. Our system automatically collects raw sensor data on the cloud server and maps them to values of semantically meaningful context variables through activity functions. A director agent organizes the story plot with a Goal Net based approach and dynamically generates storylines based on a set of scene selection rules. The proposed system is carefully studied with a simulated smart home environment.

**Keywords**—Internet of things, Smart home, Storytelling, Goal net, Curiosity

### I. INTRODUCTION

Empty nesters are elderly individuals whose children have grown up and no longer live at home. The empty nest syndrome has become a significant modern social problem [16]. Recent advances in smart home research have enhanced medical care, environmental safety, and health data monitoring for the elderly [13], [19], [20]. However, the social needs of the empty nesters have been less supported in smart home designs. According to the Socioemotional Selectivity Theory (SST) [7], the elderly prefer to spend more time with familiar individuals with whom they have had rewarding relationships. Hence, establishing a regular social connection between the empty nesters and their families can greatly satisfy their social and emotional needs.

In current smart homes, information about the elderly (e.g. fall detection) are often sent to the caregivers as warning messages. For the purpose of health monitoring, warning messages are often good enough to alarm the caregivers.

However, there is a need to establish a healthy social connection between the empty nesters and their families. To this extent, we propose a storytelling approach to organize information about the elderly.

Storytelling is the conveying of events in words, images, and sounds, with embellishments [1]. Stories stimulate our brains and induce us to relate the story to our own experiences [2]. A well-told story shapes our understanding and empathy by engaging us to identify with the characters in the story[23]. Hence, storytelling can improve emotional connections between the elderly and their adult children. It may persuade the adult children to keep in regular contact with the elderly parents.

In this work, we propose a data-driven storytelling system. This system receives raw sensor data from sensors placed in the elderly's home on the cloud server, where a director agent transforms the sensor data into a compelling story for display in the mobile console. The director agent maps the sensor data to semantically meaningful context variables through activity functions. A Goal Net [25], [27] based approach is adopted for plot organization of the story. Two categories of scene selection rules, the importance-based rules and the curiosity-based rules, are proposed for dynamic plot planning. The importance-based rules highlight the important information sought by the adult children about the elderly's activity, such as taking medicine. The curiosity-based rules select curiosity arousing information (e.g., a novel activity pattern) that may interest the adult children.

The key innovation of this work is the novel application of storytelling to address real world problems. From the perspective of IoT research, storytelling is a novel knowledge representation method with high persuasive and emotion arousing power. From the perspective of storytelling research, data driven story generation is a novel approach that connects real world data to storylines.

The rest of the paper is organized as follows: Section II discusses the related works from the traditional smart home research and storytelling research fields. In Section III,

the proposed data-driven storytelling system is presented in detail. Illustration of the working mechanism of the proposed system is given in Section IV. Conclusions are drawn in Section V.

## II. RELATED WORKS

Over the years, multiple aspects of smart home designs have been considered, such as monitoring resident's activities, inactivity detection, health data monitoring, environmental safety, medication adherence and social interaction. Lawton [13] suggested that people who live independently must be able to perform basic Activities of Daily Living (ADLs) such as bathing, using the toilet, and eating, as well as Instrumental Activities of Daily Living (IADLs) such as managing a medication regiment, maintaining the household, and preparing meals with adequate nutrition. Glacock and Kutzik [11] suggested eight activities that can be monitored to assess a person's health, including eating, overnight toileting, stove use, medication adherence, wake-up time, general up and around, bedtime and overnight sleep disturbances, and bathtub use. The data from these activities can be used for status and trend analysis. Various techniques for learning and predicting residents' activities have been proposed [9], [10], [21], [20], [28]. Inactivity detection can be used for inferring health conditions and detecting falls [19]. Several methods have been proposed to detect unusual activities by learning a model based on motion data extracted from a scene over an extended period of time [19], [20].

However, there is still a gap between the sensor data and the adult children. Storytelling is a novel approach to bridge the gap and improve the social connections between the elderly and their adult children. A story is defined as an account of an event or series of events, real or imaginary [12]. Storytelling is widely used in everyday human communication, allowing people to share information and convey knowledge of history or experience. The sequence of events is called the storyline (also known as the plot), and it involves the actions of various actors in each event. Storytelling can be a compelling medium that allows adult children to learn about and understand the condition of the elderly parents.

Currently, there are several main research directions in storytelling modeling: one is to model the story plot, e.g., Propp's 31 functions [22], Mimesis [33], Universe [14], and Brutus [4]. Another approach is to model the individual story characters involved in the story, e.g., Interactive Storytelling with hierarchical task network [8], TALE-SPIN [18], Oz project [17], and crowdsourced story generation [15].

In our previous research we proposed to use Goal Net to model story plot, in which the story events is the goal of the story character [5], [6]. In this work, we propose a data driven story generation system which combines the advances in both smart homes and storytelling. In the next section, the design of the proposed system is described in detail.

## III. THE PROPOSED DATA DRIVEN STORYTELLING SYSTEM

The architecture of the proposed data driven story generation system is shown in Figure 1. The raw signal data transmitted by sensors placed in the home environment are sent to the cloud server, where a director agent transforms the sensor data into a compelling story for display in the mobile console. The director agent maps the raw sensor data to values of semantically meaningful context variables through activity functions in its *Data Analysis* component. The historical values of context variables are stored in the *Database*. The director agent organizes story plots through a Goal Net based approach in the *Plot Planning* component. The dynamic storylines are generated based on a set of rules (importance-based rules and curiosity-based rules) in the *Rule Base*. The values of context variables stored in *Database* can trigger rules in the *Rule Base*. The detailed design of each component of the director agent will be discussed in the following sections.

### A. The Data Analysis Component

The signals generated by sensors placed in the home environment are raw data that are hard to be interpreted by human beings. Hence, the semantic meanings should be abstracted from the raw data to convey meaningful information. The data analysis component of the proposed system transforms the raw sensor data to values of semantically meaningful context variables. For example, from the signals of the force sensors and the vibration sensors mounted on bed, useful context variables such as duration of sleep and sleep quality can be analyzed.

We adopt a function-oriented modeling approach for abstracting the semantic meanings of the raw sensor data. The raw sensor data are processed by a set of *activity functions*. The inputs of each activity function are signal data transmitted by sensors attached to the objects in the home environment. Examples of the sensors include force sensors mounted on shoes, switch sensors mounted on doors, and electricity monitoring sensors mounted on TV and microwave oven. The outputs of each activity function are values of context variables. Examples of the context variables include duration of walking, leaving bedroom time, and duration of watching tv. Activity functions describe the important daily activities of an elderly at the smart home environment.

Two examples of the activity functions are shown in Table I. The *sleep* function receives input signals from the force sensors and the vibration sensors mounted on bed. It assigns values to four output context variables, which include go to bed time, leave bed time, duration of sleep and sleep quality. The force sensors provide supporting data for go to bed time, leave bed time, and duration of sleep. The vibration sensors provide supporting data for sleep quality. It can be deduced heuristically that if too much movement

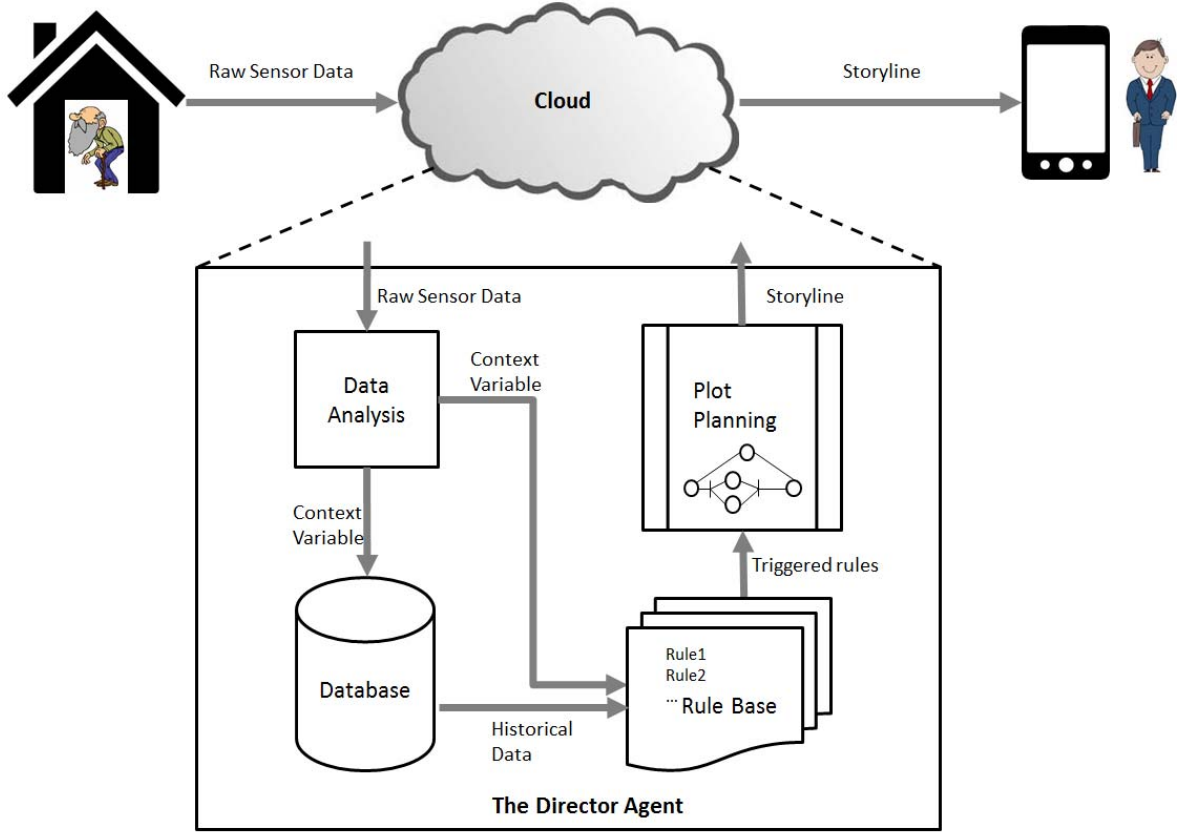


Figure 1. The Architecture of The Data Driven Storytelling System

Table I  
EXAMPLES OF THE ACTIVITY FUNCTIONS

Function Name	Sleep
Inputs (Sensor Signals)	Signals of force sensors and vibration sensors mounted on bed
Outputs (Context Variables)	Go to bed time Leave bed time Duration of sleep Sleep quality
Function Name	Watch TV
Inputs (Sensor Signals)	Signals of electricity monitoring sensors
Outputs (Context Variables)	Switch on tv time Switch off tv time Duration of watching tv

happens in the night, the sleep quality may be bad for the elderly. The *watch TV* function receives input signals from the electricity monitoring sensors and assigns values to three context variables, which include switch on tv time, switch off tv time, and the duration of watching tv.

Some of the context variables (e.g., go to bed time,

duration of sleep) take *quantitative* values such as time, time interval, etc. Some of the context variables (e.g., sleep quality) take *qualitative* values such as good, bad, etc.

#### B. The Database Component

The context variables evaluated by the data analysis component convey semantically meaningful information that are desired by human caregivers for the analysis of the conditions of the elderly. The historical values of context variables are important for analyzing the activities of the elderly and for detecting the abnormal activities. In the proposed system, the time series data of the context variables are maintained in the database component.

#### C. The Plot Planning Component

The end goal of the proposed system is to generate dynamic storylines to present to the audience (the adult children of the elderly). According to [5], one of the most important factors of a story is the plot, which is composed of a series of key scenes that are causally related in temporal relationships. In dynamic storytelling, there are three key elements:

**Director D:** A director is the storyteller, responsible for organizing the plot and presenting to the audience. In

dynamic storytelling, the director dynamically present the storyline by choosing the most appropriate scenes from the many alternatives.

**Scenes  $S_i$ :** A story is composed of temporal related acts. Each act can be further decomposed into scenes. Hence, the storytelling can be treated as the presentation of a series of temporal chain of scenes. These scenes are connected to each other in causal relationships.

**Context Variable  $V_i$ :** In dynamic storytelling, context variables (e.g., the time of event, the position of character, etc.) affect the decision of the director in selecting scenes.

In order to realize the key elements in dynamic storytelling, we adopt Goal Net approach for plot planning. Goal Net is a goal-oriented modeling method to model the goals of an agent and to model agent coordination in multi-agent systems [27]. It has been successfully applied in business forecasting systems and E-learning systems [24], [26].

1) *The Basics of Goal Net:* Goal Net is a model which is composed of *states* and *transitions*. The *states*, represented by circles, are the states that an agent needs to go through in order to achieve goals. The *transitions*, represented by arcs and vertical bars, specifies the relationships between the states it joins. Each transition is associated with a task list which defines the tasks that the agent needs to perform in order to transit from the input state to the output state.

There are two types of states in Goal Net, *atomic states* and *composite states*. An *atomic state* accommodates a single state, which can not be decomposed any more. A *composite state* can be decomposed into states (either composite or atomic) connected via transitions. A Goal Net is hierarchically structured. The root composite state at the highest level of the hierarchical structure represents the overall goal of the agent and the composite states in lower levels of the hierarchical structure represent sub-goals of the agent.

In Goal Net, there are four types of temporal transitions connecting the input states and the output states: *sequence*, *choice*, *concurrency*, and *synchronization*, which are illustrated in Figure 2.

**Sequence:** Sequential relationship designates a direct connection in sequence from the input states to the output states. For example, in Figure 2(a), state  $i + 1$  should be reached after state  $i$  is reached.

**Concurrency:** Concurrent relationship specifies a concurrent occurrence between states. For example, in Figure 2(b), state  $i + 1$  and state  $i + 2$  can be achieved simultaneously.

**Choice:** Choice relationship specifies a selective connection from one state to other states. For example, in Figure 2(c), based on selection criteria, either state  $i + 1$  or state  $i + 2$  can be selected after state  $i$ .

**Synchronization:** Synchronization relationship specifies a synchronization point among states. For example, in Figure 2(c), state  $i + 2$  can be reached only if both state  $i$  and state

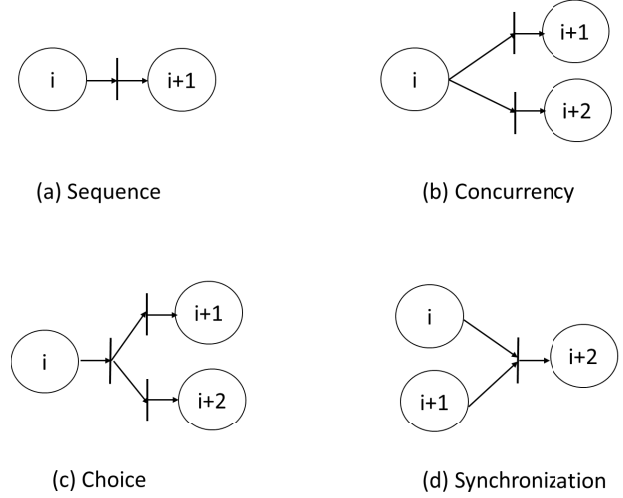


Figure 2. Goal Net Transitions: (a) Sequence (b) Concurrency (c) Choice and (d) Synchronization

$i + 1$  are reached.

2) *Plot Planning with Goal Net:* The expressiveness of Goal Net renders it an ideal tool for modeling the plots of stories. In Goal Net based plot planning, the scenes  $S_i$  that compose the plot of a story are represented by states/goals and the causal relationships between scene  $S_i$  and  $S_{i+1}$  are represented by transitions.

A complex scene is represented as a composite state and a simple scene is represented as a atomic state. A composite state can be further decomposed into states (composite or atomic) such that a complex scene can be split into sub-scenes in story plots. The causal relationships between scenes are represented by transitions in Goal Net, which is capable to describe different types of relationships. Sequential transition can represent two scenes that are linearly organized in temporal sequence. The concurrency transition can represent two scenes that can be presented independently in temporal sequence. The choice transition represent choices between scenes that rely on the context variables and selection rules of the director. The synchronization transition represent the joint point of concurrent scenes that need to be presented before the next scene can be presented.

3) *Activity Function based Plot Planning:* To present the daily life of an elderly in dynamic storylines, we need to define the key scenes and context variables in the story plot. The scenes of a story about the elderly should reflect important daily activities, the abnormality of which can indicate critical issues for the elderly. The daily activities are abstracted as activity functions in the data analysis component. Hence, the states of Goal Net (or the scene of the story plot) can be represented by the activity functions.

To create dynamic storylines, the director agent should know what scenes to be selected for presentation. The

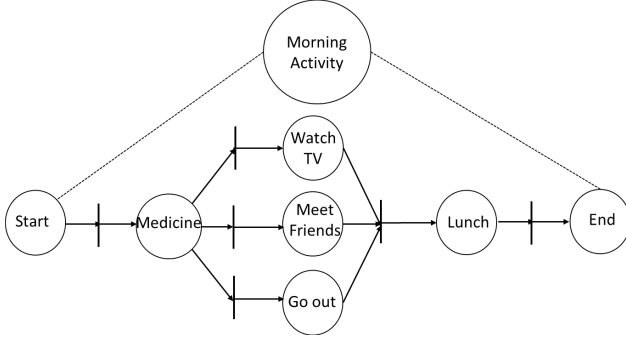


Figure 3. The Goal Net of Morning Activities of an Elderly

selection of scenes depends on the context variables. For example, if the duration of sleep is too long and triggers the alarming threshold, the *sleep* scene will be very important for presentation. The context variables can be acquired from the outputs of the activity functions.

An simple example of activity function based Goal Net is shown in Figure 3. This Goal Net models the daily activities of an elderly during morning hours (after breakfast and before lunch). The elderly first takes medicine after breakfast. Then, he will watch tv or meet with friends or go for outdoor activities. These three activities can occur without temporal dependency. At noon, the elderly will have lunch.

#### D. The Rule Base Component

Dynamic storylines are achieved by goal/state selection in a Goal Net. We adopt rule-based reasoning mechanism for the director agent to select the appropriate scenes for presentation. We define two categories of rules: the importance-based rules and the curiosity-based rules.

1) *Importance-based rules*: An importance value  $I_i$  is assigned to each scene/activity function  $S_i$  in the Goal Net, which specifies how significance the presentation of the scene/activity function means to the audience. The importance value  $I_i$  takes qualitative data such as high or low. The scenes/activity functions with high importance have higher priority for presentation. The importance value is assigned by the audience. For example, for an elderly who has dementia, taking medicine is an important activity in his/her daily life. Hence, the taking medicine activity should be assigned high importance. For an elderly who has emotional problems, the meeting with friends activity should be assigned high importance because lack of social activities can lead to deeper feeling of loneliness. The importance-based rule is defined as follows:

If  $I_i$  is high  $\rightarrow$  select  $S_i$ .

2) *Curiosity-based rules*: For scenes/activity functions with low importance, if the elderly's activity pattern is steady, then the presentation of these scenes everyday will be tedious to read. For example, if an elderly every morning

gets up at almost the same time, then presenting the elderly's wake up time would be of no interests to the audience.

A storyline should always be catching and emotion arousing to the audience. In human psychology, it has been shown that curiosity is the intrinsic motivation related to exploration and learning [3]. Curiosity-stimulating storylines will drive the audience to immerse in the plot till their curiosity is satiated. For example, if an elderly every morning gets up at almost the same time, but one day he got up two hours later, this information will be interesting because his activity pattern is suddenly disturbed and the curiosity into what caused the change may drive the audience to contact the elderly. In our previous works, we have modeled curiosity for intelligent agent characters [29] and applied curiosity in game designs and virtual learning environments [30], [31], [32].

According to Berlyne [3], novelty is one of the most significant factors that induce curiosity in human beings. He associated three criteria with the evaluation of novelty: the degree of novelty is inversely correlated to (1) how often the stimuli have been experienced before (frequency), (2) how recently the stimuli have been experienced (recency), and (3) how similar the stimuli are to previously experienced ones (similarity). Based on Berlyne's theory, we model curiosity-based rules for scene selection in Goal Net plot planning.

Curiosity-based rules are related to the historical context variables stored in the database. Each scene/activity function  $S_i$  is associated with a set of context variables (output of the activity function). These context variables conveys semantically meaningful information that describes the status of the elderly's daily activities.

The context variables can take two types of data, qualitative (e.g., sleep quality) or quantitative (e.g., duration of sleep). The novelty of qualitative variable are defined based on frequency and recency, while the novelty of quantitative variables are defined based on similarity. For a qualitative variable  $V_i$ , the frequency of  $V_i$  taking value  $d_j$  in last  $n$  records is defined as follows:

$$F_n(V_i = d_j) = \frac{Numof_n(V_i = d_j)}{n} \quad (1)$$

where  $Numof_n$  returns the count of  $V_i = d_j$  in last  $n$  records.

For a qualitative variable  $V_i$ , the recency of  $V_i$  taking value  $d_j$  is defined as follows:

$$R(V_i = d_j) = t_c - t_l(V_i = d_j) \quad (2)$$

where  $t_c$  is the current time and  $t_l(V_i = d_j)$  retrieves the time of last occurrence of  $V_i = d_j$  before.

For a quantitative variable  $V_i$ , the similarity of  $V_i$  with respect to last  $n$  records is defined as follows:

$$Sim_n(V_i) = 1 - \frac{|V_i^{t_c} - \frac{\sum_1^n V_i^{t_c-n}}{n}|}{V_i^{t_c}} \quad (3)$$

Table II  
SENSORS EMPLOYED IN HOME SIMULATION

Object	Sensors
Bed	Force sensor vibration sensor
Toilet	Force sensor On-off switch
TV set	Sound(Noise) sensor Current monitoring sensor
Shoe	Force sensor
Sofa	Force sensor
Chair	Force sensor
Doors (fridge, cupboard,cabinet)	On-off switch
Room (bed room, living room, kitchen, lavatory)	Humidity and temperature sensor Light sensor Sound(noise) sensor Passive intra-red sensor

where  $\frac{\sum_{i=1}^n V_i^{tc-n}}{n}$  returns the average value of last  $n$  records of  $V_i$ .

The curiosity-based rule is defined as follows:

$$(\exists V_i \in \text{Outputs}(S_i))(V_i^{tc} = d_j \wedge (F_n(V_i = d_j) < \theta_f \vee R(V_i = d_j) > \theta_r \vee \text{Sim}_n(V_i) < \theta_s)) \rightarrow \text{select } S_i.$$

where  $\theta_f$ ,  $\theta_r$ , and  $\theta_s$  are threshold values. The curiosity-based rule is triggered if there exist a context variable  $V_i$  belonging to the outputs of scene  $S_i$  and its frequency is lower than a threshold or its recency is higher than a threshold or its similarity is lower than a threshold, then scene  $S_i$  is selected for presentation.

For example, although sleep (scene/activity function) is not assigned high importance, if the similarity of leave bed time (context variable) is smaller than a threshold, then it indicates that the elderly's go to bed time pattern is disturbed and the director agent should present the sleep scene in the storytelling.

In the next section, the proposed system will be studied with a simulated smart home environment.

#### IV. CASE STUDY

We set up a simulated smart home environment in the lab. The sensors employed in the simulation are listed in Table II. Two types of sensors are shown in Figure 4. Figure 4(a) shows the on-off switch on doors and Figure 4(b) shows the force sensor on shoes. From the signals emitted by the sensors, the context variables with semantic meanings such as leaving room/entering room and standing/walking can be deduced.

In this case study, we focus on the storytelling of the elderly's morning activities. Based on the sensors placed in the home environment, the following activity functions are abstracted: sleep, toilet, listen to radio, exercise, eat

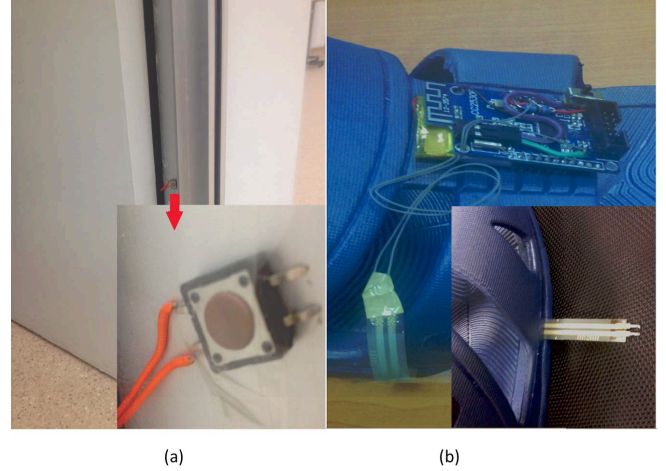


Figure 4. The Sensors Mounted on Objects (a) Switch Sensor on Doors (b) Force Sensor on Shoes

breakfast, medicine, watch tv, meet with friends, outdoor activities, and eat lunch. The Goal Net for plot planning of the morning activities is shown in Figure 5. The scenes with high importance are highlighted in grey color in the Goal Net. Toilet is assigned high importance because it is one of the most common places of fall and toileting habits can indicate the health condition of the elderly. Medicine is assigned high importance because taking medicine is crucial for the elderly with dementia. This Goal Net describes the morning activities of an elderly who usually goes to the toilet, listens to the radio, and does exercise after waking up. The elderly takes his/her medicine after breakfast and then watches TV, meets with friends at home, or goes for outdoor activities. At noon, he/she has lunch.

Case 1: Let us consider the extreme case where no scenes trigger the curiosity-based rule. The director agent of storytelling will only present the scenes with high importance based on the context variables. In this case, the storyline might be:

*After waking up, Dad went to the toilet as usual (toilet, high importance). After breakfast, Dad took his medicine on time (medicine, high importance).*

Case 2: Let us consider the case in which some scenes (high importance or low importance) trigger the curiosity-based rule. From the context variables, it is deduced that toileting is three times as frequent as the average in the past month and breakfast is skipped in the morning. In this case, the storyline might be:

*It is strange that Dad went to the toilet very frequently this morning (toilet, curiosity). Usually he goes 1-2 times in the morning, but he went 5 times today. Normally, Dad will have breakfast at around 7:30 am, but he skipped breakfast today (breakfast, curiosity). After breakfast, Dad took his medicine on time (medicine, high importance).*

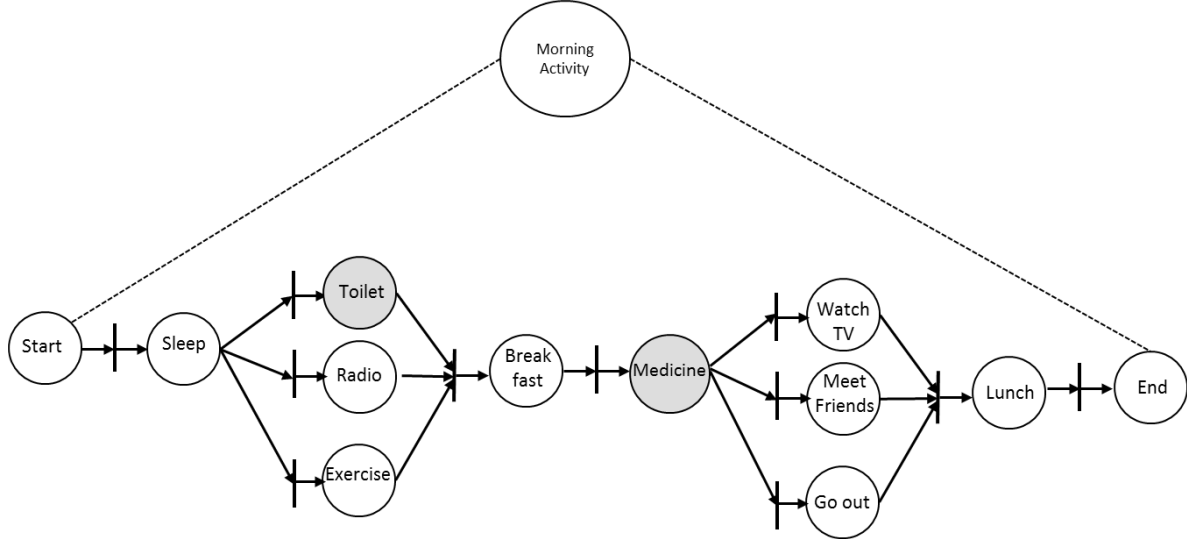


Figure 5. The Goal Net for Morning Activities of the Elderly

Case 3: It is shown by the context variables that the radio was not switched on in the morning and no friends came to visit. In this case, the storyline might be:

*Dad usually listens to the radio in the morning, but he didn't switch on the radio today (Radio, curiosity). Dad went to the toilet as usual (toilet, high importance). After breakfast, he took his medicine on time (medicine, high importance). Most days, Dad meets with friends at home or goes out in the morning, but today no one came to visit and he stayed home (meet friends, curiosity).*

From the three cases, it can be observed that the stories present the important activity information that the adult children care about as well as the curiosity arousing information that can cause their attention. Hence, the stories depict the elderly's daily life more vividly than raw sensor data. On observing the activities assigned high importance, the children can be assured about the elderly's physical conditions. The curiosity inducing information can potentially persuade the adult children to contact the elderly in order to satisfy their curiosity.

## V. CONCLUSION

To address the social and emotional needs of empty nesters, we propose a data driven storytelling system. The system transforms raw sensor data into a compelling story. A story is emotion arousing and has a high persuasive power, which can transform the sensor data into a vivid picture of the elderly's condition for their loved ones. To the best of our knowledge, this is the first work on IOT-based data driven storytelling for supporting social connections between empty nesters and their families. We believe this work opens new directions for both smart home research and storytelling research.

The system adopts a function-based approach to map the raw sensor data to semantically meaningful context variables which conveys information about the elderly's activities. The Goal Net is adopted for plot organization and the dynamic plot planning is realized by rule-based approaches. Two types of rules are proposed, namely importance-based and curiosity-based. In this way, the system successfully generates storylines based on real world data.

The current system generates stories based on the context variables derived from activity functions, which can picture the elderly's activities in the home environment. A future research direction is to mine a higher level of information from multiple dimensions such as the social status, emotional status and physical status of the elderly based on the context variables. For example, from the context variables produced by the *meet friends* activity function, it can be deduced whether the elderly is lonely and if he/she needs social company. This higher level information can be weaved into richer storylines to better captivate the adult children's attention and evoke emotional responses.

## ACKNOWLEDGEMENTS

This research is supported in part by the Interactive and Digital Media Programme Office (IDMPO), National Research Foundation (NRF) hosted at Media Development Authority (MDA) under Grant No.: MDA/IDM/2012/8/8-2 VOL 01.

## REFERENCES

- [1] <http://en.wikipedia.org/wiki/storytelling>.
- [2] <http://lifehacker.com/5965703/the-science-of-storytelling-why-telling-a-story-is-the-most-powerful-way-to-activate-our-brains>.



- [3] D. Berlyne. *Conflict, arousal, and curiosity*. McGraw-Hill New York, 1960.
- [4] S. Bringsjord and D. A. Ferrucci. *Artificial intelligence and literary creativity: Inside the mind of brutus, a storytelling machine*. MIT Press, 2000.
- [5] Y. Cai, C. Miao, A.-H. Tan, and Z. Shen. Fuzzy cognitive goal net for interactive storytelling plot design. In *Proc. of Intl. Conf. on Advances in Computer Entertainment Technology*, pages 56–63, 2006.
- [6] Y. Cai, Z. Shen, C. Miao, and A.-H. Tan. S-made: Interactive storytelling architecture through goal execution and decomposition. *Artificial Intelligence*, 2007.
- [7] L. L. Carstensen. Motivation for social contact across the life span: A theory of socioemotional selectivity. *Nebraska symposium on motivation*, 40:209–254, 1993.
- [8] M. Cavazza, F. Charles, and S. J. Mead. Character-based interactive storytelling. *Intelligent Systems*, 17(4):17–24, 2002.
- [9] W. Dewing, S. Metz, and W. Winchester. Does home-care automation for elders change the caregiver experience? *Gerontechnology*, 2(1):111, 2002.
- [10] D. Focken and R. Stiefelbogen. Towards vision-based 3-d people tracking in a smart room. In *Proc. of Intl. Conf. on Multimodal Interfaces*, pages 400–405, 2002.
- [11] A. P. Glascock and D. Kutzik. Moving telematics from the laboratory to a truly enabling technology within the community. *Assistive Technology Research Series*, 14:145–154, 2004.
- [12] L. Kernerman. *Kernerman english multilingual dictionary*. K Dictionaries Ltd, 562, 2006.
- [13] M. P. Lawton. Aging and performance of home tasks. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 32(5):527–536, 1990.
- [14] M. Lebowitz. Story-telling as planning and learning. *Poetics*, 14(6):483–502, 1985.
- [15] B. Li, S. Lee-Urban, G. Johnston, and M. O. Riedl. Story generation with crowdsourced plot graphs. *AAAI Conferece on Artificial Intelligence*, 2013.
- [16] M. F. Lowenthal, D. Chiriboga, and A. M. Assoc. Transition to the empty nest: Crisis, challenge, or relief? *Archives of General Psychiatry*, 26(1):8, 1972.
- [17] M. Mateas. *An Oz-centric review of interactive drama and believable agents*. Springer, 1999.
- [18] J. R. Meehan. *The metanovel: writing stories by computer*. PhD thesis, 1976.
- [19] H. Nait-Charif and S. J. McKenna. Activity summarisation and fall detection in a supportive home environment. In *Proc. of Intl. Conf. on Pattern Recognition*, 4:323–326, 2004.
- [20] N. Noury. A smart sensor for the remote follow up of activity and fall detection of the elderly. *Intl. IEEE-EMB Special Topic Conf. on Microtechnologies in Medicine & Biology Annual*, pages 314–317, 2002.
- [21] M. Ogawa, R. Suzuki, S. Otake, T. Izutsu, T. Iwaya, and T. Togawa. Long term remote behavioral monitoring of elderly by using sensors installed in ordinary houses. *Annual Intl. IEEE-EMB Special Topic Conf. on Microtechnologies in Medicine & Biology*, pages 322–325, 2002.
- [22] V. Propp. *Morphology of the folktale*. Bloomington, Ind, 18, 1958.
- [23] D. Roberts, H. Narayanan, and C. Isbell. Learning to influence emotional responses for interactive storytelling. In *Proc. of AAAI Symposium on Intelligent Narrative Technologies II*, 2009.
- [24] Z. Shen, C. Miao, and Y. Cai. Agent augmented game development. *Annual Microsoft Conf. on Game Development*, 2007.
- [25] Z. Shen, C. Miao, R. GAY, and D. LI. Goal-oriented methodology for agent system development. *IEICE TRANSACTIONS on Information and Systems*, 89(4):1413–1420, 2006.
- [26] Z. Shen, C. Miao, R. Gay, and C. P. Low. Personalized e-learning: a goal oriented approach. In *Proc. of WSEAS Intl. Conf. on Distance learning and web engineering*, pages 304–309, 2007.
- [27] Z. Shen, C. Miao, X. Tao, and R. Gay. Goal oriented modeling for intelligent software agents. In *Proc. of Intl. Conf. on Intelligent Agent Technology*, pages 540–543, 2004.
- [28] N. K. Suryadevara and S. C. Mukhopadhyay. Wireless sensor network based home monitoring system for wellness determination of elderly. *Sensors Journal*, 12(6):1965–1972, 2012.
- [29] Q. Wu and C. Miao. Modeling curiosity-related emotions for virtual peer learners. *Computational Intelligence Magazine*, 8(2):50–62, 2013.
- [30] Q. Wu and C. Miao. Curiosity: From psychology to computation. *ACM Computing Surveys*, In Press.
- [31] Q. Wu, C. Miao, and Z. Shen. A curious learning companion in virtual learning environment. In *Proc. of Intl. Conf. on Fuzzy Systems (FUZZ-IEEE)*, pages 1–8, 2012.
- [32] Q. Wu, C. Miao, X. Tao, and M. Helander. A curious companion for elderly gamers. *Southeast Asian Network of Ergonomics Societies Conference (SEANES)*, pages 1–5, 2012.
- [33] R. M. Young. An overview of the mimesis architecture: Integrating intelligent narrative control into an existing gaming environment. *The Working Notes of the AAAI Spring Symposium on Artificial Intelligence and Interactive Entertainment*, pages 78–81, 2001.