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Smart Objects Assisted Event Detection System Using Wireless Sensor Networks

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Abstract

In recent years, the technological improvement in wireless smart communication (WSC) and mobile computing stimulated a consistent growth both in number and types of implementations for Smart Classes and Objects (SCO). Significantly enlarging their battery longevity and hence their serviceability, it is essential to minimize power consumption and thus ameliorate power efficiency. Before a smart device initiates communication, it must discover the set of nodes that are within its direct communicating range. The gathered relevant information is kept in its internal data structures to apply with routing. The behavior of an ad-hoc and dynamic devices relies on the functioning of its neighboring interconnected devices since it must sense the medium before it starts transmitting packets to nodes in its interfering range, which can give rise to collisions at the other devices. The wireless ad-hoc devices acclimatize dynamically its topology knowledge range, leading to faster convergence of its neighboring nodes to establish smart objects communication. The design goal of SCO is to acquire the real time data acquisition with an impact of supervisory control for large scale Remote Environment. Proposed system considers a logging System for a remote communication and the power that is being wasted will be saved using sensors to indicate the microcontroller to increase or decrease the power to the required levels. Our proposed system is to help in automation of SCO that in turn makes our lives easier.

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Keywords: WSC;Logging system; Smart classes and objects(SCO) and Remote communication.

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1. Introduction

In recent years there has been a growing interest among consumers in the Smart classes and objects (SCO). Smart automation contains multiple interconnected smart devices and entertainment consoles, etc. Intelligent devices are available to the system to provide control, convenience, comfort and security to the end users [1]. With advancement in technology can control the levels and also to give more comfort to end users. All mobile devices have a maximum transmission power which establishes the largest transmission range of the device [2]. As nodes are portable, the link between two devices can break quite often depending on the spatial direction of the nodes. The mobile wireless devices out of communication range can use new nodes within their communication range to transmit the transmitted packets. If the topology is too sparse, routing requests may be obstructed due to the network partitioning, considerably increasing end-to-end packet delays. On the other hand, if the topology is excessively dense, nodes may run out of their energy quickly and may escalate interference among them [3]. However, topology control can offer substantial control over network resources such as battery power and reduce redundancy in network communications. The algorithms to control topology can be grouped into two categories: Centralized topology control algorithms and Distributed topology control algorithms. Figure 1a, b Show data acquisition using wireless sensor nodes connectivity in normal as well as data centric. Topology control algorithms thus generate, or derive, a simpler topology from the original one constructed under the common maximum transmission range [4].

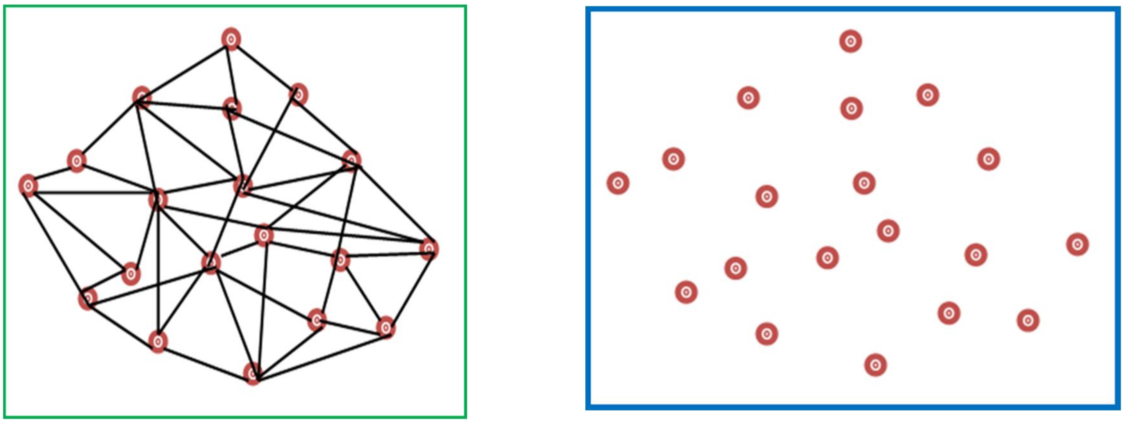

Fig. 1. (a).Data centric route acquisition; (b) Normal data acquisition.

Many applications are being developed to provide more information on demanding technologies using GSM and Embedded Systems. In GSM AT (Attention) commands are ensuring its reliability. It is mainly used for validating the SIM module and signal quality. AT commands are interfaced with microcontroller through UART port to establish the interaction using GSM [5, 6]. Conventional SCADA use PC, notebook, and PDA as a clients. The SCADA system is used for monitoring and controlling of various processes of smart environment from remote areas and provides security, system integration, data integrity, and consistency. AT89S52 is the microcontroller act as controlling unit which has an application to allow the microcontroller read the incoming commands through the GSM module and change the status of the loads accordingly [7]. The performance of the design is maintained by controlling unit. The modem forms the link between user and the system. The user communicates with the system through command which will be received by the GSM module and forwards to AT89S52.

2. Related works

Research into the optimal number of neighbours was initiated to aid in the planning of optimal wireless multi-hop network topologies. An optimal network topology is dependent on every node in the network having an optimal number of neighbours. Nodes having too few neighbours results in reduced route redundancy, which reduces the robustness of the network whilst too many neighbours results in increased interference and contention for the transmission medium. We used the following characteristics to categorize and critically analyse the published body of research results in this field. The optimal number of neighbours is either a fixed constant that is independent of the total number of nodes in the network, or it varies dependent on the total number of nodes in the network. The optimal number of neighbours' value can be either a prescribed minimum or a prescribed maximum. The lower-bound is utilized for specifying connectivity whilst the upper-bound is utilized for minimizing interference and maximizing network throughput [1, 8]. A primary purpose of determining the optimal number of neighbours is to maximize network nodes' access to the transmission medium; therefore, the specification of the optimum number of neighbours for a network should take into account the type of MAC scheme that is used to control access to the transmission medium. Despite the progress made in this field of research, the number of neighbors could only be controlled prior to the network's deployment, during the initial planning and site determination phase [2, 9]. The lack of an automated method of always ensuring that a wireless multi-hop network node had the optimal number of neighbors led to the design of topology control algorithms [10, 11].

3. Wireless communication for Smart environment

3.1. Topology Control

Topology control can be viewed as a prerequisite to determine the optimal number of neighbours in a wireless multi-hop network. This recent field of study ultimately aims to automate the process of creating a network topology wherein each node in the network is connected to the optimal number of neighbours, resulting in reduced interference and power consumption, whilst guaranteeing that the network remains connected. Topology control is often a compromise between the node's transmission range (which is proportional to the transmission power), the number of neighbours and the average number of distinct paths between every source and destination pair. The aim of this framework is to help categorise and critically analyse the published work in this field. Node characteristics - Node characteristics refer to the hardware and firmware platforms utilised by the nodes. Networks comprised of these nodes can be classified as either homogeneous or heterogeneous. Homogeneous networks contain nodes with the same characteristics, such as antenna type, transmission range, routing protocol, and so on. On the other hand, heterogeneous networks contain nodes with varying characteristics most often the transmission range.

3.2. Algorithms classification

There is an inherent trade-off between the quality of the information required and the cost of performing the algorithm. Higher quality information results in higher control message overheads, which adversely affect the performance of the network. The information that is required by topology control algorithms usually come in one of three types, namely: Location information, Direction information, Neighbor information.

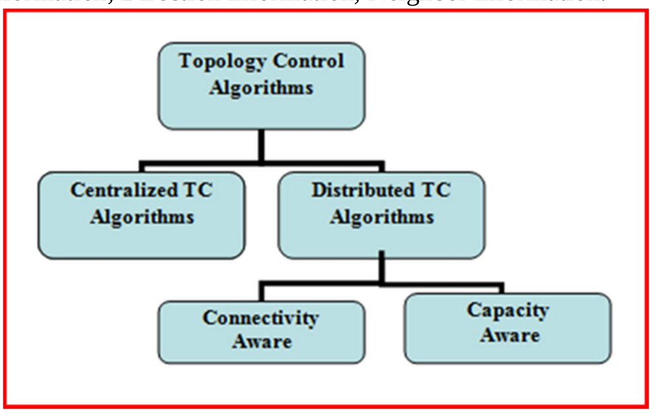

Fig. 2. Classification of Topology control algorithms

Location-based topology control algorithms rely on the network node's ability to determine its location usually through the use of a GPS-based system. Direction based algorithms assume that network nodes do not know their positions but possess the ability to estimate the relative direction of each neighbor. The most common information requirement for topology control algorithms is neighbor based information. Neighbors are distinguished by some form of identification, usually an Internet Protocol address and are usually ordered by link quality. The works reviewed are based on a requirement for neighbor-based information. The various algorithm classifications for topology control is shown in figure 2.

4. Architecture Setup For Establishing SCO

The real time monitoring has been an important feature that can be used in the home automation systems. The user interactions are transferred to a sink which is usually done by gateway and as a change in the status of the devices occurs, the user can be informed in real time. The sink processes the user commands and sends them to the relevant units. GSM (Global System for Mobile communication) is used as external communication medium to establish internet connectivity used in smart objects. End user is being informed when there is an event detection using text services. GSM has been used for its high availability, coverage and security. AT commands can be used to control the smart object devices. The text delivery relies on the networks and delayed communication flow is also possible [12]. The system does not have any state information related to the devices and expects the user to keep track of it. It is a system that can be programmed for the application as per requirements. The system also has the ability to control mechanical measures through sensors that convert electrical to mechanical signals. However it is not designed to provide feedback to the user. Proposed architecture allows the user to monitor and control interconnected smart devices. The following figure 3 illustrates the architecture setup for SCO environment. The smart devices are used to provide a user friendly interface and connected together. They also serve to send instructions and receive feedback from the system and forward it to data as well as event models.

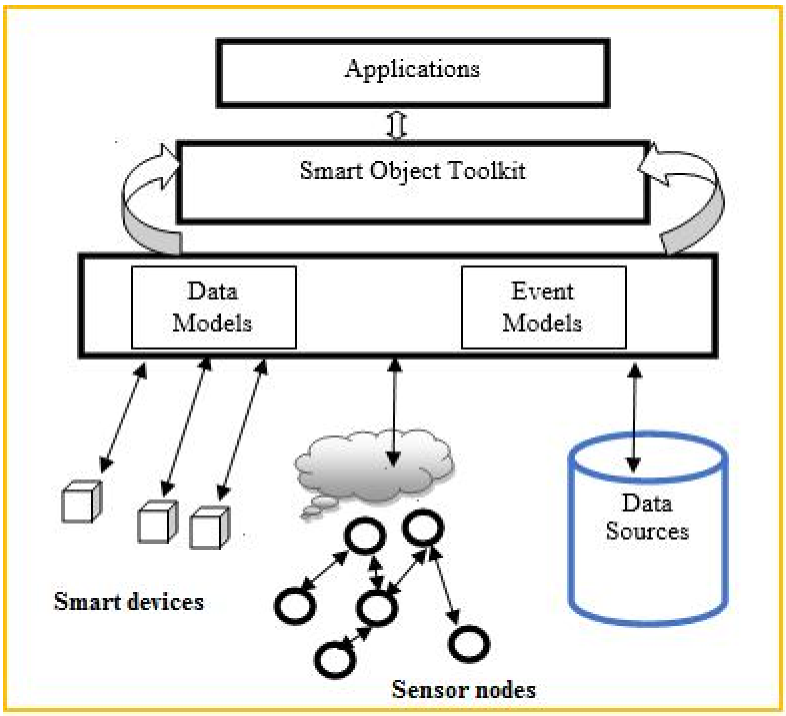

Fig. 3. Smart objects infrastructure for event detection.

A smart object toolkit is the controller used to interface the applications and devices. It consists of peripheral drivers and relays to achieve the interfacing. The interconnected smart devices, Wireless sensor networks and various data sources are generating the sensed data when an event is detected and it is forwarded to event models and normal data are sent to data models. The smart object toolkit interacts the sensed data with the applications. This allows the user to control the smart objects and also ensures the reliability. Also the interface is preprogramed and can be customized based on devices. The system also sends back feedback to alert the user about the results. This makes easier for everyone to control objects into their comfort level as one can also change the range.

Architecture **-** The architectural structure refers to the functioning of the topology control. It uses a single (usually central) node to determine the best connectivity for each node in the network. Other schemes are distributed in nature whereby each node determines its own best connectivity based on the information gathered. Connectivity relates to the number of neighbors that a node is able to connect. Link Characteristics **-** This refers to the types of links that are eventually created by a topology. Links can be either unidirectional or bi-directional in nature. Connectivity Flexibility **-** This refers the ability to vary the connectivity of the network that is created once the infrastructure is enabled. The SCO environment possess the ability to create a network topology with varying degrees of connectedness whilst other algorithms do not offer such flexibility.

5. Results and Discussion

The following parameters are organized for experimental environmental scenario as listed in Table 1 to communicate the wireless sensor networks with data and event models.

Table 1. Simulation scenario.

Parameters	**Values**
Number of sink nodes	2
Number of common nodes	25
Transmission range(Meters)	100 – 300
Sensing range(Meters)	550
MAC protocol	802.11
Channel bandwidth (Mbps)	1
Simulation area	200*200
Running duration (in secs)	900
Rtproto	DV
Shortest path disabled (in secs)	60

Resource consumption is a vital constraint which decides the lifespan of entire network. Energy consumption for data processing is computed as [13],
(Ep) = (Ed) energy dissipation + (Pl) power loss due to leakage, Where energy dissipation is calculated using

$$Ed = C_c * C_a * V^2 \qquad (1)$$

C_C indicates Clock cycles per state, C_a is Total switches capacitance and V is Supply voltage. The power loss is computed by using,

$$p_i = \left(I_0 * e^{\frac{v}{n} \cdot V_t}\right) * \left(\frac{N}{f}\right) \qquad (2)$$

Io indicates Leakage current, Vt is threshold voltage, n is Constant for processor hardware, f is Clock frequency. Energy consumption for transmitter and receiver in distance is computed through [14].

$$Ec = Etx\,(k, d) + Erx\,(k) \qquad (3)$$

Etx indicates energy consumed at transmitter side, Erx is energy consumed at receiver side and d indicates distance between transmitter and receiver. The probability of business of the link usage is determined for congested and non-congested situation as listed in Table2.

Table 2. Probability decision on busy channel.

Nature of channel	**Nature of data delivery**	
	fidelity	**Infidelity**
congested	P>=0	P=0
Non-congested	P=1	P<1

The influencing factors about link level and node level congestions are listed as below in Table3. The factors such as infidelity, energy level and data rate are considered also test cases of SCO are validated and listed in Table4.

Table 3. Influencing factors.

Flow of congestion	**Factors for failure**		
	Infidelity	**Energy level**	**Data rate**
Link level	Link error	Relay node dried	inadequate
Node level	excess	Buffer overflow	Surplus

Table 4. Test cases

Parameters	**Test case values**
Test case	GSM
Assumptions	Network availability
Preconditions	GSM module enabled
Steps to reproduce	Text message/voice call using GSM
Expected Result	Message/call received notification
Channel bandwidth (Mbps)	1
Actual outcome	Text/call received
Running duration (in secs)	900
Post condition	Ready to perform actions according to the message

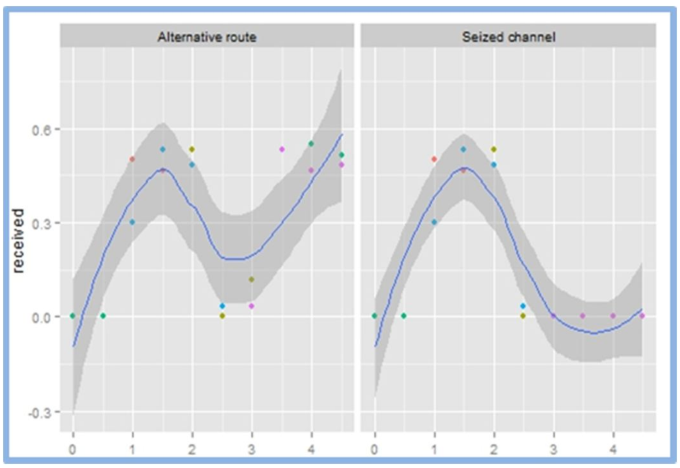

Fig. 4. Synchronized communication in seized channel.

The parameters configured in Table1 are considered as scenario for Synchronized communication and it has been experimented for seized channels. When the congestion bit is set, the channel becomes busy. Scattered tiny sensor nodes are experimented along with various condition sets as per the discussion mentioned. The comparisons captured are addressed as shown in figure4.

4. Conclusion

Smart objects are devised to automate the process of ensuring the creation and subsequent maintenance of optimal wireless multi-hop network communications. This approach provides a distinct infrastructure for event detection and data refining using wireless sensor networks. . If an application not responding, it would not disturb the infrastructure. The components are easily configurable, flexible and closed circumstances does not lead to hardware malfunction. Intended applications are autonomous, platform independent and has ordered sequences to accomplish the requirements. The toolkit often have competing design criteria and as a result they usually determine the network throughput, the interference levels experienced and the average number of distinct paths between every source and destination pair in the network. The SCO can also lead to network stability due to a synchronization amongst interconnected devices whilst converging in deployed scenarios. According to our study, it is identified the design criteria necessary for low cost, resource-constrained network also concentrates on provision of synchronicity between neighboring devices even if it is heterogeneous.

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