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FUZZY BASED OPTIMAL ENERGYCONSERVATION SCHEME FORDISTRIBUTED WSN

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ABSTRACT

Internet of Things (IoT) refers to uniquely identifiable objects and their representation in an Internet-like structure. The term, IoT although coined way back in 1999, became popular after the onset of RFIDs. There are estimates of more than 30 billion devices being wirelessly connected to the Internet of Things by 2020 system in form of a use case that proves the correctness of the proposed model.Wireless communication over closed networks and remote networks like IOT is being influenced by various factors that degrade its performance. In order to carry effective communication, it is essential to design models that can adapt with the intervening models. Fuzzy Optimization based efficient route selection algorithm is proposed to improve communications in IOT. It is inspired by the behavior of ants in discovering paths through pheromone update.

INTRODUCTION

The concept of Internet of Things (IoT) started with things with identity communication devices. The devices could be tracked, controlled or monitored using remote computers connected through Internet. IoT extends the use of Internet providing the communication, and thus inter-network of the devices and physical objects, or 'Things'. The two prominent words in IoT are "internet" and "things". Internet means a vast global network of connected servers, computers, tablets and mobiles using the internationally used protocols and connecting systems. Internet enables sending, receiving, or communicating of information. Thing in English has number of uses and meanings.

The Internet of Things (IoT), sometimes referred to as the Internet of Objects, will change everything including ourselves. This may seem like a bold statement, but consider the impact the Internet already has had on education, communication, business, science,government, and humanity. Clearly, the Internet is one of the most important and powerfulcreations in all of human history.
As with many new concepts, IoT's roots can be traced back to the Massachusetts Institute ofTechnology (MIT), from work at the Auto-ID Center. Founded in 1999, this group was workingin the field of networked radio frequency identification (RFID) and emerging sensing technologies. The labs consisted of seven research universities located across fourcontinents. These institutions were chosen by the Auto-ID Center to design the architecturefor IoT.

According to Cisco Internet Business Solutions Group (IBSG), IoT is simply the point in time whenmore "things or objects" were connected to the Internet than people.In 2003, there were approximately 6.3 billion people living on the planet and 500 milliondevices connected to the Internet. By dividing the number of connected devices by the world population, we find that there was less than one (0.08) device for every person. Based on Cisco IBSG's definition, IoT didn't yet exist in 2003 because the number of connectedthings was relatively small given that ubiquitous devices such as smartphones were justbeing introduced.

The Internet of Things (IoT) is an important topic in technology industry, policy, and engineering circles andhas become headline news in both the specialty press and the popular media. This technology is embodiedin a wide spectrum of networked products, systems, and sensors, which take advantage of advancements incomputing power, electronics miniaturization, and network interconnections to offer new capabilities notpreviously possible. An abundance of conferences, reports, and news articles discuss and debate theprospective impact of the "IoT revolution"from new market opportunities and business models to concerns about security, privacy, and technical interoperability.

The large-scale implementation of IoT devices promises to transform many aspects of the way we live. For consumers, new IoT products like Internet-enabled appliances, home automation components, and energy management devices are moving us toward a vision of the “smart home’’, offering more security and energyefficiency. Other personal IoT devices like wearable fitness and health monitoring devices and networkenabled medical devices aretransforming the way healthcare services are delivered.

1. NEED FOR IOT-CLOUD INTEGRATION

Cloud computing and IoT have witnessed large evolution. Both the technologies have their advantages, however several mutual advantages can be foreseen from their integration. On one hand, IoT can address its technological constraints such as storage, processing and energy by leveraging the unlimited capabilities and resources of Cloud. On the other hand, Cloud can also extend its reach to deal with real world entities in a more distributed and dynamic fashion by the use of IoT. Basically, the Cloud acts as an intermediate between things and applications, in order to hide all the complexities and functionalities necessary for running the application. Below are some of the factors that led to the amalgamation of Cloud and IoT.

Storage capacity: IoT comprises of a large number of information sources (things), which produce huge amounts of non-structured or semi-structured data. As a result IoT requires collecting, accessing, processing, visualizing and sharing large amounts of data. Cloud provides unlimited, low-cost, and on-demand storage capacity, thus making it the best and most cost effective solution to deal with data generated by IoT. The data stored on the Cloud can be accessed and visualized from anywhere through standard APIs.

Computation power: The devices being used under IoT have limited processing capabilities. Data collected from various sensors is usually transmitted to more powerful nodes where its aggregation and processing can be done. The computation needs of IoT can be addressed by the use of unlimited processing capabilities and on-demand model of Cloud. With the help of cloud computing, IoT systems could perform real-time processing of data thus facilitating highly responsive applications.

Communication resources. The basic functionality of IoT is to make IP-enabled devices communicate with one another through dedicated set of hardware. Cloud computing offers cheap and effective ways of connecting, tracking, and managing devices from anywhere over the internet. By the use of built-in applications IoT systems could monitor and control things on a real-time basis through remote locations.

Scalability: Cloud provides a scalable approach towards IoT. It allows increase or decrease in resources in a dynamic fashion. Any number of “things” could be added or subtracted from the system when cloud integration is provided. The cloud allocates resources in accordance with the requirements of things and applications.

Availability: Any time any where availability of resources becomes very easy with cloud integration. Many of the cloud providers assure 5 nine availability. With cloud, the applications are always up and running and continuous services are being provided to the end users.

Interoperability: IoT involves the use of devices that are heterogeneous in nature. These devices may have different hardware or software configurations as a result causing compatibility issues. It becomes very difficult in an IoT environment to ensure interoperability among these devices[19]. Cloud helps in addressing this problem as it provides a common platform where various devices can connect and interact. Devices are allowed to share and exchange data in a format that is acceptable to them.

2. RELATED WORK

L. Atzori, A. Iera, and G. Morabito, “The Internet of Things: A Survey,” were proposed a new technology for creation of pervasive network infrastructure, which enables a wide range of physical objects and environments to be monitored in fine spatial and temporal detail. The detailed, dynamic data that can be collected from these devices provide the basis for new business and government applications in areas such as public safety, transport logistics and environmental management. There has been growing interest in the IoT for realizing smart cities, in order to maximize the productivity and reliability of urban infrastructure, such as minimizing road congestion and making better use of the limited car parking facilities. In this work, two features were considered , they are

A. smart car parking scenarios based on real-time car parking information that has been collected and disseminated by the City of San Francisco, USA and the City of Melbourne, Australia.
B. A prediction mechanism for the parking occupancy rate using three feature sets has been presented. Furthermore, the relative strengths of different machine learning methods in using these features for prediction has been analyzed.

The author did not address the issue like real time parking availability information to the public with the sensors.

Y. Kawamoto et al., "Internet of Things (IoT): Present State and Future Prospectswere presented the parking guidance system based on Zig Bee and Geo magnetic sensor technology. Real-time vehicle position and related traffic information were collected by geomagnetic sensors around parking lots and updated to center server via Zig Bee network. On the other hand, out-door Liquid Crystal Display screens controlled by center server can display information of available parking places. In this paper, guidance strategy was divided into four levels, which could provide clear and effective information to drivers. The experimental results prove that the distance detection accuracy of geomagnetic sensors was within 0.4m, and the lowest package loss rate of the wireless network in the range of 150m is 0%. This system can provide solution for better parking service in intelligent cities.

This paper did not explore the issue of mass deployment
Zhanlin Ji et. Al., were proposed the generic concept of using cloud-based intelligent car parking services in smart cities, as an important application deployed on the Internet of Things (IoT) paradigm. The corresponding IoT sub-system includes sensor layer, communication layer, and application layer. A high-level view of the system architecture is outlined. To demonstrate the provision of car parking services with the proposed platform, a cloud-based intelligent car parking system for use within a University campus isdescribed along with details of its design and implementation.

More energy consumption and time factor is major issue.

3. PROPOSED SYSTEM

We propose a fuzzy logic based approach to coping with the power consumption problem in WSNs. In theproposed smart solution, the sleeping time of network nodes is dynamically regulated by a Fuzzy Logic Controller (FLC).
Besides, a Particle SwarmOptimization (PSO) algorithm is introduced to obtain theoptimal values and parameters of the proposed FLC. In detail,the PSO is used to optimize the membership functions, by varying their range to achieve the best results regarding thebattery life of sensor nodes.

4. SYSTEM ARCHITECTURE

This section describes the high level architecture for the smart parking system along with a mathematical model. The parking system that we propose comprises of various actors that work in sync with one another. Below is the mathematical model that defines our smart parking system.

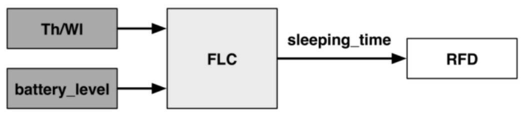

Figure 1: Proposed FLC Architecture

Talking of the above mentioned figure, A general representation of the approach proposed in thiswork is depicted in Figure above. This illustration is quite straightforward and general. However, it clearly shows what are the input parameters of the FLC and also the one that returns asoutput.

4.1 PSO Optimization

PSO algorithm simulates the social behavior of groups ofanimals, such as a flock of birds to obtain optimal, or nearoptimal, solutions of a multi-variable objective function in a continuous exploration space. It is a population-based method in which a swarm of particles, i.e. a group of individuals whosepositions describe the candidate resolutions of the addressed problem, moves in the search space. The particle performance is based on its position and is estimated using a cost functionwhich depends on the considered optimization problem.The purpose of using Apache Cordova is to create applications that can run on both android and iOS platform with the same source code. The application is connected with the IBM MQTT server through a secure channel and a 2 factor authorization.

Steps in PSO algorithm can be briefed as below:

A. Initialize the swarm by assigning a random position.
B. Estimate the fitness function for each particle.
C. For each individual particle, compare the particle‘s fitness value with its pbest. If the current value is better than the pbest value, then set this as pbest and the current particle‘sposition, xi, as pi.
D. Identify the particle that has the best fitness value. This fitness function identified as gbest,
E. Revise the velocities and positions of all the particles using steps (1) and (2).
F. Repeat steps 2–5 until a sufficiently good fitness value is achieved.

4.2 PSO Control Parameters

Particle Swarm Optimization technique design is based on two important factors: Exploration and exploitation. The ability of search algorithm to explore various search space to locate good optimum solution is known as exploration and the ability to concentrate the search around promising area to find out a solution is called as exploitation. There must be perfect balance between exploration and exploitation and in order to achieve this firstly quick identification of regions in search space instead of spending time in region which are already explored or which do not provide high quality solutions and secondly exploitation of collected search experience to locate optimal solution. These two factors are very contradictory that’s why trade-off between these two objectives must be achieved for optimal solution. Particle in swarm fly into the search space by their exploration and exploitation capabilities and use local best and global best positions to reach the best solution in PSO. Variations in PSO are very necessary in order to improve speed of convergence and quality of solution. PSO has many control parameters like swarm size, inertia weight, neighborhood size, dimension of problem, number of iterations etc. These parameters are used to improve PSO performance.

4.3 Velocity Clamping

This phenomenon was introduced to avoid a phenomenon known as swarm explosion. With no restriction on the maximum velocity of the particles, a simple one-dimensional analysis of the swarm dynamic concludes that the particle velocity can grow unbounded while the particle oscillates around an optimum, increasing its distance to the optimum on each iteration. To control global exploration, velocity clamping is necessary. For that purpose, it’s important to set some limit for the velocity of particle so that it will remain in the search area.

4.4 Inertia Weight

Inertia weight plays an important role in the process of providing balance between exploration and exploitation. Main purpose of inertia weight is to control the initial velocity. It determines contribution of previous velocity to the current step’s velocity. Basic PSO doesn’t have any inertia weight. The momentum of particle is controlled by it by weighting the contribution of previous velocity

5. IMPLEMENTATION & WORKING NS2 SOFTWARE

Ns are a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks.

Ns began as a variant of the REAL network simulator in 1989 and have evolved substantially over the past few years. In 1995 ns development was supported by DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. Currently ns development is support through DARPA with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI. Ns have always included substantial contributions from other researchers, including wireless code from the UCB Daedelus and CMU Monarch projects and Sun Microsystems. For documentation on recent changes, see the version 2 change log.

5.1 .Broadcast

In a broadcast, the source node discovers all possible neighbors that route to the destination. The routing protocol is responsible for initiating broadcast that is routed to the appropriate destination.

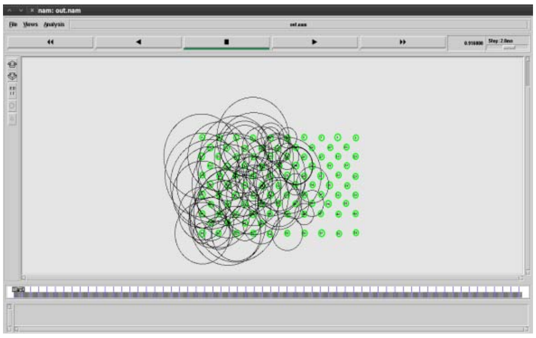

Figure 2: Screenshot of Broadcast

5.2 Transmission

Illustrates the data transmission from the source node to the destination through the selected neighbors. The nodes relay packets using TCP/ UDP in the path formulated by the routing protocol.

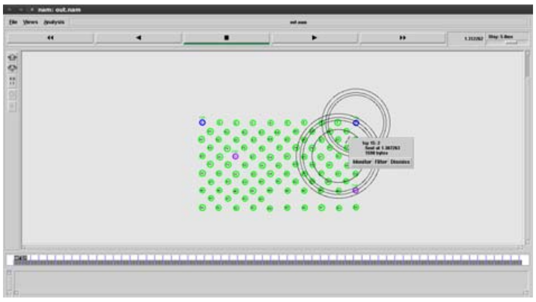

Figure 2: Screenshot of Transmission

5.3 Energy Drain State

Figure above illustrates the node's half energy level state. If a node's energy drops to half its initial energy, then it is said to be in half dead state.

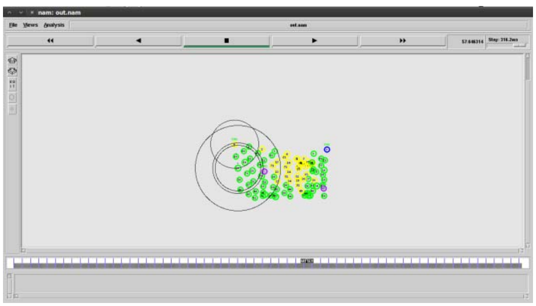

Figure 2: Screenshot of Energy Drain State

5.4 Throughput Graph

Illustrates the throughput observed with the increasing node density. As the number of nodes increases, the number of links associated with the nodes increases, facilitating maximum availability that increases data transfer rate.

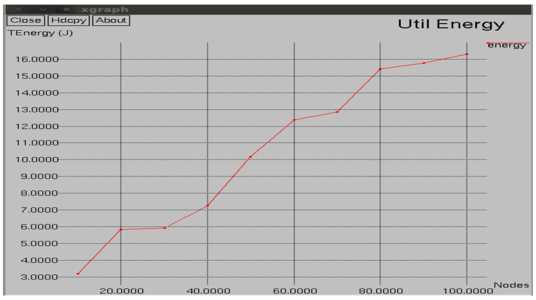

Figure 2: Screenshot of Throughput Graph

5.5 Energy Graph

Illustrates the energy consumed by the nodeswith the varying density. As number of nodes increases, the operations experienced in the network increases. This required additional energy and thereby demanding

6. SOFTWARE DESCRIPTION SIMULATOR USED :NS2

Ns are a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. Information directly into a web-based payment form, which you can then use to process an electronic transaction.

Ns began as a variant of the REAL network simulator in 1989 and have evolved substantially over the past few years. In 1995 ns development was supported by DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. Currently ns development is support through DARPA with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI. Ns have always included substantial contributions from other researchers, including wireless code from the UCB Daedelus and CMU Monarch projects and Sun Microsystems. For documentation on recent changes, see the version 2 change log. NS was built in C++ and provides a simulation interface through OTcl, an object-oriented dialect of Tcl. The user describes a network topology by writing OTcl scripts, and then the main NS program simulates that topology with specified parameters

7. CONCLUSION

In this work, a fuzzy-based approach to deal with theproblem of energy consumption in Industrial Wireless SensorNetworks has been presented. The suggested solution providesthe possibility to obtain the optimal values and parametersof the proposed Fuzzy Logic Controller, i.e. optimizing themembership functions, by varying their range, to achieve thebest results concerning the battery life of sensor nodes, byusing a Particle Swarm Optimization algorithm. This work offered a deep analysis for the configuration of the FLCassisted by the PSO to obtain the one that achieves the bestperformance. The work also has provided extensive simulative assessments, regarding the energy utilization, throughput and delay with overhead.

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