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A RUN TIME SELF HEALING ALGORITHM FOR NODE FAILURE

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ABSTRACT

The need for monitoring devices increases day by day due to the evolution of smart low powered sensors and controllers. Wireless sensor network comprises of several wireless nodes with low powered sensors attached to them. Wireless Sensor Network (WSN) covered a large area with advancement in antennas and used in applications like applications such as structural health monitoring, Patient or elderly people care, environmental monitoring and biochemical monitoring. The user administers the system employed for the application. The system is user-friendly, and no technical expertise is required. In wireless sensor network, node discontinuity is a major drawback. In time, critical applications such as in nuclear power plant the node discontinuity may lead to hazardous conditions. .Such discontinuity in communication between nodes can be eliminated by the self-healing Method. Turbo coding and game theory mechanism was implemented in proposed framework to avoid network failure in the WSN network.

Keywords:self-healing,Turbo coding,sensors, Game theory

INTRODUCTION

Wireless sensor networks are designed to collect the information about the environment and send the collected data to the central node through wireless communication. WSN consists of many nodes, which possess different sensors to monitor the deployed environment. The development of micro electromechanical system leads to the development of small, less power consuming sensors that leads in increasing the lifetime of the node. WSNs nodes consist of inbuilt processor unit, which helps, in distributed processing and to compute power. The WSNs are developed to monitor structural health, medicinal helps like patient monitoring using GPS and accelerometers, total body monitoring like ECG, temperature monitoring, wildlife surveillance and ecological monitoring.

These networks are utilized in major instances from urban to rural with various requirements and assets. The WSN network is mostly portable and also should be adaptable to the environment changes because most of the clients utilizing WSN applications are non technical. So the nodes in the network should forecast every change and adapt to the present environment. Some applications like human health monitoring mostly depends on the patient so the node should be error free and long lasting. Wireless sensor network is a combination of various system interfaced to the particular environment. The systems in the network provide different information, which are integrated to form a data of the physical environment. The collected data portrays the current information of the physical substances. These substances may be a place or a person or a task to which the application is installed to generate a result for its client. Many systems are interconnected together to monitor the physical environment of the user.

EXISTENCE

The existing work shows a centralized manager node which was placed. Before the sink node which control and monitor the behavior of the nodes placed in the network. The managing node regularly transmits queries to other nodes in the network to collect information about the nodes to predict the occurrence of a failure in the network. If the centralized manager node is placed outside the network, then the nodes in the network will spend extra power to transfer the information to the managing node. Moreover, the sink node performs a maximum operation to maintain the network by passing information's of network to managing node and perform the healing operations The introduction of centralized management provides healing of network but also generates overhead and other network limitations in the system. If the centralized manager node is placed outside the network, then the nodes in the network will spend extra power to transfer the information to the managing node. Moreover, the sink node performs a maximum operation to maintain the network by passing information's of network to managing node and perform the healing operations The introduction of central The introduction of centralized management provides healing of network but also generates overhead and other network limitations in the system.

DRAWBACK OF EXISTING MODEL

- Lesser the packet splitting greater the Signal to Noise ratio.
- It produces overhead and other network limitations.
- When network size increases energy consumption also increases.

PROPOSED MODEL

1. **TOOLS USED**
2.
    - **UBUNTU 12.4**
      Ubuntu releases are made semi annually by canonical limited , the developers of the ubuntuu operating system, using the year and month of release as aversion number.
    - **NS2 STIMULATOR**

      NS is a name for a series of discrete event network simulators, specifically NS 1,NS2, NS3, NS4.All are discrete event computer network simulators.They are written in c++ and Python.

NAM ANIMATOR

Nam is a TCL/TK based animation tool for viewing network simulation traces and real world packet traces. NAM began at LBL. It has evolved substantially for the past few years. It supports topology layout, packet level animation**.**

❖ X GRAPH PLOTTER

X graph is a general purpose xy data plotter with interactive buttons for panning, zooming, printing and selecting display options. It will plot data from any number of files on the same graph and handle unlimited data set sizes and any number of data files.

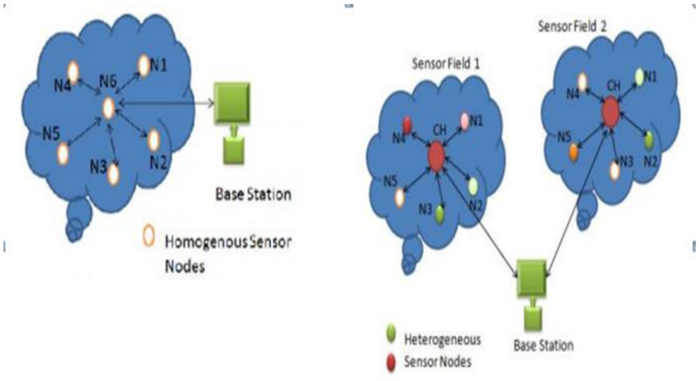
❖ VMWARE WORKSTATION

Vmware workstation is a hosted to hypervisor that runs on x64 versions of window and linux operating systems, It enables the user to setup virtual machines on a single physical machine and use them simultaneously along with the assumption.

DISTRIBUTED WIRELESS SENSOR NETWORKS

Sensor nodes in an open environment regularly sense the physical and environmental changes and transmit the information to the centralized server called a gateway. The computational rate and interaction of sensor nodes with the physical environment is different for different nodes in the network. In real time, sensor nodes are more constrained in its computational energy and storage resources.

The sensor nodes are intelligent to observe an extensive diversity of ambient circumstances that includes flow, temperature, pressure, humidity, moisture, noise levels, mechanical stress, speed, etc. Many novel applications are being developed due to the new concept of micro sensing and wireless networking for these smart sensing devices. Some of the possible assorted applications of WSN 's are temperature control, inventory management, physiological monitoring, habitat monitoring, precision, agriculture, forest fire detection, nuclear, chemical, and biological attack detection, military, transportation, disaster relief, and environmental monitoring.



SELF HEALING IN WIRELESS SENSOR NETWORKS

The concept of a self-healing framework for sensor reading faults and its requirements in order to understand the faults that need to be detected and how the system needs to adapt to the faults are formalised. Values received from sensing devices are subject to transient or permanent faults due to environmental factors such as interference that distorts the observed attribute, electronic fouling of a sensor's circuitry, physical damage or deterioration of quality due to low energy levels of nodes. Consequently, the sensor's observation, $d_\sigma(x, t)$, at the time instance t of an attribute modelled as a random variable X, will be the ground truth, $g(x, t)$, plus a random error factor, $\sigma(x, t)$, as illustrated in equation (1)

$$D(x,t) = g(x,t)+ , \sigma(x, t)$$

The goal of a self-healing framework is to minimize the error factor, $\sigma(x, t)$, in order to approximate the ground truth as accurately as possible. Hence, the reading from a sensor, where the ground truth value is $g(x, t)$ at time instance t, becomes the approximation function $\mu(x, t)$, dependent on variables x and t. The error factor is affected by both transient and permanent faults on sensors. A transient error is a random deviation from reality that does not deteriorate the state of the sensor. Instead, it only affects the input temporarily. A permanent error is an error that the sensor cannot recover from and has an effect on all subsequent readings, unless corrective measures are taken. A typical approach in the literature to reduce transient errors, is model-based correction, where the expected behaviour of observed attributes in the environment is formally represented as a mathematical, probabilistic or heuristic, rule-based models. This approach provides an estimate of the input values based on a-priori knowledge of the observed subject by correlating readings in time, which constitutes a prediction model. Figure 3.1(a) illustrates this approach, where transient errors in a sensor distort the ground truth. The observed value, $d_\sigma(x, t)$, is subject to errors. The estimated value of the system, $\mu(x, t)$ is a composition of the observed and expected, $e_\sigma(x, t)$, values. Assuming a linear combination of the two values the error correction unit would produce and update parameters α and β in equation 2. The expected value is generated by the data prediction unit that uses the attribute model with recently observed values to produce its estimation.

$$\mu(x, t)= \alpha d(x,t) + \beta\, e_\sigma(x, t)$$

In cases where multiple sensors are available, cooperation in a neighborhood can be employed to reduce errors. The process, known as information fusion is illustrated in figure 1.4 (b). Observations from a group of sensors are aggregated in the fusion point, where they are combined to produce the estimated value. The fusion function depends on the type of sensors involved – homogeneous sensors that monitor the same attribute, or heterogeneous sensors that monitor different but correlated attributes. In homogeneous groups the fusion function, $f_\sigma([xi/i \in S], t)$, is a combination formula among participating nodes in set S. For instance, majority voting for binary random variables or an averaging formula for continuous random variables. Such schemes can be enhanced with weighted alternatives, where weights represent belief in the sensor's quality or degree of relevance for the considered attribute. Homogeneous fusion is a case of explicit redundancy, where readings from defective nodes can be adequately replaced with readings from remaining nodes. In heterogeneous fusion there is instead an implicit redundancy of sensing devices, where different types of correlated sensors monitor different attributes of the same phenomenon. Loss of a sensor cannot be entirely compensated. Instead, remaining sensors produce a rough estimation of missing values and provide a potentially degraded but operational service. Finally, permanent, non terminal (fail-stop) errors may manifest over time in sensors and affect their accuracy. Such faults are commonly referred to as drift, i.e. deviation from ground truth, and are cumulative – the error increases over time amplifying the effect of previous errors. Collaborative on-line recalibration algorithm have been studied that use co-located nodes to construct a correction function, $\Delta_\sigma(x, t)$. By combining different fault correction components – model-based, collaborative and drift correction – the estimation function $\mu(x, t)$.

Parameters α, β, γ and δ are the weights for each component that represent the relative impact each observation estimation function has on the final result. A fault handling framework should allow deployment of such functions on the network nodes when necessary to maintain the quality of the monitoring service within acceptable levels. In set-ups where energy conservation is important, deployment of these functions is dictated by indications of fault manifestation. Hence, fault detection mechanisms for accurate identification of sensors' state are the first step for a self-healing pervasive systems. It should be noted that in our study we make the assumption of linear drift functions in order to simplify the modelling and our analysis. This assumption may not always be correct as drift may be exponential rather than linear in some cases, however this does not have a major impact on the framework. The correction function $\Delta_\sigma(x, t)$ would have to be modified to cater for the specific type of drift, but the models we present in the thesis are still relevant.

Distributed Fault Detection

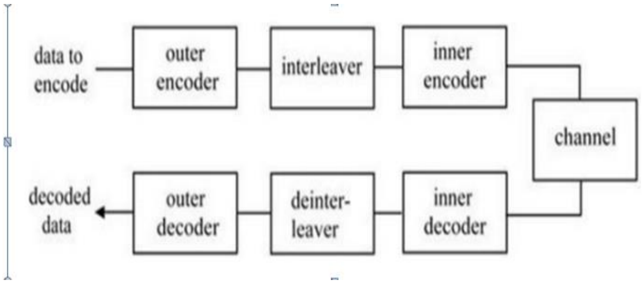
Centralised solutions for fault monitoring and handling, where performance metrics and signals are collected outside the network for analysis in a resource unrestricted environment, do not scale as the network size and complexity increase. This is mainly caused by increased communication cost due to relaying messages from remote locations of the network. Distributed solutions become more attractive in large-scale networks. However, even in a distributed environment there are alternatives for building the network structure and managing communications.

LOCAL DETECTORS

Local fault detectors can be applied for checking sensor features to validate readings with respect to a model of the attribute. Models are tied to the application and deployment usually by setting hard thresholds that define erroneous behaviour, e.g. the room temperature cannot exceed 42 ◦C. Such heuristic thresholds represent an expert's knowledge about the domain. Moreover, without external knowledge it is not feasible to assess whether a threshold has been exceeded due to a sensor malfunction or an unexpected event that renders the irregular value legitimate, e.g. a fire started in the room. Furthermore, fixed thresholds do not cope well with variable-state attributes, i.e. attributes that modify their behaviour over time. Additionally, large number of false positives that are typically yielded in local detectors are potentially more critical and expensive than the number of false negatives.

Local fault detectors inherently depend on the accuracy of monitored attributes models, assuming that a-priori knowledge exists. If this is not the case, it may instead confuse the system, decreasing overall quality. Moreover, local monitors are unable to handle unexpected behaviour that has not been foreseen when building the model. For instance, a model that restricts acceleration values of a sensor to those that can be achieved by a human, falls short when the user uses a vehicle that will increase sensor values. Nevertheless, local detectors are an initial, inexpensive detection step. They can operate even when a node has additional information from its neighborhood and are a first indication of fault appearances.

TURBO CODE IN WSN



Properties of the Turbo Code

1. Parallel concatenation is performed to generate simpler decoding.
2. Weight is distributed evenly using interleaver.
3. Soft decoding is used to increase the performance of the decoder and generates maximum gain in the decoded information.

Turbo Encoder

The turbo encoder is developed using parallel recursive systematic convolution (RSC) encoders. The convolutional codes are represented using two identifiers they are r, code rate and k, constraint length. The k denotes the length of the convolutional encoders. The number of input bits and the output bits concentrates on the constraint length value. The K value is denoted as

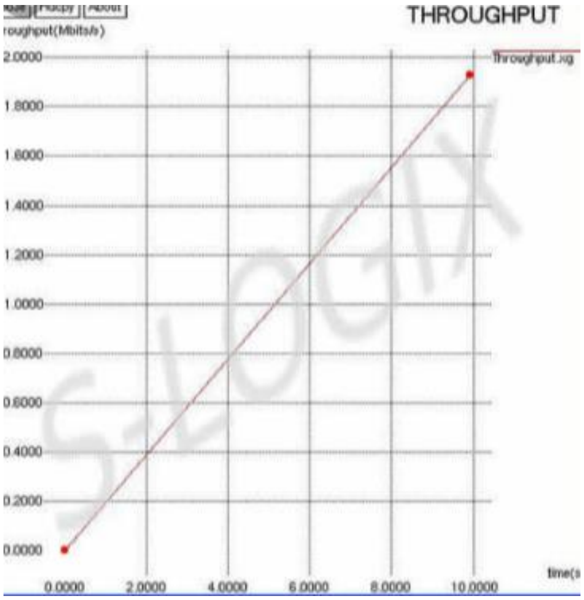
$$K = m+1$$

Where m is the levels in shift registers. The shift register stores the information's of the states of convolutional system and the k value provides the number of steps to be performed.

The RSC encoder's posses shorter k values to reduce the complexity of decoder process. The RSC encoders are placed in the rate of r=1/2 and each encoder is separated by an interleaver module. The output of the turbo encoder posses systematic data and the parity outputs of the two RSC encoders. The systematic outputs are not used because both the outputs are similar in nature. Thus the rate of the RSC encoder becomes r=1/3. The first RSC encoder outputs the systematic result, c1 and the convolutional result, c2 but the second RSC encoder drops the systematic result and generates only the convolutional result, c3. The figure shows the turbo encoder were

1. R1 and R2 are code rates of RSC 1 and the RSC 2. Were the RSC1 and RSC2 be 1/2. The overall code rate will be written as R=1/3.
2. By comparing the RSC 1 and the RSC2 code rate we achieve R1=R2=2/3 and the overall code rate becomes 1/2.
3. Non linear interleaver is preferred to this process. The size of the interleaver M is not predictable.

RESULTS



CONCLUSION

The proposed model increases overall performance of network and thus the signal to noise ratio can be reduced. Hence the total quality of service is increased. It will have more scope in future because of increased throughput, packet drop ratio, delay and power consumption.

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