GPS BASED CLOCK SYNCHRONIZATION FOR WIRELESS SENSOR NETWORKS

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Introduction

Wireless Sensor Networks assume that local clocks at each sensor node that need to be synchronized to a common notion of time. Some intrinsic properties of sensor networks such as limited resources of energy, storage, computation, and bandwidth, combined with potentially high density of nodes make traditional synchronization methods unsuitable for these networks (). Currently, Reference Broadcast Synchronization (RBS) is used to synchronize the clocks in a wireless sensor networks. In that method, an initiator broadcasts a reference message to urge the receivers to adjust their clocks. In order to maintain an accurate time, each node should listen to that message continuously. This involves idle listening within the network and leads to energy wastage. This additional power consumption leads to lower performance of network nodes which may cause inaccurate time stampings as the time passes on. Idle listening also leads to CPU time waste. It has direct impact on network performance. Not only that, in wireless communication, extraction of data from far distance sensor is inefficient due to power consumption. A lanog-term evaluation of several off-the shelf GPS timing receivers (H¨ochtl and Schmid, 1997) revealed spurious 1pps omissions and errors due to certain receiver technologies. Furthermore the dependability upon a single system seems questionable for critical real-time implementations. Hence GPS is great when complemented with other technologies (Ver´issimo et.al., 1997). The external time obtained from GPS satellites into broadcast-type LANs with a software-based approach with accuracies in the 10s range. Even smaller precisions can be achieved if a separate fully connected clocking network is used. In this paper we propose a Global Positioning System (GPS) based clock synchronization method for sensor networks.

Materials and Methods

In this work, we concentrate on synchronizing clocks in nodes of the sensor networks. In order to provide accurate time management GPS receivers are used.

GPS Based Clock Synchronization

In general sensor network architecture consists of RF Receiver, Micro Controller, Battery, Sensor and an Analog to Digital Converter (ADC). We propose to extend this architecture by incorporating a GPS Receiver in order to obtain more accurate time information and the position of sensor nodes. Except the base node, every other sensor node is powered with a GPS receiver. The extended sensor node architecture is extended by incorporating a GPS Receiver as shown in Fig 1.

In the proposed architecture, each node in the network consists of a GPS In the proposed architecture, each node in the network consists of a GPS receiver. Therefore, it is not necessary to have a message passing mechanism for adjusting their local clocks. This results in eliminating the message passing overhead and conserving energy.

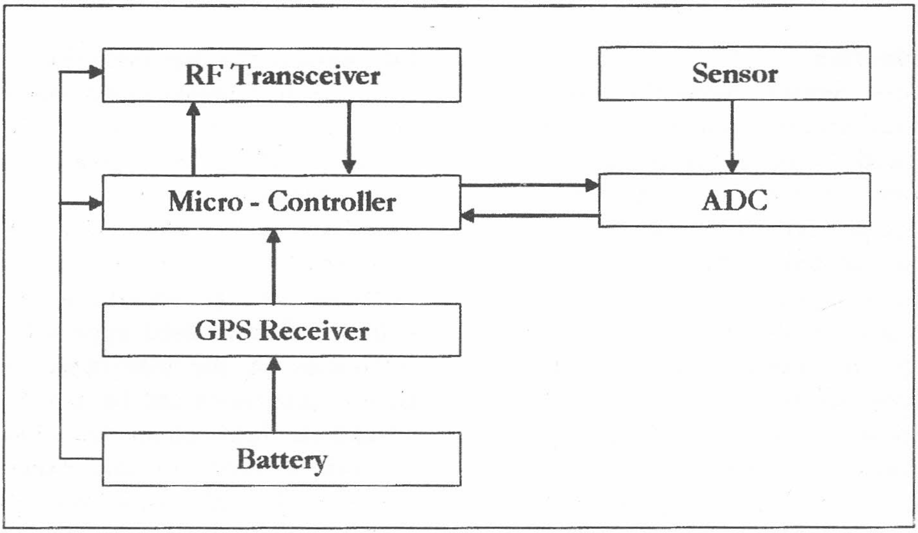

Fig 1. Proposed Sensor Node Architecture

Usually, the base node is not battery powered and wired power is used for the base node functionality. However, if needed, either it can also be connected with this GPS system via a GPS receiver or it is possible to connect it with a time server. GPS based Wireless Sensor Network system is depicted in Fig 2.

Results and Discussion

In the proposed GPS based sensor network, each node can manage its time independently, because it has a GPS receiver. Additionally synchronization errors could be reduced. Since nodes can adjust there clocks without passing messages among nodes, energy can be conserved. Other advantages of the proposed system include: the distance among nodes will not be a limiting factor in synchronizing clocks and GPS devices provide accuracy within few nanoseconds. Although the proposed method facilitates accurate clock synchronization, its cost might be high and the GPS coverage may not be available for all parts of the world.

Conclusion

The proposed solution uses GPS devices and, therefore, it facilitates accurate time management. Since each node in the network consists of a GPS receiver, clocks can be synchronized without a message passing mechanism. The proposed solution is more appropriate for small and moderate size wireless networks due to the cost factor.

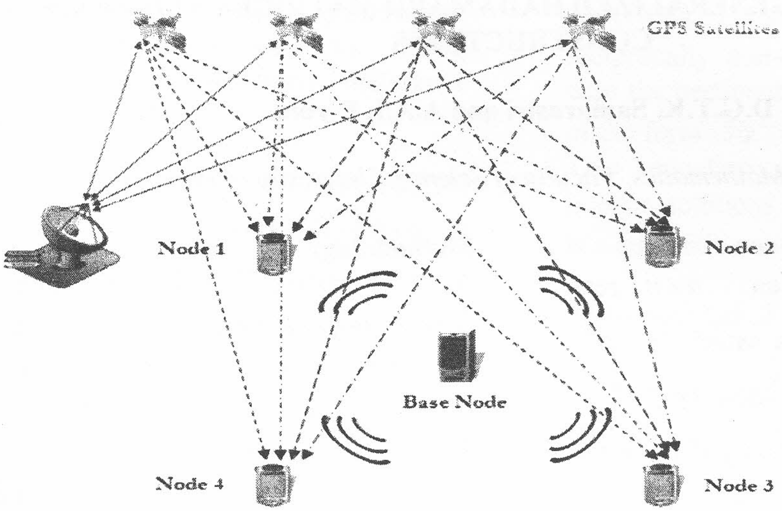

Fig 2. Complete Design Architecture of GPS Integrated Wireless Sensor Network

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