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Reduce Energy Consumption and Improve Performance in Wireless Network Control System

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ABSTRACT
The communication system design for a WNCS requires guaranteeing the performance and stability of control system, with the limited battery resources of sensor nodes, despite the unreliability of wireless transmissions and delay resulting from packet transmission and shared wireless medium. The key parameters that need to be considered by both control and communication systems are the packet error probability, delay requirement and sampling period of the sensor nodes in the network. In this paper we proposed a new model for the wireless network controlled system and improve the performance of network using enhancement on performance parameter.

Keywords: Wireless sensor-actuator networks, Wireless networked control systems, OFE, USR, SFDM.

INTRODUCTION
WNCSs are spatially distributed control systems in which sensors, actuators and controllers communicate through a wireless network. The usage of wireless communication in control systems results in low cost and flexible network architectures by decreasing the cost of the installation, modification and upgrade of the system components compared to their wired equivalent [1]. Wireless networked control systems (WNCSs), in which physical elements (plants, sensors, controllers, and actuators) communicate via wireless networks, have received increasing research interests. WNCSs have a wide spectrum of applications in mobile sensor networks, remote surgery, intelligent transportation, unmanned aerial vehicles, mobile robots, and so on [2].

The scheduling algorithms of WNCSs have been studied for event-triggered controllers acting in response to spatially distributed time-triggered sensor nodes. The main challenge in the scheduling algorithm design is the exploitation of the periodic transmission nature of the sensor nodes in meeting the contradicting requirements and capabilities of the control and wireless communication systems: The strict timing and reliability requirements of control systems should be met by the wireless communication systems that introduce non-zero packet error probability and non-zero delay at all times. Previous work however either did not exploit the periodic nature of the sensor node transmissions or adopted the algorithms designed for the scheduling of the periodic controller tasks running on a processor to WNCSs without considering the wireless communication imperfections [4].

A major technological concern in wireless networked systems is the power consumption of sensors equipped with small batteries. Transmitting measurements too often, as is normally the case in today's digital control systems, can drain the energy reserves of a battery-driven sensor in a few hours. New control theoretical advancements on this front have started to appear in the literature, inspired by the seminal work on event-based control by. Several techniques have been proposed providing suitable closed-loop performance guarantees , dealing with decentralized systems, network effects , and being experimentally validated. In particular, the work of and its follow-ups aims at reducing communication by proposing an a periodic control scheme. While in a traditional sampled-data paradigm new measurements and controller updates are performed periodically, regardless of the state of the plant, this new a periodic paradigm is based on events triggered only when stability or a pre specified control performance are about to be lost. Moreover, there is a strong effort to provide adequate communication protocols for wireless control [5].

Communication system design for networked control systems has received little attention in the literature mainly due to the difficulty of formulating the impact of communication on the control performance. Assuming no packet error of a network, some scheduling algorithms optimize the sampling interval and delay parameters of the sensors to minimize the overall performance loss while ensuring network schedulability [6].

The most common power source for a sensor node is battery, which can either be replaced or recharged based on the situation where it is deployed. The limited battery supply constraints led many researchers to develop alternate energy provisioning mechanisms by utilizing ambient energy [5–9]. By harvesting ambient energy, a sensor network can have near perpetual operation. However, there exist limitations to energy harvesting based approaches as there might exist scenarios where a node suffers from limited harvesting opportunity than its power requirements [12].

A Wireless HART network supports two types of routing approaches: source routing and graph routing. Source routing provides a single directed path for routing from a source to a destination device. Graph routing involves a routing graph consisting of a directed list of paths between the two devices, and is adopted for enhanced end-to-end reliability. In graph routing, packets from field devices are routed to the Gateway through the uplink graph. To every field device, there is a downlink graph from the Gateway. The end-to-end communication between a source (sensor) and destination (actuator) happens in two phases. In the sensing phase, on one path from the source to the Gateway in the uplink graph, the scheduler allocates a dedicated slot for each device starting from the source, followed by allocating a second dedicated slot on the same path to handle a retransmission. Then, to offset failure of both transmissions along a primary link, the scheduler allocates a third shared slot on a separate path to handle another retry. Then, in the control phase, using the same method, the dedicated links and shared links are scheduled in the downlink graph of the destination [10].

The rest of this paper is organized as follows in the first section we describe an introduction of about the Wireless networked control systems. In section II we discuss about the Joint optimization. In section III we discuss about the comparative result study using optimal solution with utilization based space reduction techniques for the Wireless networked control systems, finally in section IV we conclude the about our paper which is based on the literature survey and specify the future scope.

II JOINT OPTIMIZATION

The optimization problem formulations for WNCSs mainly aim to address the trade-off between the energy consumption of the wireless communication and the performance of the control system the energy consumption of sensor nodes in the wireless network is minimized subject to the stability and performance requirements of the control system, whereas [1] maximize the control system performance subject to the packet loss probability of wireless links and/or the energy constraints of sensor nodes. However, these studies mostly assume a constant packet loss probability over wireless links and fixed energy consumption per packet transmission without analyzing their dependency on the transmission power and rate of the sensor nodes, and the scheduling of sensor node transmissions.

The joint optimization of controller and communication systems taking into account all the wireless induced imperfections and the parameters of both the wireless communication system and the control system has been studied in [1] with the objective of minimizing the power consumption of the communication system guaranteeing the performance and stability of the control system and the schedulability in the communication system for MQAM modulation scheme. In this paper, our goal is to extend this study by generalizing the optimization problem for a wide range of objectives and modulation schemes satisfying certain properties and propose a general solution method that can be applicable for the studied generalized optimization problem.

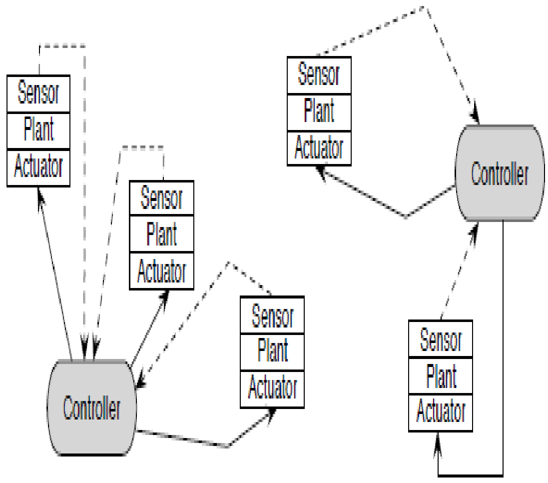

Fig 1: Overview of the WNCS architecture [3].

III EXPERIMENTAL RESULT ANALYSIS

In this paper we propose two optimization algorithms based on a search space reduction technique that exploits the utilization concept used in real-time scheduling, energy consumption dominance relations of the constellation size of each sensor node and smart searching technique that proceeds by evaluating the feasibility conditions and objective function of neighboring constellation size vectors. These search space reduction technique based heuristic algorithms decrease the complexity of the optimal algorithm significantly while keeping the performance very close to optimal.

Here we compare three different methods such as OFE (Optimal solution), USR-SFDM (Utilization based space reduction-Seek Feasible Degrade Minimum) and USR-OF (based space reduction-Optimal solution with optimization function) Methods. And our proposed methods shows better result than existing techniques.

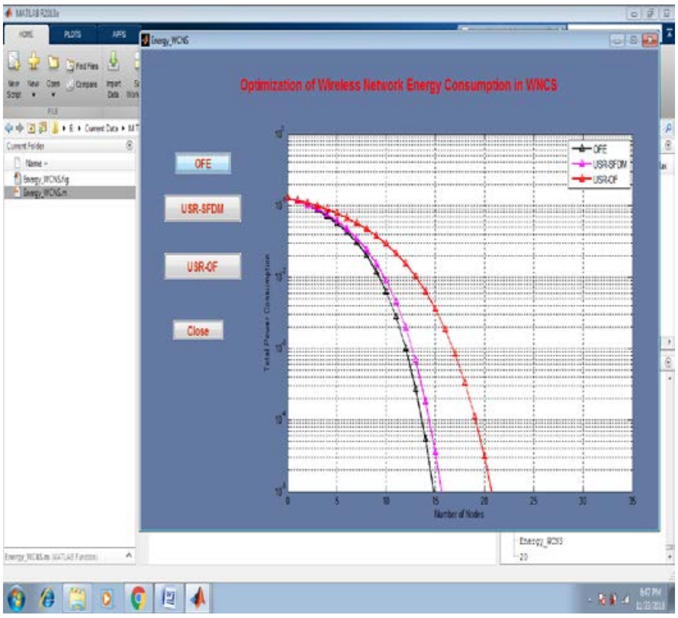

Fig 2: This figure shows the results window for using OFE (Optimal solution) Methods.

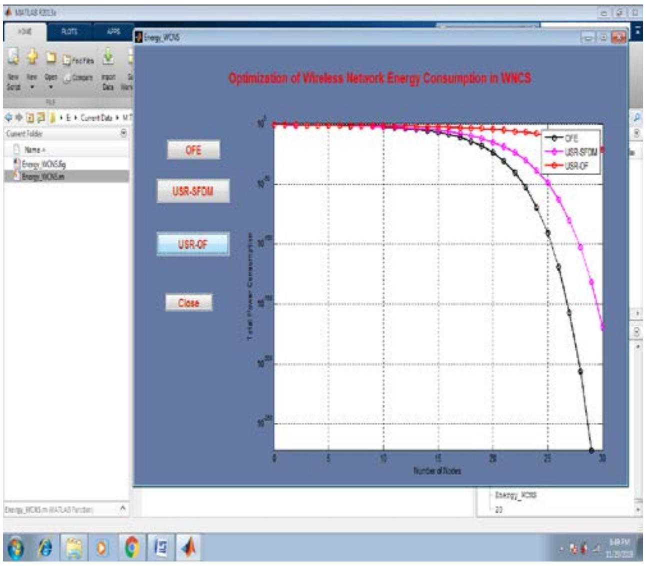

Fig 3: This figure shows the results window for using USR-OF (Optimal solution with optimization function) Methods.

IV CONCLUSIONS AND FUTURE WORK

A wireless control system comprises feedback control loops connecting sensors, controllers and actuators through a wireless mesh network. Sensors measure variables of the plant and send the measurements to a controller over the wireless mesh network. The controller then sends control commands to the actuators in order to control the physical processes. Industry plants pose harsh environments for wireless communication due to significant channel noise, physical obstacles, multipath fading, and interference from coexisting wireless devices. In this paper we improved the energy and reduce power consumption in wireless sensor network in near future we also using some optimization methods for the energy improvement.

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