

The State-of-the-Art of the Applications of RTS in Various Areas: A Survey

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Abstract

A real-time system is required to complete its work and deliver its services on a timely basis. A system is said to be real-time if the total correctness of an operation depends not only upon its logical correctness, but also upon the time in which it is performed. Malfunctioning of some real-time systems can have serious consequences. We want such systems to work correctly and responsively. This paper comprehensively discusses applications of RTS. Real-time systems are used commonly in digital control, optimal control, command and control, signal processing, telecommunication system, tacking, real-time databases, multimedia, etc. Traditionally, real-time communications are used in hard and soft real time applications running in distributed process control applications such as power plants, avionics, chemical process control, automobiles, etc.

Keywords: *RTS, logical correctness, hard and soft RTS.*

INTRODUCTION

A real-time system is any information processing system which has to respond to externally generated input stimuli within a finite and specified period. A real-time system is required to complete its work and deliver its services on a timely basis.

Every day these systems provide us with many important services. Unlike PC's and workstations that run non real-time applications, the computers and networks that run real-time applications are often hidden from our view.

A system is said to be real-time if the total correctness of an operation depends not only upon its logical correctness, but also upon the time in which it is performed. Real-time systems, as well as their deadlines, are classified by the consequence of missing a deadline:

- **Hard** – missing a deadline is a total system failure.
- **Firm** – infrequent deadline misses are tolerable, but may degrade the system's quality of service. The usefulness of a result is zero after its deadline.
- **Soft** – the usefulness of a result degrades after its deadline, thereby degrading the system's quality of service.

Thus, the goal of a hard real-time system is to ensure that all deadlines are met, but for soft real-time systems the goal becomes meeting a certain subset of deadlines in order to optimize some application-specific criteria.

When real-time systems work correctly and well, they make us forget their existence. Malfunctioning of some real-time systems can have serious

consequences. We want such systems to work correctly and responsively. Hence it is essential to validate the real-time systems.

Application areas:

Real-time systems are used commonly in digital control, optimal control, command and control, signal processing, telecommunication system, tracking, real-time databases, multimedia, etc.

In a real-time digital signal processing (DSP) process, the analyzed (input) and generated (output) samples can be processed (or generated) continuously in the time it takes to input and output the same set of samples independent of the processing delay. It means that the processing delay must be bounded even if the processing continues for an unlimited time.

Traditionally, real-time communications were used in hard and soft real time applications running in distributed process control applications such as power plants, avionics, chemical process control, automobiles, etc. However, the current advancements in communication technologies has made it possible for supporting applications in many different areas such as : video broadcasting and

applications on the Internet such as banking, stock trading, e-commerce, etc.

Focus of the study in RTS:

The study in this area can make one a better judge of the accuracy of the models. More specifically it is about the study of the characteristics of the workload generated by the applications and the relation between their timing and functional requirements.

RELATED WORK:

With the advancement of RTS, the solutions to many problems in several areas are obtained either as soft RTS or hard RTS. The schedulability notion can meet theoretically solutions to many real time problems. Below we present some such major areas where the applicability of RTS has made its stamp.

1. Wireless Networks:

In the past years, the adoption of wireless networks in industrial distributed control systems has been progressing slowly, mainly because of the intrinsic unreliability that affects the ether, making wireless communication unable to address the (often hard) real-time requirements characterizing these applications. Indeed, data delivery among sensors/actuators and controller devices typically has to occur

within specific time-intervals, in order for the implemented monitoring /supervising /control applications to work as expected [1].

The effect of data transmission and retransmissions centralized scheduling to combine reliability and timeliness and increase the overall delivery success probability in presence of errors is studied in [2]–[4]. A dedicated node (coordinator) is responsible for scheduling time-critical data transmissions by sending a request packet to the source nodes. Upon reception of a request packet, the source transmits the updated value (instance) of the required time-critical datum to the destination via a data packet.[1]

2. Sensors:

Different sensors have been used to perform human action recognition. These sensors include conventional RGB cameras, e.g. [5]–[7], depth cameras, in particular Kinect, e.g. [8]–[11], and inertial sensors, e.g. [12]–[14]. Kinect is a low-cost RGB-Depth camera sensor introduced by Microsoft for human-computer interface applications. It comprises a color camera, an infrared (IR) emitter, an IR depth sensor, a tilt motor, a microphone array, and an LED light. Collaborative representation classifier

(CRC) is a computationally efficient classifier that has been used in many image classification applications. [15].

For real-time operation, it is necessary to identify the start and end of an action. Action segmentation is a challenging task. In [16], the author has discussed real-time marker-based visual sensor architecture for mobile robot localization and navigation. Hardware acceleration architecture for post video processing system was implemented on a field-programmable gate array (FPGA).

3. Virtualization & Cloud computing:

With the prevalence of cloud computing and virtualization, more and more cloud services including parallel soft real-time applications (PSRT applications) are running in virtualized data centers. However, current hypervisors do not provide adequate support for them because of soft real-time constraints and synchronization problems, which result in frequent deadline misses and serious performance degradation. CPU schedulers in underlying hypervisors are central to these issues. In [18], author identifies and analyzes CPU scheduling problems in hypervisors.

Then, they designed and implemented a parallel soft real-time scheduler according to the analysis, named Poris, based on Xen. It addresses both soft real-time constraints and synchronization problems simultaneously. Authors have introduced priority promotion and dynamic time slice mechanisms to determine when to schedule virtual CPUs (VCPUs) according to the characteristics of soft real-time applications. Besides, considering that PSRT applications may run in a virtual machine (VM) or multiple VMs, they present parallel scheduling, group scheduling and communication-driven group scheduling to accelerate synchronizations of these applications and make sure that tasks are finished before their deadlines under different scenarios.

In [19], a new hybrid approach for providing control services from the cloud that can handle the essential communication locally in case of a broken cloud link is proposed. When using virtualised services from a cloud for industrial automation, such as a virtual PLC (vPLC) from a cloud [20], a seamless connection is required as the industrial devices require constant transfer of process data in both directions.

With the current technology, it is not possible to promise an unbroken seamless connection to the cloud because of numerous connectivity issues that current technology face. A solution to this problem is to have a middleware with local control, which could take over the virtualised service from the cloud for a short period of time while the connection is recovered.

4. Robotics:

Based on real-time Finite Element Method (FEM), [17] author obtain a globally defined discrete time kinematic model in the workspace of soft robots. From the kinematic equations, they deduced the soft-robot Jacobian matrix and discuss the conditions to avoid singular configurations. Also they proposed a novel observer based control methodology where the observer is built by Finite Element Model which deals with the control problem of soft robots. A closed-loop controller for position control of soft robot is designed based on the discrete-time model with feedback signal being extracted by means of visual servoing.

5. Avionics:

The modern flight control systems are complex since they have a non-linear nature. Also, modern aerospace vehicles

are expected to have non-conventional flight envelopes and, in order to operate in uncertain environments, they must guarantee a high level of robustness and adaptability. A Neural Networks controller can be used in applications with manned or unmanned aerial vehicles.

In [21], the author proposes the mathematical model for hexacopter dynamics and a comparison between two different technique for stabilization and trajectory control: proportional, integral, derivative controller and real time system controller based on Neural Networks.

Recently proposed approaches are based on soft computing techniques. Among these, Neural Network (shortly NN) controllers have been proposed as adaptive controller for nonlinear system applied simply based on observation and experience without a deep knowledge of the dynamical system.

LIMITATIONS:

In [17], it is said that if the simulation model is highly imprecise, for example to deal with the dynamic problem with the controller based on quasi-static model, the control performance maybe unsatisfactory and even unstable. So a more complex

control method is needed to increase the robustness and adaptivity of the controller.

FUTURE WORK AND CONCLUSION:

Based on the various applications above, the authors have made many directions open for the further work. As per [15], it has been proposed to examine specific applications of the fusion framework presented in the paper by using depth cameras and wearable inertial sensors that have recently become commercially available.

In [1], a framework for providing predictable levels of timeliness and reliability in data delivery over single-hop wireless sensor actuator networks, implementing soft real time industrial control applications, has been investigated. Extension to the multi-hop case is non-trivial and is left for future work. [19]

Author proposes that more work needs to be done to identify the safe state of the control system on the cloud. In addition, more work will also be conducted to reduce the latency to such a level that difference between using the local control system and not using it is negligible. This work also provides the basis for using the

control services from the cloud in a real-time environment.

In [22] author focuses on the connection between QoS and probabilistic deadlines in several application domains. Also extend analysis and the application of the methods to the case of applications based on multiple tasks and to the case of computation time that is not i.i.d.

[21] Future work concerns the optimization both of the neural network and the PID controller in order to maximize their performance even in presence of aerodynamic effects.

[23] Author states the need to extend the approach to heterogeneous HPC data centers, where servers may contain different types of processing cores.

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