THE ARCHITECTURE AND DESIGN OF PARALLEL PROCESSING FOR REAL-TIME MULTIPLEXING TELEMETRY DATA

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ABSTRACT

The parallel processing technology has been widely applied to many science and engineering technical fields, also to telemetry. In particular, telemetry develops towards the trend of large capacity, high rate, several data streams and programmable formats. This sets a still higher demand on processing for real-time multilexing telemetry data. On the basis of analyzing of the characteristics of telemetry data processing (TDP), the parallel processing conception and methods are adopted, countering multiiple-channel data streams of different objects, several architectures of parallel processing for real-time multiplexing telemetry data are presented. It makes better use of the concurrency during the process of TDP and handles the telemetry information effectively in every processing level of the whole telemetering information processing system. The paper shows the property comparison of these parallel processing architectures and main features too. Experiments have indicated that it is an economical and effective method to improve the performance of telemetry information processing system by using paralle processing architecture which is based on concurrency of telemetry data processing.

KEY WORDS

Parallel processing, Telemetry architecture, Real-time multiplexing telemetry data, Telemetry data processing(TDP)

INTRODUCTION

Real-time processing of telemetry data, as the key link of the telemetry information processing, its function is to

filter selected channel, reassemble fragmented words, merge several data streams and time, convert data stream picked up from the telemetry former sets, and to form the intuitional and meaningful data, chart or diagram, then send these measurements to relative systems and users respectively, in addition, to file and store the measurements in a storage device.

With the development of microelectronic and computer technology, modern telemetry technology is also developing towards the trend of large capacity, high rate, multiple-channel data streams, and programmable formats. This sets a still higher demand on the real-time processing of telemetry data. The characteristics of TDP—diversified tasks, strict correlationship between information and time, etc—demand the whole telemetry information processing system must be improved on the processing methods and hardware structure, so as to meet the development of telemetry technology.

On the basis of analyzing the telemetry data processing and adopting the conception and methods of parallel processing, countering the simultaneity and concurreny during data processing, this paper presents the hardware schemes which are satisfied with high rate data stream processing. By means of studying the processing methods of multiple-channel telemetry data, the structure of telemetry information processing is divided effectively. In the paper the main features and the property comparison of these parallel processing schemes are given.

CHARACTERISTICS OF TELEMETRY DATA PROCESSING

Just as digital signal processing modes are divided, the processing of telemetry data also includes sample processing, real-time processing and partial processing. The task of TDP is to process variouse data, such as slow time-variance parameter, fast time-variance parameter, binary data, event, time, switch pulse and tagging service data etc. With different methods of data compression, the above processing tasks can filter the corresponding data from the raw data and make engineering units conversion and perform floating operation and high-speed frequency analysis.

But if we think the whole course of a typical telemetery application system, TDP mainly includes real-time, quasi-real-time and post-event analysis and evaluation.

(1)Real-time processing refers to measuring the important flight data such as flight situation monitering and engine propelling status parameters. The meaningful data determining flight success or failure must be handled immediately. To get results of this processing timely and rapidly, we must adopt real-time processing and partial processing to improve the speed.

(2)Quasi-real-time processing refers to performing the TDP immediately after flight is over. Rapid processing is demanded but its timeliness is slightly worse than real-time. Thus we can adopt sample processing.

(3)Post-event analysis and evaluation processing refers to the overall, large and reliable data processing which can evaluate a flying vehicle comprehensively, we can adopt sample processing and partial processing.

Besides, TDP has the characteristics of strict correlation between information and time and diversification of the tested parameters. So the correlation must be maintained in the TDP. This also determine the versatility and complexity in the processing methods of telemetry data.

THE PARALLEL PROCESSING ARCHITECTURE OF REAL-TIME MULTIPLE-CHANNEL TELEMETRY DATA

In order to process the high-rate data streams, electronic components and minicomputers need developing more greatly and different level concurrency should be used in the architecture of real-time multi-channel TDP. They can gear up each other.

We know, as long as there are time-overlapping and concurrency, two or more tasks -- either the same or not -- can be finished in the same time or in a same intervel. Because the parallel processing is an important way in morden information processing and throughout the whole course of the processing, it deals with a wide range of fields such as algorithm, language, software and hardware. We can use parallel processing in the telemetry computer system and do arrangement of each task with hardware

architecture, so as to improve the concurrenlism of every task. This is also an effective way to improve the high-speed processing of real-time telemetry data streams.

1. The multiple-channel processing architecture on resource replication

This architecture, which give credit for large quantity of hardware, is a way to improve the processing speed of telemetry data greatly. In the whole course of TDP, we can deal with the different physical parameters in different way. It shows that the architecture is multiple-processing units and multiple-memory components, as shown in Figure 1.

As shown in the block diagram, the parallel output data from frame sync and word sync are put into the channel-selector simultaneously. Based on the channel position of physical parameters in the frame and sub-frame, the channel-selector can select the appropriate processing unit (altogether N units), finish the engineering-units conversion, display and store the meaningful data separately. The channel-selector is composed of multiple-channel switches, programable counters and control circuits. The processor is made up of intelligence processor or non-intelligence processor which has the same function.

This processing architecture based on resource replication has high processing speed, but its hardware system architecture is very complicated. The performance-price ratio of this TDP system architeture is lower unless the price of hardware reduces greatly. It is hard to competent the TDP of multiple-data streams.

2. The time-sharing processing architecture on resource sharing

If time factor is introduced to parallelism conception, the parallelism has concurrency. During the TDP, in accordance with the different characteristics of the slow or fast time-variance, speed binary, event, time, switch and pulse parameters etc., we can sort data, send them to the coresponding modules and handle with them. The processing architeture is shown in Figure 2.

In this structure, the output data from the sync and word sync pulse are fed to a memory buffer of time-sharing system. The different property measurement parameters are

delivered to the special unit of memory buffer. In the same time each slow-variance parameter processing module, fast-time variance parameter processing module, event, time, switch and work status parameters processing module and tagging service processing module are connected to the memory buffer through the high-speed bus. Then a distributed processing system are formed depending on less concentrated software, hardware and data. In fact, by diverging through the memory buffer, the speed of data which come into each module is decreased. The real-time processing of high-rate data streams can be realized. This kind of time-sharing processing structure on resource-sharing has such characteristics as high flexibility, presetable conversion parameter and compressing gate. But it demands large handling capacity and high speed memory buffer. Otherwise, when the multiple-data streams are lumped up together and tagging service is added into the data streams, the data stream capacity expand so it is easy to leave the memory buffer to be narrow-pass that restrict the module processing speed and handling capacity.

3. The pipeline processing architecture on time overlapping

In the light of the relative independence among the real-time processing tasks of telemetry data, we can divide the tasks according to their functions. A task can be devided into several contact parts by functions. In this architecture, each function module fulfils different task which don’t replicate in resource. Figure 3. is a principle diagram of the pipeline processing structure based on time-overlapping.

In this kind of structure, when we divide the grades of processing, we should make the accomplishment time of every grade close and decompose the function module by their processing time properly. In order to balance with each function module matchable, we can merge some modules with shorter processing time or decompose some module with longer processing time. At the same time, in order to work with the continous and stable data flow among the every function module in the processing architecture, we set up buffers between each module. For this kind of TDP structure to work continously and stably, it’s required that the high-speed data supplying capability of the buffer and the handling capacity of the pipeline be matched. So we adopt memory-sharing to communicate among modules.

This kind of pipeline processing structure has the advantages of excellent flexibility and simple hardware systerm structure. But its processing speed is lower than the two structures mentioned above. It suited to multi-data streams processing.

4. performance comparision to the three schemes

Table 1. displays the perfornamce comparison to these three schemes, the comparison is in general. We must adopt the corresponding structure to meet the particular TDP, different conditions, different telemetry application targets, different application occasions and the quantity of measurement parameters. We can put them together to improve the degree of parallelism greatly, thus make real-time multiplexing TDP more effectively.

CONCLUSION

This paper introduce three kind of real-time multiple-channel telemetry data processing (TDP) architectures; the multiple-channel processing struture based on resource replication, the pipeline processing structure based on time overlapping and the time-sharing processing structure based on resource-sharing. But they don’t repel one another. In modern telemetry computer system design, we can utilize them comprehensively to get the complementary effects.

Using parallel processing structure, we can easily make arrangement of the processing tasks with system architecture. Thus the parallelism of every task can be improve greatly. So the system has the property of high handling capacity and short response time. For its modularization design and standard interface, it is easy to expand and adopt the latest VLSI technology rapidly. So the systems performance-price ratio can be increased.

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Table 1. Performance Comparision. of Three Schemes

Structure Function	Multipl-Channel Processing Architecture	Time-Sharing Processing Architecture	Pipeline Processing Architecture
Realization Way	Resource Replication	Resource Sharing	Time Overlapping
Hardware System	Complex	Middle	Simple
System Flexibility	Bad	Good	Good
Function Modularization	Difficult	Easy	Easier
Processing Speed	Highest	Higher	High
Expanding Performance	Bad	Middle	Good
Several Data Streams Adaptability	Bad	Bad	Good

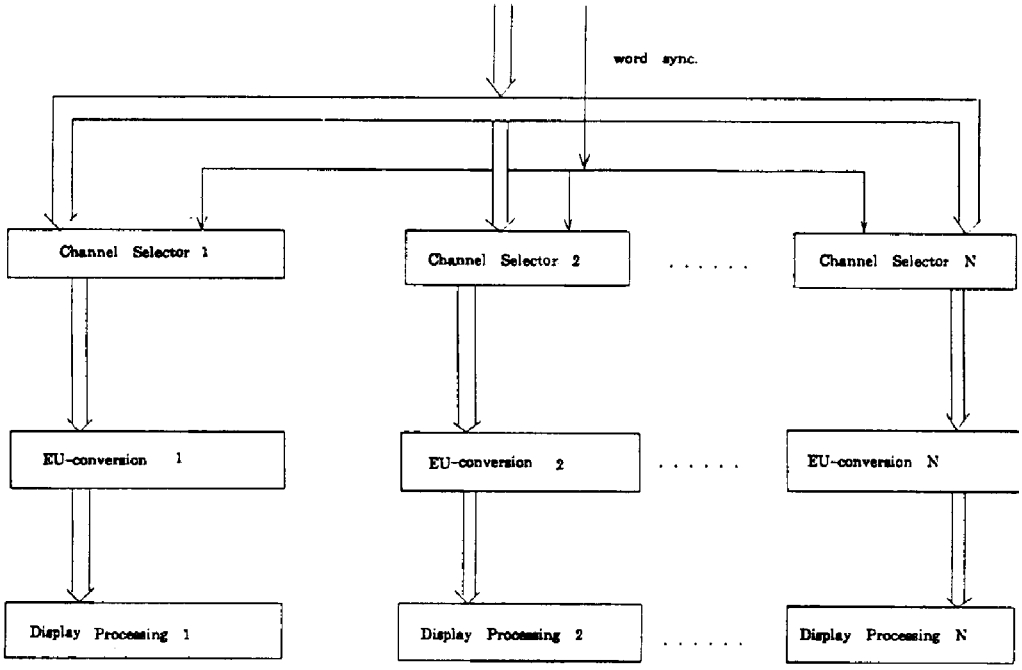

Figure 1. Multiple-channel Processing Architecture

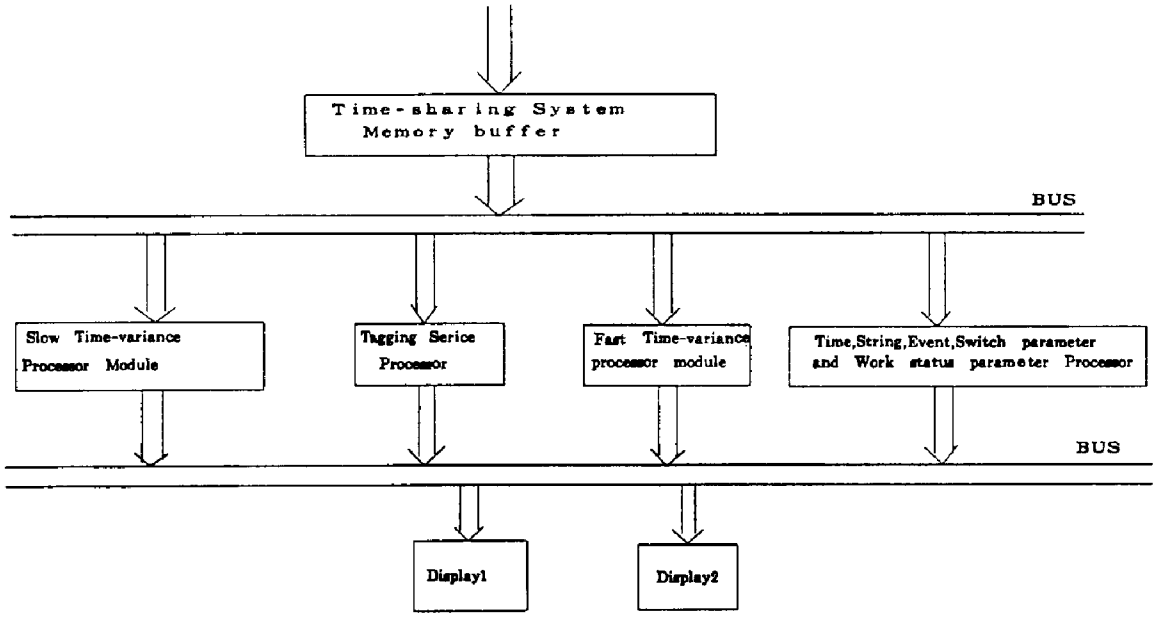

Figure 2. Time-sharing Processing Architecture

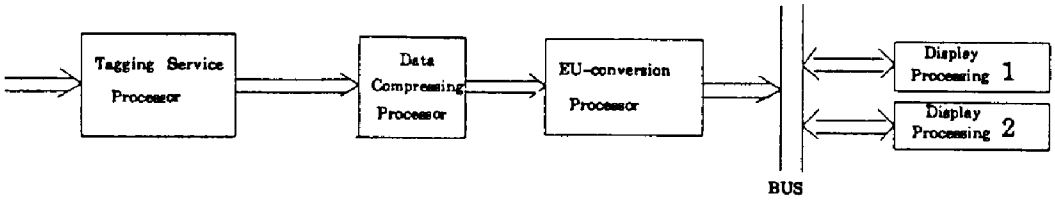

Figure 3. Pipeline Processing Architecture