Title

“Time Revising Robust Frequency-Voltage Cooperative Power Reduction for Multi-tasking Multimedia Applications”

Extended Abstract

Mobile applications, especially for cellular phones, need to satisfy the requirement for low power consumption keeping multimedia performance high enough. Thus software and hardware combined approach for low power becomes really important. One of such techniques is “frequency-voltage cooperative control (FV control)”[1][2][3] that lowers the MPU clock and core voltage at the same time when maximum execution speed is not necessary. FV control drastically decreases the power and energy consumption without sacrificing real-time feature because frequency and voltage contribute to its reduction by the order of three. This technique is suitable for moving picture processing which is one of main applications for 3G mobile phone, because its workload is various during execution. Also this technique is suitable for audio processing, because its processing has laxity time with maximum execution MPU speed. FV control can be applied to several levels, such as a whole application, a task, or a fragment of a program (application slice). We mainly develop an application slice level FV control with “Check Point Algorithm” because program structure can be used to control power more precisely[4][5]. In FV control based on program slices, where CPU changes its speed during program execution, timing constraints must be satisfied when such programs are running as multi-tasks.

Also, we implemented “Time Revising Robust FV Cooperative Control (TRR_FV)” and low power modes equipped to the MPU in cooperation. In the Time Revising Robust FV Cooperative Control under multi-tasking situation, each task observes its WCET(Worst Case Execution Time) and is scheduled to activate the next frame by the deadline. And Ready Watcher Task (Fig.1) manages a preemption time and a dispatch time of task to calculate task interruption time under multi-tasking situation, too. The Check Point Algorithm of the Time Revising Robust FV Cooperative Control revises a laxity time using the task interruption time calculated by the Ready Watcher Task, because the task interruption time disturbs a power control’s preciseness in the Check Point Algorithm. When there is the revised laxity time for the WCET, frequency and voltage are lowered. And when there is an idle time for the deadline, low power mode starts up.

We applied MP4 File Player to the Time Revising Robust FV Cooperative Control with Application Processor[6]. MP4 Player has MPEG-4 Video Decoder and MPEG-2 AAC Decoder. As the deadlines are updated with the current time when the laxity time is estimated, the laxity time will be precise even an interruption from other tasks occurred. MPEG-2 AAC decoder task has higher priority to MPEG-4 Video decoder task. For its higher priority, MPEG-2 AAC decoder task preempts MPEG-4 Video decoder task and is activated in order to execute in its time frame. The Ready Watcher Task is the highest priority, because it should manage the preemption and dispatch time of task and calculate the task interruption time as if RTOS(Real Time Operating System).

The Time Revising Robust FV Cooperative Control reduce high power control time (Table1), energy (Fig.2), and makes 50% energy reduction of an application processor under an MPEG-4 Video decoder and MPEG-2 AAC decoder multi-tasking environment. And overhead of the Time Revising Robust FV Cooperative Control’s execution is less than 1% increase.

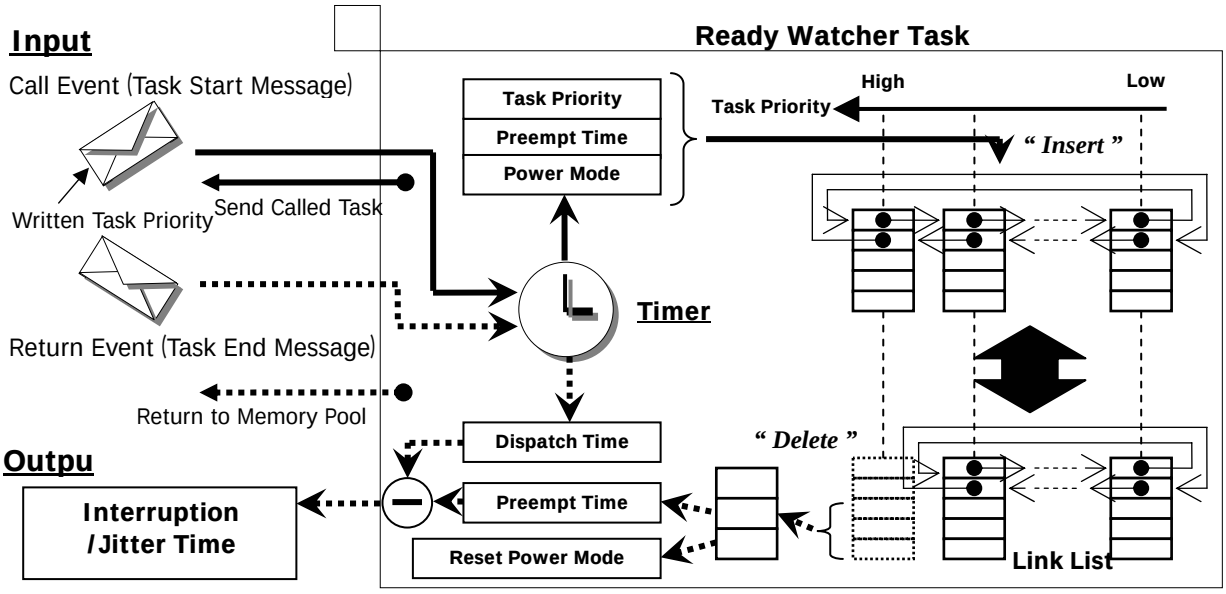

Fig.1 Ready Watcher Task in TRR_FV for Multi-tasking Multimedia System

Table 1 The Number of Application Slices for Clock Frequency with FV Control

Contents		Classification: CM / Time Sequence 30[sec] /											
Power Mode (MHz)		Traditional FV Control						TRR_FV Control					
		Min. (20)	Low (30)	Middle (60)	High (80)	Max. (120)	Sleep [msec]	Min. (20)	Low (30)	Middle (60)	High (80)	Max. (120)	Sleep [msec]
2 Mode Control	AAC			0		1294	5734			286		1008	5074
	MPEG4			4856		30730				6252		29334	
2 Mode Control	AAC	0				1294	5349	159				1135	4232
	MPEG4	2095				33491		4250				31336	
3 Mode Control	AAC	0		0		1294	5038	180		37		1077	3926
	MPEG4	1755		2823		31008		2500		4706		28380	
5 Mode Control	AAC	0	0	0	4	1290	5161	152	6	25	31	1080	3844
	MPEG	1400	1465	969	1017	30735		1978	2491	1530	1325	28262	
Total Execution Application Slice : AAC Decoder : 1294 / MPEG4 Video Decoder : 35586													

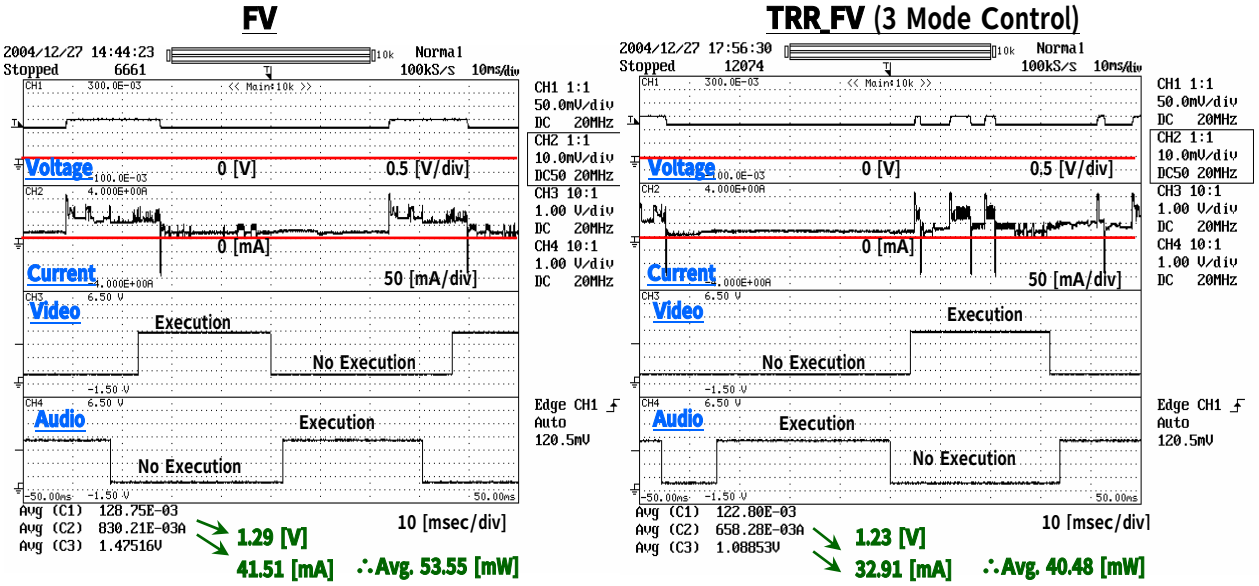

Fig.2 Characteristic of Voltage and Current (Compare TRR_FV with Traditional FV)

Reference

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