Adaptive-Speed Quasi-CAV Algorithm In A CD-RW Drive

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I. Introduction

The performance of a CD-RW drive is evaluated mainly in terms of recording data rate, access time, and power consumption. Constant linear velocity (CLV) recording technology is broadly employed in almost all the commercially available CD-RW drives today. In the CLV mode, the spindle motor which is driven by the real-time linear velocity of the disc will always be braked while seeking outwards or accelerated for inward-oriented seeks. Since the motor driver is driven in saturation, additional power dissipation will occur. This is undesirable in a CD-RW drive especially during data recording and accessing and huge power consumption will thus take place.

When a long sequence of recording and seek actions are taking place, the spindle motor keeps braking and accelerating to result in excessive heat generated. Further, with even higher than 16X CD-RW drives on the horizon, the CLV would not only cause over heating but also induce larger vibration to distort the system. A feasible approach to avoid the excessive heat and vibration is to employ constant angular velocity (CAV) to record the data in a CD-RW drive. Since CAV recording would require the on-the-fly optical power calibration (OPC), this imposes a totally new generation of technology requirement on the chipset and system design which are not currently available yet to the mass market. A quasi-CAV recording technique is thus proposed in this paper. This quasi-CAV recording algorithm can not only effectively reduce the heat dissipation in a CD-RW drive during recording but also avoids the complicated interaction of on-the-fly write strategy adjustment.

In this paper, both experimental results and software implementation technique are presented.

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II. Quasi-CAV recording algorithm and implementation

In order to realize the quasi-CAV recording in a CD-RW drive, a software technique is employed to arrange the data recording area into zones and stored in the drive firmware while the physical disc is no difference as compared to the regular CD-R disc. Within each speed zone, a corresponding recording speed is mapped.

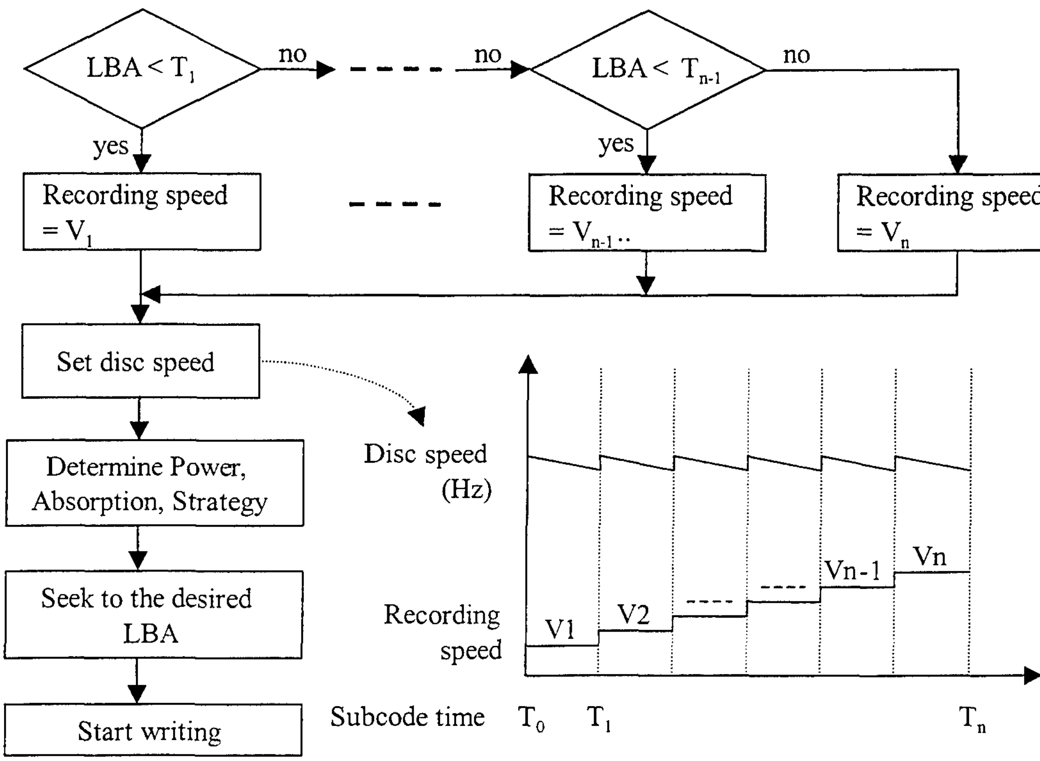

Figure 1. This figure shows the quasi-CAV firmware algorithm and conceptual zoning of the recording areas. V_n is the disc recording speed for zone n.

The each speed zone subcode address can be determined by

$$T_i = (R^2_i - R^2_0)/(V_a q) + T_0 \quad i = 1, 2, \ldots, n \quad \text{Eq. (1)}$$

$$\text{where } R_0 = (N_1 V_1)/\omega_0 \quad \text{Eq. (2)}$$

$$R_i = (N_{i+1} V_1)/\omega_0 \quad \text{Eq. (3)}$$

where T_0 is the subcode location of the logic block address (LBA) where the data recording area starts on a disc, R_0 is the physical radius of T_0, T_i is the subcode location where the recording speed switches from V_i to V_{i+1}, n is the number of speed zones, R_i is the physical radius of T_i, V_i is the recording velocity of speed zone i where the subcode time starts at T_{i-1} and ends at T_i, N_i is the overspeed factor corresponding to the i^{th} speed zone, V_a is the linear velocity of 1.3 m/s, ω_0 is the starting disc angular velocity of each speed zone, and q is the track pitch of 1.6 μm in a CD disc. To obtain the optimized writing quality, the optical laser power calibration procedure is stored in EEPROM of a CD-RW drive to map the optimal laser power for each corresponding speed zone. The procedure of optimal power calibration (OPC) is executed through firmware implementation.

OPC for recording speed V_i, i = 1, 2, ... n

Optimal write power for speed zone i = P_i

Write strategy for speed $V_i = WR_i$

Absorption of write speed $V_i = AB_i$

EFM clock of write speed $V_i = ECK_i$

Figure 2 The procedure of optimal power calibration of each speed zone.

To execute a sequential writing with starting address at T_s and ending address at T_e on a disc, the function block of writing through firmware execution is shown in Figure 3. Packet writing methodology is implemented in this writing algorithm. For continuous random writing, this functional block can be recalled and executed repeatedly to complete the writing process. The starting and ending address for each writing cycle is not necessarily to be coincided with the starting and ending address of each speed zone but can be anywhere in the data recording area on a disc.

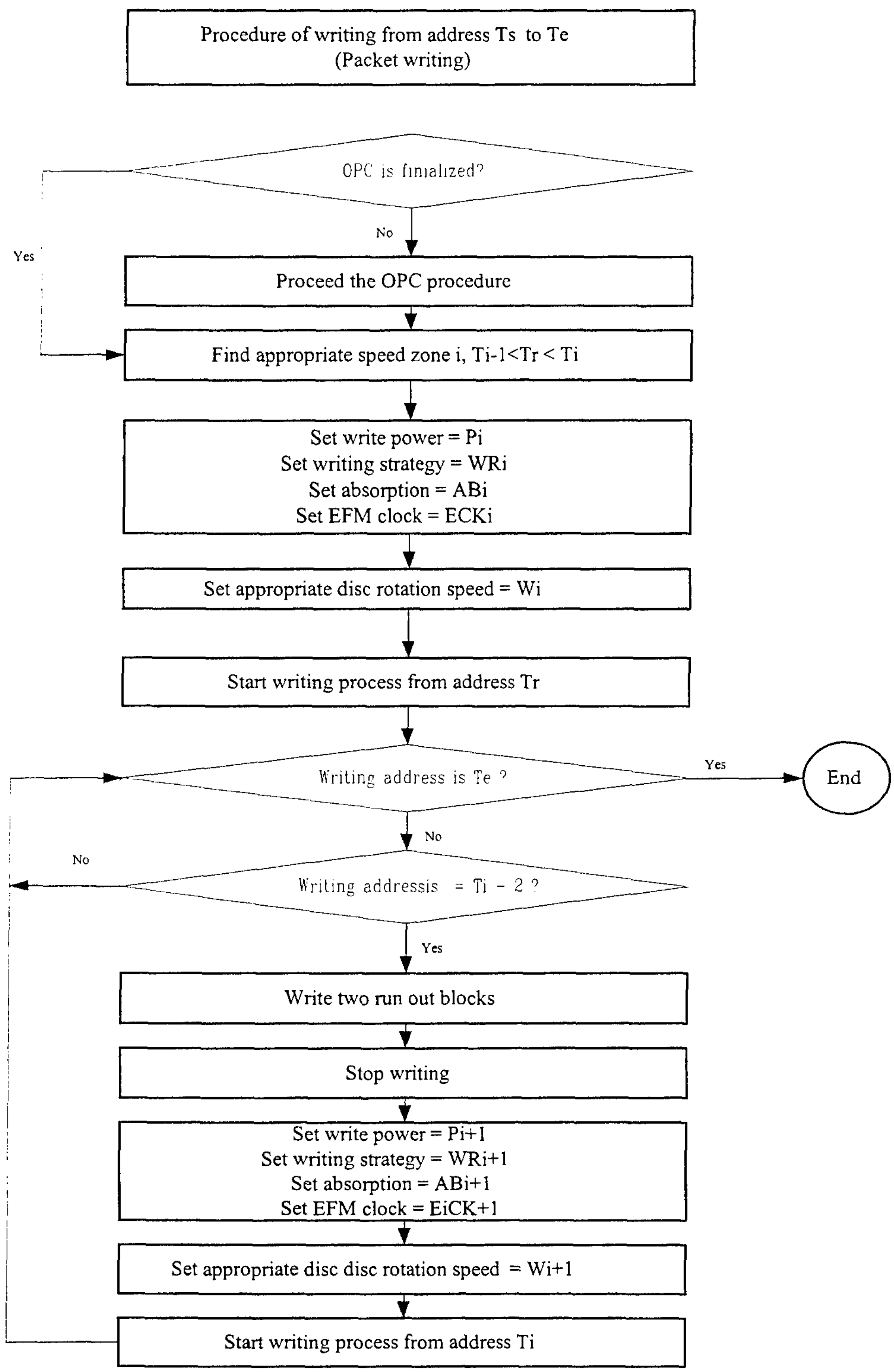

Figure 3 The functional flowchart of execution a sequential writing with a starting address at T_S and ending address at T_e.

III. Experiment and result

The CD-RW drive used in this experiment is a prototype of Acer CDRW1232A which employs this quasi-CAV recording algorithm. The speed zone of this CD-RW drive reported in this paper is defined as shown in figure 4. The power consumption of the spindle motor loop is significantly reduced when quasi-CAV recording is activated during continuous recording, as shown in figure 5.

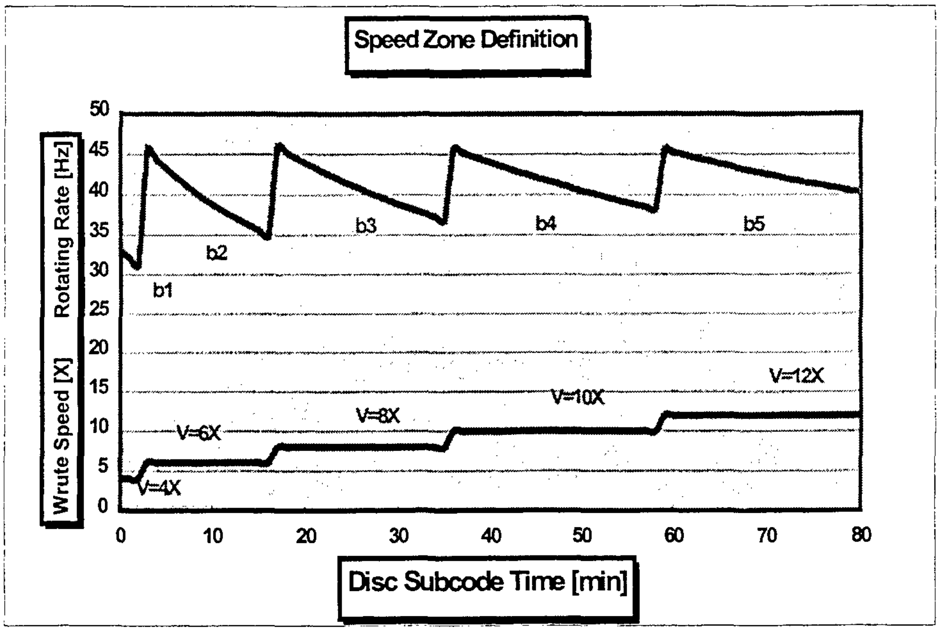

Figure 4 Speed zone definition in prototype of Acer 1232 CD-RW drive.

	CLV recording at 8X	Quasi_CAV recording at 12X
Spindle motor Temperature	60° C	41° C
Power consumption of motor driver	4.3W	1.8W

Figure 5 The power consumption comparison of CLV and quasi-CAV recording.

IV. Conclusion

A quasi-CAV recording algorithm in a CD-RW drive is proposed. This algorithm can greatly improve the power consumption in a CD-RW drive as compared to the commonly employed CLV recording algorithm. This quasi-CAV algorithm also relaxes the system design requirement as compared to the true CAV recording system.

Reference:

[1] S. G. Stan, H van Kempen, C.C. Steve Lin, M.S. Mason Yen, and Wai William Wang, "High Performance Adaptive-Speed/CAV CD-ROM Drive", Vol. 43, number 4, PP. 1034-1044, Consumer Electronics, Nov. 1997.