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AUTOMATIC TURN-ON MECHANISM FOR PC (NOTEBOOKS) FROM COMPLETE SHUTDOWN

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Abstract- With the increase in the needs of man, technology has evolved with an exponential pace. Technology has made us independent and allowed us to organize our time. Thus, "Automatic turn-on mechanism for pc" has become a need of the hour. Although there are many other software's to cater the need of automatically turning on PC's from hibernation or sleep mode but since sleep and hibernation mode consumes power supply, it is proposed here in this paper to use mechanisms that turns on pc from complete shutdown state. In this paper, we are using the +5VSB and digital alarm clock technique to power on the pc. To accomplish this task, there has to be a device which can be synchronized with the system clock i.e. the crystal oscillator clock. The device will be user interactive via specific software system. The time entered by the user in the device clock will be matched with the PC Clock running in background. As soon as this time matches, the device will send a 5V signal to power supply to tell it to turn on. The power supply also has a circuit that supplies 5 volts, called VSB for "standby voltage" even when it is officially "off", so that the power button will work automatically.
Keywords- Automatic Turn-On, Clock Synchronization, Hibernation, 5VSB, Digital alarm, Power Consumption.

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Introduction

The need for the Automatic Turn On mechanism from complete shutdown arises to regulate the pc working in accordance with the user. The main purpose of this device is to reduce the power consumption and to increase the ease for the user. The table given below illustrates the power consumption of PC's in different modes [5]; the least among these is the shutdown m
ode.

Table 1- Power Consumption of Computer in different States.

Power Consumption Chart	
Computer State	**Consumption**
Powered On	100%
Powered On, but Monitor Off	60%
Standby	35%
Hibernation	1%
Powered Off	0%

Utilization of the shutdown mode can drastically reduce the power consumption. To achieve this, a device can be used which will wake up the PC at required time. Device uses the 5VSB for this purpose. 5VSB supports the system stand-by power under both system on and system off. The sketch of our mechanism is given in Fig.1.

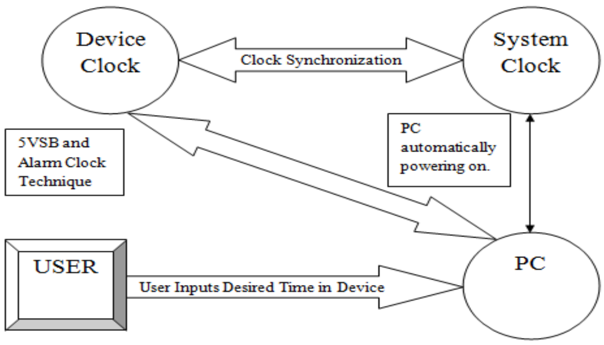

Fig. 1- 5VSB and Alarm Clock Technique used for Automatically Powering-On the System.

System states

According to the ACPI (Advanced Configuration and Power Interface) specifications, the standby modes have five states, S0/S1/**S3**/**S4**/**S5**, which may be described as follows [4].

S0

“System on” is the power on state for the normal working state of the computer, which means that the OS and whatever applications are running. In this state the power consumption is at its highest.

S5

“System off” is system shutdown state, when the power consumption is at its minimum. Only the power consumption for a few devices needs power on.

S

“Power on Suspend” is the first state of a standby mode. In this state the system turns off some unnecessary peripheral devices like the monitor or the hard disk to save power. But since the CPU, system memory and interface card are still working, there is only a limited amount of power saving.

S3

“Suspend to RAM” is the third state of a standby mode. In this state the main memory is still powered, although it is usually the only component in use. In this state, the OS, all applications and the opened documents are stored in the main memory; the main memory needs to consume power to maintain these stored data. The S3 state is simply the “SLEEP MODE”.

S4

“Suspend to Disk” is the fourth state of a standby mode. In this state, all the content of the main memory is saved to the hard drive, the preserving the state of the OS and all applications and opened documents. The power consumption is equal to shutdown as there is no extra power needed to maintain the machine state. The S4 state is simply the “HIBERNATION MODE”.

The system standby state depends on the ACPI controller and the OS. When the user sets the standby mode in the OS and the BIOS, the OS requests a standby command from the ACPI controller, and the ACPI controller generates the S3#, S5#, and POK (Power OK) signals to control the system standby state. Fig. 2 shows the state transition in the standby mode. The system initially starts up from S5, and when S3#, S5# and POK are logic high the system turns the power on and switches into the S0 state. When the system goes into the S1 state, S3#, S5# and POK don't change.

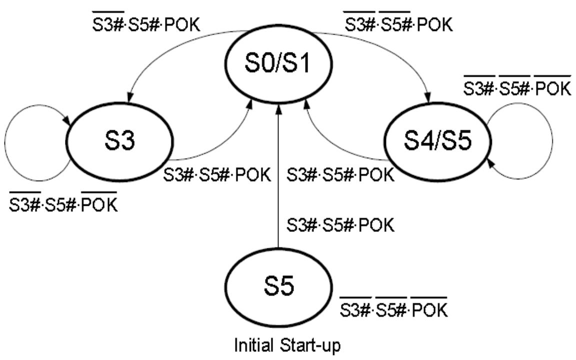

Fig. 2- The System State Transition Diagram.

When S3# becomes low and S5# and POK stay high in S0 mode, the system switches into and stays in S3 state till S3# changes to high. When both S3# and S5# change to low and POK stays high in the S0 state, the system switches into and stays in S4 or S5 state till S3# and S5# change to high. The S0 and S1 states are controlled by the OS; the standby mode is also controlled by the ACPI controller, while the S4 and S5 states of the standby mode or states are controlled by the OS.

The ACPI controller also consumes standby power to manage and regulate the power in the power on, shutdown and standby modes or states.

Overview

Hibernation is a special feature provided by many computer operating systems where the contents of memory (RAM) i.e. all the running instances are written on a non-volatile storage such as HDD or magnetic tape as a separate file before the computer turns off. When the computer is restarted then it reloads the contents of RAM via that file and restores to the previous state where hibernation was invoked.

Hibernation is a great way to quickly boot up your computer to the previous state where the user had left. Hibernation mode is used for the ease of users (data retention i.e. running instances restoration and resuming) and hardware maintenance. In Hibernation mode the power is being consumed; though the rate of consumption is less but it’s being consumed and eventually it will lose all the power (battery (notebooks restricted)). This is shown as:

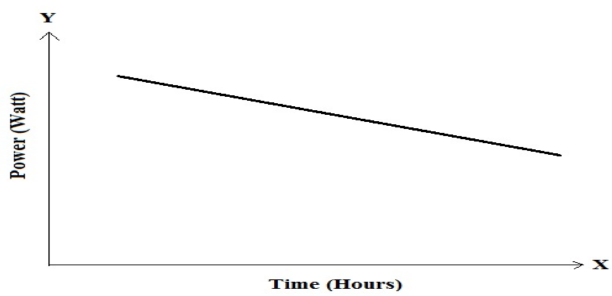

Fig. 3- Power Loss Graph.

Many systems also support a low-power sleep mode in which the processing functions of the machine are powered down, using a little power to preserve the contents of RAM and support waking up; wakeup is almost instantaneous. Here, the memory is in wake up state and thus some power is consumed. In sleep mode, the booting time is reduced and the usable desktop is in front of the user. Waking up the computer is almost instantaneous.

In sleep mode the memory (RAM) is in wake up state so there must be a continuous power supply until the computer wakes up else the data and all the running instances will be lost, as the memory is volatile in nature.

When in the S3 state (Sleep Mode), extra power is needed for the OS to be stored into the DRAM, and the energy cost is constantly increased. To comply with the “ENERGY STAR® Program Requirements for Computers” we need to improve the power consumption of the system [7]. If a laptop is under sleep mode for a long duration of time then it automatically goes to hibernation mode.

Observations

We put some notebooks under hibernation mode and observed the power consumption. Initially we charged the laptops to 100% (i.e. FULLY CHARGED) and then invoked hibernation. We came to infer from the same that some power is being consumed. This is shown in the chart below:

Table 2- Power Consumption in Hibernation Mode

Power Consumed for Hibernation Mode	
Time (Hours)	Battery (%) Remaining
0	100%
0-10	96%
Oct-20	91%
20-30	84%
30-40	80%

We took different models of notebooks and observed the same in all. The results are shown via this graph:

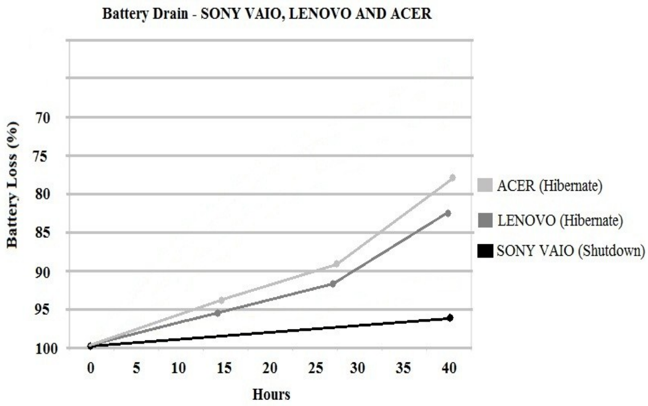

Fig. 4-Power Consumption for different Models of Notebooks in Hibernation and Shutdown Mode.

We even observed the some power is lost as shown in the case for shutdown (S5) state as it takes some power in booting and opening and closing of the system but this consumption is negligible.

Problems with Hibernation Mode

As stated earlier, in hibernation mode there is a consumption of power. However, this consumption is less but consumption is there and eventually the battery will be drained off.

The other problem that can be faced with hibernation mode will be the incorrect operation on restarting, due to the problems with the hibernation software or with the hardware devices which are not full complaint. Thus, hibernation will usually cause the connections to peripheral devices to terminate; this may cause the problem for the user to not able to access the peripheral devices that were available at the time of hibernation. As for example, we observed that when we resumed the notebook from hibernation mode then services such as "Bluetooth Services" were terminated. The user had no option then to restart the system. It depends from system to system and it may even be the case that no service terminates.

Hibernation takes some amount of time and the initial surge from reading the 2 Gigabytes (GB) of hibernation file (hiberfil.sys) also accounts to negotiation in battery savings.

The Proposed Mechanism

Advances in digital technology have been phenomenal over the years, giving birth to digital systems which continue to serve as a great source of successor and comfort to mankind in many ways. These days, numerous applications in Electronics and other technologies use digital techniques to perform operations that were once performed by analogue methods. The digital systems owe their versatility and superiority over analogue methods to the fact that they are less affected by spurious fluctuations in voltage; have greater precision and accuracy; and can store billions of bits of information in a relatively small space [3]. These systems are mostly electronic, but can also be mechanical, magnetic or pneumatic. A clock is fundamentally used for measuring time, but it may also be used to control a device designed to work according to time such as an alarm clock. Clocks may be analogue or digital. A digital clock is "an electronic device" which "generates a repetitive series of pulses, known as clock pulses, whose frequency is accurately controlled" [1]. Digital clocks use electronic methods such as the 60 Hertz oscillator of ac power or a crystal oscillator. The digital clock typically displays a numerical hour range of 0-23, or 1-12 (am or pm) using liquid crystal displays or LED displays. Digital signals are representations of discrete data often derived from analogue data. An analogue signal is a datum that changes continuously over time [2].Digital clocks are very small, useful and inexpensive; therefore, they are often incorporated into bed-side alarm clock, radio, television, microwave ovens, watches, computers and cell phones.

The building blocks of a digital clock can be represented as:

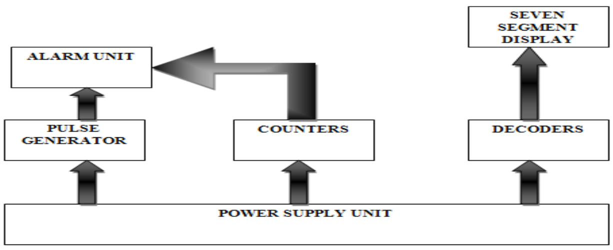

Fig. 5- Blocks of a Digital Clock.

There are mechanisms by which we can power on the system from hibernation mode or sleep mode but there is no such mechanism by which we can automatically power on the system from complete shutdown state (i.e. S5 state acc. to ACPI). By this, power consumed in hibernation mode is overcome and certain other problems associated with hibernation mode too.

In order to implement our proposed mechanism, a small hardware device has to be embedded inside the notebooks. This hardware device will basically consist of:

A Physical Clock implemented by the COUNTER and the small button size battery (cell).

As in the case for alarm clocks or remainder services in digital devices, the user feeds the desired date and time and it's stored. When this times matches with the internal system time, the output is achieved. (In form of light and sound) We are directing this output for turning on the system. The hardware will consist of the physical clock which is implemented by the Counter. Before putting the notebook to the S5 (System Off) state, the user will input the desired date and time via software part (provided by the OS).

Now this physical clock needs to be synchronized with the system clock. As soon as this time matches, our pc automatically powers on. This Counter Clock is supported by the button cell. A Counter is a sequential logic circuit capable of counting the number of clock pulses arriving at its clock input. The count sequence may be ascending, descending or non-linear.

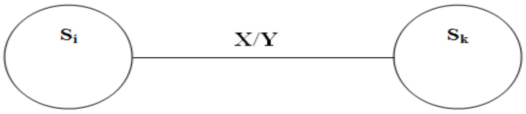

Fig. 6- State Diagram for Counter.

Where Si and Sk are states of system, X is input representation and Y is output representation.
Computers each contain their own physical clock. These clocks are electronic devices that count oscillations occurring in a crystal at a definite frequency, and that typically divide this count and store the result in a counter register. The operating system reads the node's hardware clock value Hi(t) scales it and adds an offset so as to produce a software clock Ci(t) = αHi(t) + β that approximately measures real, physical time t for processes pi.
Computer clocks can be synchronized to external sources of highly accurate time. The difference in the oscillation period between two clocks might be extremely small, but the difference accumulated over many oscillations leads to an observable difference in the counters registered by two clocks, no matter how accurately they were initialized to the same value. For ordinary clocks based on a quartz crystal, this is about 10-6 seconds/ second – giving a difference of 1 second every 1,000,000 seconds, or 11.6 days. Therefore, both the clocks must be synchronized with each other i.e. the hardware device clock and the internal system clock in order to meet the correct time and produce the output at the desired time.

The Berkeley Algorithm
Gusella and Zatti in 1989 described an algorithm for internal synchronization that they developed for collections of computers running Berkeley UNIX. In it, a coordinator computer is chosen to act as a master. The computer polls the other computers whose time needs to be synchronized with it, called slaves. The slave sends back their clock values to the master. The master estimates their local clock time by observing round trip time and then it averages the values obtained (including its own clock reading). Similarly, the internal system time can act as a master and the hardware device clock can act as a slave. Then these two clocks can easily be synchronized.

+5VSB
5VSB is a standby voltage that may be used to power circuits that require power input during the powered-down state of the power rails. The 5VSB pin should deliver 5V ñ 5% at a minimum of 10mA for PC board circuits to operate. Conversely, PC boards should draw no more than 10mA maximum from this pin unless a power supply with higher current capabilities is clearly specified. This power may be used to operate circuits such as soft power control. For future implementation, it is recommended that the 5VSB line be capable of delivering 720mA. This increased current will be needed for future implementations with features such as "wake on LAN."

The Increased +5VSB Current to output
Trends in PC system power management solutions are driving a need for increased +5VSB current capability for all ATX-family power supplies [6]. The previous +5VSB output requirement is being raised to 1.0 amps, with 2.5 amps preferred. Recommendations for momentary peak current have also been added to enable USB "wake on" devices. The increased +5VSB can be used to power on the system.

Comparisons Between different modes (Hibernation, Sleep and Complete Shutdown)
Resuming is much quicker in sleep mode than hibernation. A hibernated system restores its previous state through that file (hiberfil.sys) from the disk and reads back the data to RAM, which takes tens of seconds. While in sleep mode, there's only need to power up the CPU and the display which is instantaneous. In sleep mode there is power consumption as memory is in wake up state but in hibernation mode it's very less. In hibernation mode, the data retention is made but on the other side a little amount of power is also consumed. Since the initial urge from reading the 2 (GB) of hibernation file also accounts in decline in battery savings. It also has some hardware services conflicts such as Bluetooth services (some services gets terminated). Where as in the complete shutdown state, power consumption is reduced, by our approach the system automatically powers on thus providing all the services working properly. The system reboots all together from S5 state to S0/S1 state.

Conclusion
At present time, there are many software utilities and hardware mechanisms to reduce system power consumption and power-on the system from hibernation and sleep mode. Moreover, increased +5VSB is being used for implementing "Wake-up on LAN systems". Low-Power sleep mode and out-of-band wake-up for indoor Access Points is also the recent work in the year 2009 for power reduction and system wake-up at different environments.
An approach to implement "*Automatic Turn-On Mechanism for PC (Notebooks) from Complete Shutdown*" is a flexible cross-way linking framework and is a successful mechanism for increasing the ease for the user. This not only saves power consumption but also provides a facility for the user to automatically power on its system. The user can use the "Startup" services in order to perform the desired task at a desired time. The hardware device (consisting of a physical clock and button cell) used here is also durable and cost-effective. It's a simple device that will cost approximately around 500 to 700 INR including its manufacturing and assembling.

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