IJ TECH

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February 20, 2006

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Functional Specification for a Smart Alarm Clock

Dear Dr. Rawicz,

The enclosed document, Functional Specification for a Smart Alarm Clock, details the functional requirements of our product currently in development for the ENSC 440 course.

In an active attempt to remedy the sociological problem of sleep deprivation plaguing over 50 million Americans, we are constructing an alarm clock with a biosensor module that awakes individuals at the designated sleeping stage to feel more energetic and less prone to the effects of sleep inertia. An MP3 module allows users to rise to their favourite tunes, while a light control plug simulates the gradually intensifying light of a sunrise.

The accompanying document outlines the functional features and specifications that the Smart Alarm Clock has to offer upon completion. The main components of our device include an Alarm Clock subsystem, a Music Player subsystem, a Pulse Measurement subsystem, and a Light Control subsystem. System and module requirements are listed in accordance of the proof-of-concept model to be delivered in April and the production version to be developed thereafter.

Inglewood Jack Technologies Inc. consists of five talented and innovative individuals who study engineering at Simon Fraser University: Albert Su, Christian Le, Herman Leung, William Ng, and Matthew Ng. If you have any questions or concerns, we will be pleased to answer them. We can be contacted via email at ensc440-IJtech@sfu.ca.

Sincerely,

Christian Le
Chief Operations Officer
Inglewood Jack Technologies, Inc.

Enclosure: Functional Specification for a Smart Alarm Clock

Inglewood Jack Technologies, Inc

# Functional Specification for a Smart Alarm Clock


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# EXECUTIVE SUMMARY

With the advent of electrical lighting, shift work, social diversion and global competition, modern lifestyle has evolved to sacrifice an average of two hours of sleep a night for more time and productivity in society. Sleep deprivation results in increased vulnerability to accidents, reduced work performance and decreased concentration, yet people in industrialized nations refuse to tradeoff their busy lifestyle for more sleep. As a practical solution to the widespread and serious health problem, the Smart Alarm Clock applies the theories of circadian rhythm and strives to allow its users to wake up feeling more refreshed, sustaining better moods and performing tasks with improved efficiency and accuracy.

Central to the Smart Alarm Clock is a pulse measurement device that monitors user sleep rhythm. Sleeping cycle data are relayed and processed to awake the user at the Rapid Eye Movement stage in the closest proximity to the preset wake time. To promote a pleasant waking experience, an MP3 subsystem and a light control module replaces agonizing alarm sounds with music and light.

To demonstrate the concept of the Smart Alarm Clock, a proof-of-concept model will first be designed and constructed. In the first phase of development, the proof-of-concept model will support full functionalities including the following features:

1. Active sleep cycle monitoring to activate gradually intensifying music and light at the proper sleep stage and time to reduce grogginess.

2. MP3 storage and playback capabilities for the user to awake to music.

3. A functional light control unit that enables user to rise to their favorite light or the operation of other electronic devices.

4. Easy to use alarm clock and menu system.

5. Preliminary compliance to safety and environment standards.

Upon the completion of the proof-of-concept model in April, we will pursue to the development of a production version which adds:

1. Attractive packaging and casing for the alarm clock and light control unit.

2. Additional MP3 capabilities for the user to awake to customized music.

3. Full compliance to safety, environmental and energy efficiency standards.

 

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## Glossary

AC: Alternating Current

CMDCAS: Canadian Medical Devices Conformity Assessment System

CSA: Canadian Standards Association

dB: Decibel

EMI: Electromagnetic Interference

EMS; Electromagnetic Stirring

FDA: Food and Drug Administration

FM: Frequency Modulation (radio)

IEC: International Electrotechnical Commission

Kbps: Kilobits Per Second

MP3: Moving Picture Experts Group Layer 3

MB: Megabyte

MTTF: Mean Time to Failure

REM: Rapid Eye Movement

RoHS: Restriction of Hazardous Substances

SAC: Smart Alarm Clock

SNR: Signal to Noise Ratio

SWS: Slow-Wave Sleep

UL: Underwriters Laboratory

 

# 1. Introduction

The Smart Alarm Clock is a device that will help users wake up in the morning with greater ease and feeling more refreshed. This goal is achieved by using a combination of gradually intensifying light and sound as stimuli initiated based on the user's sleep stage. Users can wake up to their favourite music by simply loading MP3 files into the device. The users can also use their existing bedside lamp for the light feature by simply plugging the electrical plug into a subcomponent of the Smart Alarm Clock. Sleep stage is monitored by examining the user's pulse rate for transitional cues. The project will be developed in two phases. Phase one consists of developing a prototype as a "proof of concept" model scheduled for completion in April of 2006. Phase two consists of improving upon the features' effectiveness and usability in preparation for commercial sales.

## *1.1. Theoretical Background*

Sleep stage is divided into two distinct groups: Rapid Eye Movement (REM) sleep and Slow-Wave sleep (SWS). SWS is further broken down into four stages from 1 to 4. REM sleep stage is characterized by the high amount of brainwave activity associated with it, which is very similar to brainwave patterns of an individual who is awake. Stages 1 and 2 of SWS also show similar brainwave patterns as waking. However, Stages 3 and 4 show a much slower brainwave activity.

One sleep cycle consists of many sleep stages. The period of each cycle is typically between 90 to 110 minutes. The figure below shows the various stages of a typical night of sleep.

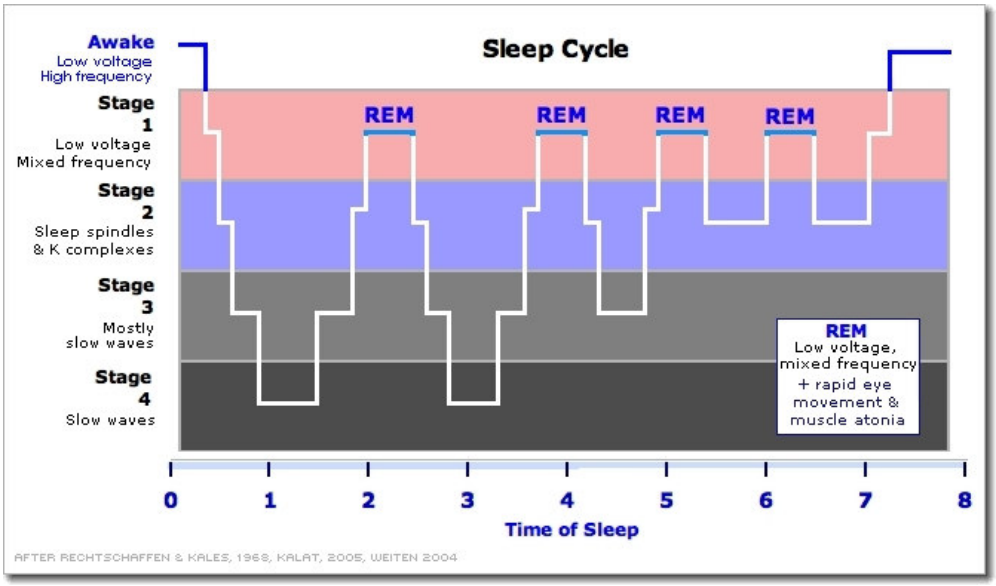


**Figure 1: Sleep Cycle Throughout a Typical Night of Sleep**

 

Sleep inertia is a physiological state characterised by a decline in motor dexterity and a subjective feeling of grogginess, immediately following an abrupt awakening from deep sleep. The effects of sleep inertia typically last from one minute to several hours. Studies have shown that waking up from Stage 3 or 4 produces the most sleep inertia, whereas Stage 2, REM, and Stage 1 produces reducing amounts of sleep inertia, in that order. Thus, it is ideal to wake the individual during, or shortly after the completion of REM stage.

The autonomic activities associated with the SWS and REM sleep can be used to differentiate the two. REM sleep is characterized by variable heart rate with high bursts whereas SWS shows slow decline in heart rate. By using a pulse rate or heart rate monitor, it is possible to track the variable heart rate pattern associated with REM, and identify when transitions between SWS and REM occur.

## *1.2. Scope*

This document standardizes the functionalities to feature in the proof-of-concept and production Smart Alarm Clock models. An exhaustive list of functional requirements for the proof-of-concept model provides the design and development framework for our module and integration engineers. Additional specifications towards the production model represent our current vision of what consumers' demands and will be modified upon further prototype tests and market studies.

## *1.3. Referenced Documents*

David, G.M., 1998. *Psychology.* 5th ed. New York: Worth.

Feyer, A.M., 2001. Fatigue: time to recognize and deal with an old problem. *British Medical Journal.* Volume:322, 808-809.

Rosenzweig, M.R, Breedlove, S. and Leiman, A.L. *Biological Psychology*. 3rd ed. Massachusetts: Sunderland.

## *1.4. Intended Audience*

The primary audience of this document are product developers, integration engineers and quality assurance personnel. The functional specification acts as a guideline through which all module and system designs must comply.

Chief engineers and executives can make use of this document to plan, direct, motivate and control development progress. In carrying out market function and consumer study, the functional specification provides a reference to product features for the marketing staffs.

 

## 1.5. Objectives

The following convention is used throughout the functional specification to indicate functional requirements:

**R[#]** A functional requirement.

A number (*n*) will be appended to each functional requirement to denote the priority of each functional requirement. The symbol (*n*) signifies:

**(1)** A functional requirement for both the proof-of-concept prototype and the production device.

**(2)** A functional requirement for only the proof-of-concept prototype.

**(3)** A functional requirement for only the production device.

 

# 2. System Overview

The Smart Alarm Clock is composed of four subsystems working together to provide the overall system functionality. The figure below shows an overview of the various subsystems and their interconnections.

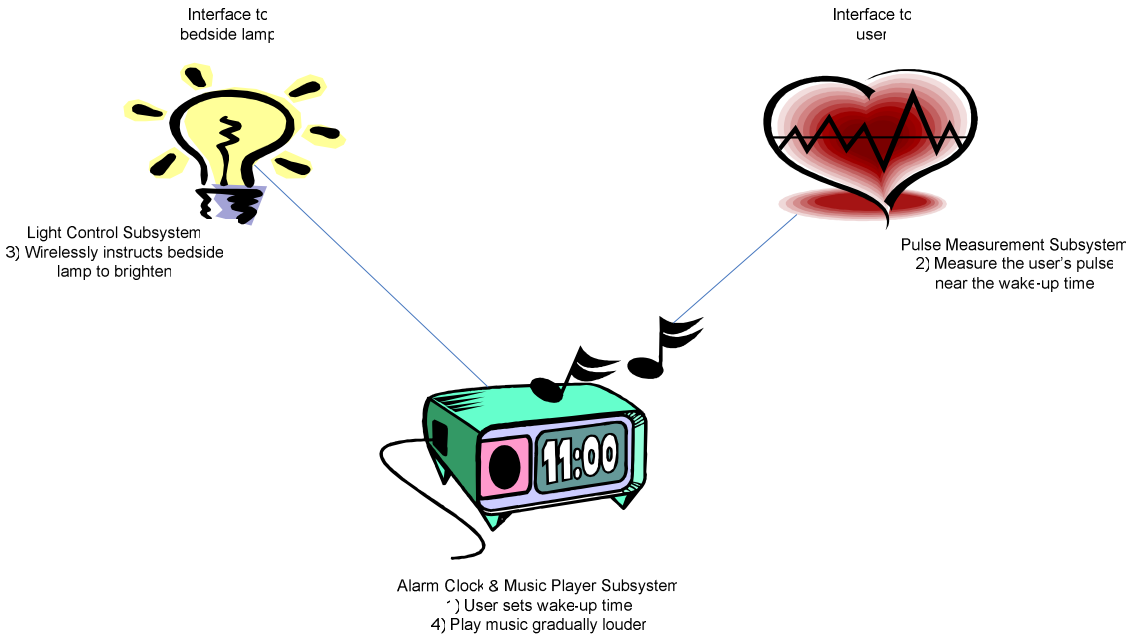


**Figure 2: Smart Alarm Clock Modules & Interconnections**

## *2.1. Alarm Clock Subsystem*

As the central component, the Alarm Clock subsystem keeps track of the current time and the time when the user needs to wake up. A user interface allows easy setting of the wake-up time, selection of the music to wake up to, and various other user configurations.

This subsystem is responsible for communicating with the other subsystems during the waking process. It takes the user's pulse rate from the Pulse Measurement subsystem and processes the raw data to determine the appropriate time to initiate the light and sound features. Communication with the Light Control subsystem is performed wirelessly to instruct the gradual brightening of an external light source. Similarly, communication with the Music Player subsystem instructs it to play the specified song while gradually increasing the sound volume.

 

## 2.2. Music Player Subsystem

This subsystem incorporates MP3 processing and non-volatile storage, allowing the users to load their own songs. Speakers and audio amplifiers are also incorporated to provide support for stereo sound. Digital volume adjustment features are available for automatically increasing the sound volume of the current song being played, as controlled by the Alarm Clock subsystem.

Though there are two subsystems for the alarm clock and music player, these subsystems will be in the same physical unit as shown in Figure 1.

## 2.3. Pulse Measurement Subsystem

This subsystem is responsible for measuring the user's pulse rate in a non-invasive manner. The measured data is then passed to the Alarm Clock subsystem where processing is done to determine any changes in the pulse rate.

## 2.4. Light Control Subsystem

This subsystem interfaces to the user's current bedside lamp, which acts as the external light source. It controls the light intensity by varying the amount of AC power that gets passed to the external light source. It communicates with the Alarm Clock subsystem wirelessly.

 

# 3. Overall System Requirements

This section provides a general overview of the requirements that apply to the SAC as an entire system. Requirements relating to specific subsystems shall be described in other sections of the document.

## *3.1. General Requirements*

This section outlines the general requirements that apply to the SAC system. These requirements are similar to the requirements provided by a typical alarm clock.

R[1] The system must accept the wake-up time as set by the user. (1)

R[2] The system must accept the new clock time as set by the user. (1)

R[3] The system shall wake the user either at, or before the wake-up time arrival. (1)

R[4] The user must be able to turn off or disable the system when the system is alarming the user. (1)

R[5] The system shall employ the use of a sound source to wake the user. (1)

R[6] The system shall employ the use of a light source to wake the user. (1)

## *3.2. Functional Requirements*

This section outlines the specific functions that will be provided by the SAC system. These functions must be fulfilled in order to satisfy the claims suggested in the proposal.

R[7] The system must play MP3 songs or alarm sounds during the waking process. (1)

R[8] The system must be able to play songs at an increasing sound volume level during the waking process. (1)

R[9] The system shall play only a fixed selection of predetermined MP3s. (2)

R[10] The user shall be able to specify which MP3 songs or alarm sounds are used, or pseudo-randomly. (3)

R[11] The song name shall be displayed to the user while it is in play. (1)

R[12] The system must be able to interface with the user's existing bedside lamp. (1)

 

R[13] The system must be able to control the external light at an increasing light intensity level during the waking process. (1)

R[14] The system must be able to measure the user's pulse rate. (1)

R[15] The system shall be able to determine the transition into, or out of REM sleep stage through the user's pulse rate. (1)

R[16] The user shall be able to set the duration of the monitoring window period for which the system begins monitoring the user's sleeping stage through the pulse rate. (1)

R[17] The system shall commence the waking process only during the monitoring window period. (1)

R[18] The system shall wake the user either during, or shortly after a REM sleep stage that occurs before the wake-up time arrival. (1)

## 3.3. Safety, Regulations and Energy Efficiency Requirements

This section states the various safety, regulations and energy efficiency requirements that must be conformed by the overall system. Since the device will reside at the bedside of the user, and will establish physical contact with the user, special safety regulations must comply.

R[19] The enclosure for all components related to the system must not have sharp corners or edges that may otherwise harm the user. (1)

R[20] There must be no exposed wires and all electrical cables and wires must be properly isolated. (3)

R[21] The user shall not be connected to the system in any manner through a wired interface to prevent shock or strangling during sleep. (3)

R[22] The device must conform to IEC 60601-1 standards for general medical and dental equipment. (3)

R[23] The device must conform to IEC 60601-1-2 Electromagnetic Requirements; Radiation (EMI) and Immunity (EMS). (3)

R[24] The device must conform to Class I medical device standards set by the Food and Drug Administration (FDA) and Canadian Medical Devices Conformity Assessment System (CMDCAS). (3)

 

R[25] The system must be tested and comply with limits for Class B digital device for usage in residential environments. (3)

R[26] The system must be pursuant to Part 15 of the FCC Rules. (3)

R[27] The system shall conform to requirements for UL, CSA, and CE for domestic use. (3)

R[28] The system shall conform to ENERGY STAR's specification for external power supplies. (3)

## 3.4. Environmental Requirements

This section describes the environmental requirement that the assembly process and components must conform. It also states the operating conditions of the device.

R[29] The device shall be Restriction of Hazardous Substances (RoHS) compliant. (3)

R[30] The device printed circuit board shall withstand the higher temperature used in lead-free assembly process. (3)

R[31] Lead-free solder shall be used for soldering third party components in place. (3)

R[32] The enclosure must not contain halogenated flame retardants. (3)

R[33] The device shall operate over a temperature range of 0 degrees to 40 degrees Celsius. (1)

R[34] The device shall operate over a humidity level ranging from 5% to 95%. (1)

## 3.5. Compatibility Requirements

This section details the compatibility of the SAC with other devices.

R[35] The device shall be able to co-operate with existing wireless household items without interference. (1)

R[36] The device shall be compatible with any standard indoor household lamps that is powered by AC. (1)

 

## 3.6. Reliability Requirements

This section outlines the ability of the SAC to perform without failure.

R[37] The device shall have a Mean Time to Failure (MTTF) of 10 years. (3)

R[38] The system must operate for extended periods of time (up to 3 months) without the need to re-cycle power. (3)

R[39] In the event of system failure, recovery can be made by cycling the power. (3)

R[40] In the event of a power failure, the system must continue operation at reduced power consumption level and reduced features. (3)

## 3.7. Overall Test Requirements

This section outlines the various tests that shall be performed to verify the functions provided by the SAC.

R[41] The Alarm Clock subsystem shall directly instruct the Music Player subsystem to play an MP3 at an increasing sound volume to verify connectivity. (1)

R[42] The Alarm Clock subsystem shall wirelessly instruct the Light Control subsystem to turn on an external light source and increase the light intensity to verify connectivity. (1)

R[43] The Alarm Clock subsystem shall acquire pulse readings from the Pulse Measurement subsystem to verify connectivity. (1)

R[44] The Alarm Clock subsystem shall combine the features of all the subsystems to execute the waking process. (1)

R[45] Control groups will be selected to test the ability of the SAC to minimize sleep inertia and ease the waking process. (3)

 

# 4. Interface Requirements

This section describes the various interfaces that are available for user interaction. This includes visual feedback, user input, and user monitoring.

## *4.1. General Interface*

This section outlines the general interface that is available to the end user.

R[46] There shall be a button to turn the alarm off. (1)

R[47] There shall be a button to turn the external light source on and off. (1)

R[48] There shall be directional buttons (up, down, left, right) for traversing through the user menu. (1)

R[49] There shall be a dedicated display for showing the current time. (1)

R[50] There shall be an indicator for AM/PM. (1)

R[51] There shall be a display for showing other information, such as the user menu. (1)

## *4.2. User Menu Interface*

This section outlines the user menu that is available for the user for configuring the SAC.

R[52] The Root Menu shall be displayed whenever the device receives no button input for a predetermined amount of time. (1)

R[53] The user shall be able to set the current time. (1)

R[54] The user shall be able to set the alarm time. (1)

R[55] The user shall be able to choose between 12 and 24 hour mode. (1)

R[56] The user shall be able to enable or disable the alarm. (1)

R[57] The user shall be able to adjust the duration of the monitoring window period in multiples of 15 minutes. (1)

R[58] The user shall be able to adjust the initial volume level for which the songs start playing at. (1)

 

R[59] The user shall be able to browse and select the desired MP3 song/sound to play, or randomize the song/sound. (3)

## *4.3. Pulse Measurement Interface*

The section describes how the user will interface with the pulse measurement device.

R[60] The interface must be worn comfortably by the user throughout the night. (3)

R[61] The interface must not lose contact with the user or change its orientation. (3)

R[62] The interface shall measure the user's pulse when instructed by the Alarm Clock subsystem to do so. (1)

 

# 5. Alarm Clock subsystem Requirements

The Alarm Clock subsystem is the foundation or "home base" of the SAC. The unit communicates with other modules in order to perform the overall functions previously stated. In addition, the majority of the user interface is performed on the alarm module; thus, its requirements should provide ease of use and clear instructions for the user. Finally, the Music Player subsystem is incorporated into the Alarm Clock subsystem so that they belong in one physical unit.

## *5.1. General*

This section describes the alarm module functions of the SAC.

R[63] The accuracy of the clock system shall not deviate more than ±1 minute per month at 25 degrees Celsius.[1] (1)

R[64] The latency between the internal system time and the displayed time shall be no more than 1 second (meaning it takes no more than 1 second to reflect the time on the numeric LCD). (1)

## *5.2. Physical Requirements*

Considering that the SAC will be used on a frequent basis, the functional requirements should be defined such that the module is easy to use.

R[65] The time and other information shall be on the front face of the unit. (1)

R[66] The directional buttons shall be accessible at the front face of the unit. (1)

R[67] All other buttons will be placed on the top face so that the alarm module does not slide every time the user pushes a button. (1)

R[68] The alarm clock shall have its chassis isolated from the surface it rests on. (3)

R[69] The Alarm Clock subsystem shall have grippers on the bottom of its chassis to prevent slippage. (3)

[1] http://www.futurlec.com/News/Dallas/Crystal.html

 

## 5.3. Audio Requirements

The audio requirements of the alarm module are for the playback of songs when waking the user.

R[70] The unit must be able to support MP3 music format. (1)

R[71] The unit must be able to decode a minimum of 128Kbps MP3 bit rate. (1)

R[72] The unit must be able to support at least 32 MB and up to 256 MB of non-volatile memory. (1)

R[73] The unit must be able to produce stereo sound, at a signal to noise ratio (SNR) of at least 70 dB (which is equal to or better than FM). (1)

R[74] The onboard speakers must be able to produce at least 80 dB of sound pressure level, relative to 0.000002 $N/m^2$ of pressure, or the threshold of hearing.[2] (1)

R[75] Alarm music shall be played at a sound pressure level between 20 dB (about twice as loud as a barely audible sound source) to 60 dB (intrusive).[3] (1)

## 5.4. Visual Requirements

This section describes any important information that the user sees on the alarm module.

### 5.4.1. General

The general functions are for when the SAC is in its ideal mode. Also, note that these general visual requirements are also in effect when the alarm is in the waking process.

R[76] The current time will be shown in the HH:MM format, either in the 12-hour or 24-hour mode. (1)

R[77] The time “12:00” shall appear upon the occurrence of power interruption, or initial power up. (1)

R[78] The clock subsystem will display whether alarm is enabled or disabled. (1)

R[79] User shall be able to read the digits on the alarm clock in darkness. (3)

[2] http://www.jimprice.com/prosound/db.htm
[3] http://www.eie.fceia.unr.edu.ar/~acustica/comite/soundlev.htm

 

### 5.4.2. Music & Sound

These functions are for songs or sound effects being played when the alarm is on and the time is approaching the user's wake-up time.

R[80] The name of the song or sound effect will be displayed. (1)

R[81] The sound level of the song or sound effect is displayed, in plain English, for future reference for the user when adjusting the starting sound volume. (1)

## 5.5. Communications Requirements

This section describes how the Alarm Clock subsystem communicates with other subsystems of the SAC.

R[82] The alarm subsystem must be able to give input and accept output from the Light Control subsystem. (1)

R[83] The alarm subsystem must be able to give input and accept output from the Pulse Measurement subsystem. (1)

## 5.6. Power Requirements

The Alarm Clock subsystem must be properly powered to ensure functionality. Power efficiency is also considered so that using the subsystem is low cost.

R[84] System must operate on a 120 V AC, 60 Hz power source. (2)

R[85] Standby (no alarm, no light, no pulse) power consumption must be less than 0.3 W. (3)

R[86] The production unit will be powered on by a power cord. (3)

## 5.7. Testing Requirements

This section lists all the testing requirements needed to ensure the alarm module functions.

R[87] Use a synchronized clock to measure the current time on the Alarm Clock subsystem for accuracy. (1)

R[88] Measure the alarm sound levels to verify that it increases to the proper thresholds. (1)

 

# 6. Pulse Measurement subsystem Requirements

The Pulse Measurement subsystem measures the pulse rate of an individual and communicates its information with the Alarm Clock subsystem.

## *6.1. General*

This section describes the pulse measurement module functions of the SAC.

R[89] The system must be able to measure the pulse rate up to 200 beats per minute. (2)

## *6.2. Physical Requirements*

Considering that the SAC will be used on a frequent basis, the functional requirements should be defined such that the Pulse Measurement subsystem is safe and comfortable to use.

R[90] The Pulse Measurement subsystem must have a weight of less than 100 grams. (1)

R[91] The Pulse Measurement subsystem shall be connected to the Alarm Clock subsystem through a signal communication wire of length of less than 150 cm. (2)

## *6.3. Communications Requirements*

This section describes how the Pulse Measurement subsystem communicates with other subsystems of the SAC.

R[92] The pulse measurement system shall communicate with the Alarm Clock subsystem through a wired connection to meet the objectives of the SAC. (2)

R[93] The Pulse Measurement subsystem shall communicate with the Alarm Clock subsystem wirelessly to prevent the user from choking on any tangled wires while sleeping. (3)

R[94] The Pulse Measurement subsystem must be operable in conjunction with the Alarm Clock subsystem when separated by an open distance of 200 cm. (3)

 

## 6.4. Power Requirements

This section lists all the power requirements needed to ensure the pulse measurement module functions and meets power regulations.

R[95] The Pulse Measurement subsystem must be battery powered. (3)

R[96] The Pulse Measurement subsystem must have a minimum battery life of three months. (3)

## 6.5. Testing Requirements

This section lists all the testing requirements needed to ensure the pulse measurement module functions.

R[97] Compare pulse measurements with a certified product and verify the unit's accuracy to within 10%. (1)

R[98] After confirming the accuracy of the pulse monitor, previous sleep research data on pulse rate and REM can be applied. (1)

 

# 7. Light Control subsystem Requirements

The Light Control subsystem controls the light intensity of the user's existing bedside lamp. The smart Alarm Clock subsystem will communicate wirelessly to this Light Control subsystem.

## *7.1. General*

This section describes the light control module functions of the SAC.

R[99] The Light Control subsystem must be able to control the brightness of a light source. (1)

## *7.2. Physical Requirements*

Considering that the SAC will be used on a frequent basis, the functional requirements should be defined such that the Light Control subsystem is safe and easy to use.

R[100] The Light Control subsystem shall be enclosed in a rigid box such that there is no risk of electrical shock. (3)

R[101] The subsystem's enclosure shall be small and compact (less than 400cm$^3$). (2)

R[102] The production unit must have a 3-prong plug inlet for connecting to other light sources. (3)

R[103] The production unit must have a 3-prong plug inlet for connecting with any electronic devices. (3)

## *7.3. Communications Requirements*

This section describes how the Light Control subsystem communicates with other subsystem(s) of the SAC.

R[104] The Light Control subsystem must be able to wirelessly communicate with the Alarm Clock subsystem. (1)

 

## 7.4. Power Requirements

This section lists all the testing requirements needed to ensure the Light Control subsystem functions and meets power regulations.

R[105] The Light Control subsystem must be able to interface with 120V AC power systems. (1)

R[106] The subsystem must be designed to handle a maximum load of 1200 W. (1)

## 7.5. Testing Requirements

This section lists all the testing requirements needed to ensure the Light Control subsystem functions.

R[107] The light intensity will be verified by checking that it increases to proper thresholds. (1)

R[108] The light will be turned on to the maximum threshold immediately. (1)

R[109] The light will be turned off at all levels of light intensity. (1)

 

# 8. Documentation and User Training

As the Smart Alarm Clock targets primarily the mass population of industrialized nations within the age range of 20 to 40, documentation needs to be concise and the device should require minimal user training. Motivated by this target marketing strategy, the following list provides a set of functional criteria for documentation and user training.

R[110] User installation and operating instructions for the production model will be provided in English, French, German, Spanish, Japanese, traditional and simplified Chinese and Korean. (3)

R[111] User installation instructions are to provide step-by-step guideline towards installation of the device for an audience ranging from beginner to expert level of experience with electronic devices. (3)

R[112] User operating instructions is to promote clear understanding of device operation for an audience ranging from beginner to expert level of experience with electronic devices. (3)

R[113] User operating instructions is to include precautions, specifications, and troubleshooting remedies for operation in North America, Middle East, Europe, Australia and Asia. (3)

R[114] User should be able to operate the device with minimal user training. (1)

R[115] User documentation will provide complete training necessary for safe user operation. (3)

R[116] Service staff will provide all user training necessary for safe user operation in English, Japanese and Chinese. (2)

 

## 9. Device Limitations

Under current medical and psychological developments, an absolute pulse pattern corresponding to REM sleep is in dispute amongst experts in the field of physiology. According to Dr. Ralph Mistleberger from the Psychology Department at Simon Fraser University, it is not uncommon for experts to disagree on patient REM sleep period upon sole consideration of brain, eye, facial and pulse signals. To that end, we employ a generally accepted definition of REM sleep signal to wake up the user in the designated period and will not guarantee that the stage in which the device awakes the user is the REM sleep stage under universal consensus.

Further device limitation is imposed on user with severe chronic heart diseases which results in the possibility of irregular pulse pattern during sleep. To compensate for the device limitation due to user illness, an absolute alarm sound and light at the designated wake time will be integrated into our device.

 

# 10. Conclusion

This document clearly defined the specifications and attributes of all four subsystems that are a part of the SAC. The functional specification document presents in detail all that is required in order to complete the SAC to wake an individual up feeling perky instead of groggy.

Using this document, the Smart Alarm Clock prototype will be completed by April of 2006, satisfying all the requirements specified.

 