CONCEPT GENERATION OF SENSOR-BASED HEAD READING LAMP

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ABSTRACT: *Reading lamp is a lamp that is used specifically to provide sufficient lighting when reading or studying. However, the current reading lamp has a few inadequacies, due to the inflexibility, shape, and functional limitation. The main purpose of this study was to design a head reading lamp that is more flexible and appropriated to user needs. After gathering user's requirements, some technical specification targets were set up. Finally, all requirements were translated into concepts. The chosen concept was reading sensor based headlamp that has the ability to adjust the light intensity depends on the environment. The proposed concept is also equipped with the time and distance sensor to ensure that the reading condition is still acceptable. The concept would be continued to embodiment and detail design phase.*

Keywords: Hotel, Product Design, Head Reading Lamp, Sensors

1. INTRODUCTION

Lamp is one useful tool to provide lighting to the room. Specifically, a reading lamp, a tool used by some people to read in the room with unfavorable lighting conditions. Reading light is needed; especially when the lighting conditions in the room are inadequate for reading. For the purposes of reading, required lighting levels should be greater than the level of lighting to look at the condition of general activity. In comparison, for daily activities, it takes around 100-300 lux (or lumens / square meter) of illumination. However, it requires around 300-500 lux for reading activities and around 500-1200 lux for intensive reading could be [1].

In general, at home, the lights in the room just meet the level of lighting for general activity. The needs of special lighting levels in reading activities becomes more crucial if one wants to read in a long time, for example in studying or working.

The issues arise because of a reading lamp that is widely available today are in the form of a table lamp. In fact, based on discussions with several respondents from students (high school and college students), they claimed did not like to study at the table and prefer the position of studying or reading in bed, relaxed sitting, prone, supine or almost. The study said that instead of sitting on a desk, children often lie down on the floor, sofa, and a bed. Sometimes they place a pillow below their book and do their homework. Even some elderly people adopt this wrong posture for reading, regardless of age or sex [2].

A survey on the program "Digital Citizenship Safety" organized by UNICEF [3], in addition to learning activities, 80% of children and adolescents use the gadgets for entertainment every day. However, the digital display gadget trend today has become one cause of the decline in the quality of vision in humans [4]. This statement is supported by Dr. Sanchez-Ramos [5] which states that the blue light contained in the digital display screen or gadget can damage the retina, mainly due to the light source directly illuminates the eye. Good lighting condition is when light bounces to the object seen. Therefore, the light from the gadget, which directly leads to the user's eyes, is not good for human vision. This phenomenon further reinforces the fact that although the gadget can be operated in a dark environment (as he himself put out the light), others believed that availability of other lighting sources, for example, a reading lamp, is still needed to reduce the negative impact of the gadget. Besides the conventional table reading lamp, there are many kinds of a reading lamp. The main differences between them are the location on which the lamp put.

In all of these types of lamps, lighting intensity usually is fixed or can be set manually on multiple levels (e.g. high, medium, low). Considering available products in the market, our previous research has developed portable sensor-based reading lamp [6]. The design of the previous design still has shortcomings and need to be redesigned to eliminate or reduce the weaknesses and make the reading light is able to meet the needs of the user better. More potential developments mainly are related to optimality of sensor function, energy and level of ergonomic tools. Therefore, this study is expected can assist the user in reading activities. The main objective of this study was to design light and distance sensor-based head reading lamp.

2. METHODS

2.1 User Needs and Technical Requirements Identification

To obtain preliminary data from the user, we conducted some Focus Group Discussion. The participants of each FGD were 6-12 college students with the age of 18-21 years. There are 4 FGDs with a total of 32 participants. Each participant was asked about their reading activities at home (frequency, objective, position, and light intensity). Moreover, each participant was asked to try the current (prototype) product like it is shown in figure 1 and give an opinion about the product. Participants gave feedback about their needs and wishes of both the general reading lamp and previous concept design.

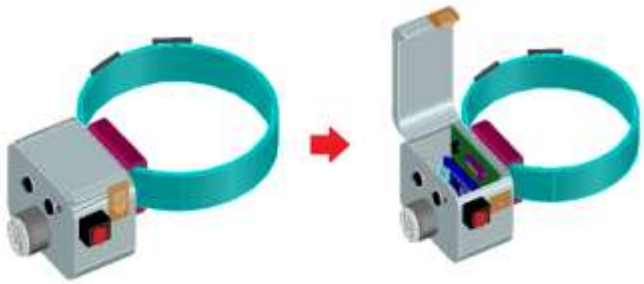

Figure 1. Previous Head Reading Lamp Concept Design

Based on user need and expectation, each user's statement was translated into technical requirements. By translating the needs to technical requirements, the target of development was set quantitatively. Product Design Specification [7] then was made to describe the overall targets to be achieved in a product reading lamp.

2.2 Concept Exploration

After the function list is obtained, the next step was done by doing a brainstorming process to determine the possible concepts can be formed. At this stage, a lot of sketches were made to illustrate concepts that can realize the preferable functions and feature. For concept generation, researchers used the SCAMPER checklist [8] to help to generate ideas. Alternatives of concept that related to speci9ic function than were combined in a Morphological Chart [9]. Finally, each alternative of concept then was compared and assessed using methods Pugh [10].

2.3 System Level Design

At the design stage level, the concept chosen for developed starting fine detail components. After identifying the schematic diagram, chunks (components collection that forms a specific function) were identified. All chunks are arranged in a product architecture. Furthermore, the design phase configuration [11], will help to refine the components, both in terms of the workings of each component and the linkages between each component. Next, the parametric value of each component will be determined, in order to achieve the targets that have previously been specified in the technical requirements. To support this phase, detail electric circuit should be established.

In this paper, only limited system level design phase that was presented. After concept generation, the schematic diagram was established. However, the configuration and parametric design were not presented in the paper.

3. RESULT

The final result of the previous research was a prototype of portable reading distance based on light intensity and distance. However, based on trial, the design still had the weakness, i.e. 1) dimension of the lamp was quite big and heavy so it was not comfortable for the user. 2) Lack of button to deactivate the sensor. This condition causes the required energy to operate the device was quite big. In the previous design, 1 alkaline AA battery only can operate the device for 10 minutes. The time was measured in extreme condition when the light was continually changed and caused sensor continually work to adjust the light intensity

Next, based on Focus Group Discussion to the user and intense discussion with the team, the Product Design Specification was decided

A. Product Title: Sensor-based Head Reading lamp
B. Purpose: Designing a portable reading lamp with development functions of form, function and function indicator light read which has a high reliability.
1. Ease of activation on the reading light
2. The light that can be adjusted both automatically and manually based on light intensity
3. Can detect the reading distance
4. The direction of light can be adjusted as desired
5. Can be used anywhere and inflexible posture position
6. Does not use wires
7. Light and small
8. Reduce the dimension of the proposed device by distributing each electric circuit at the belt surface.
9. The system can be switched as an automatic or manual mode.
10. Can turn off automatically when the reading time is too long

C. Intended Market: High school students/equivalent and the student / i aged 15-21 years who are still in their productive years of learning and activity using a gadget. With the middle and upper levels of the economy.
D. Performance Requirements (Table 1):

Table 1. Technical Specification of proposed Sensor-based Head Reading Lamp

No	Technical requirement	Target
1	Light intensity	0-220 lux
2	Warning sound	30 db
3	Light intensity detection	< 0.1 detik
4	Maximum angle of lamp	360º
5	Source of energy (Baterry)	> 1 jam
6	Weight	< 210 gram
7	Total dimension of product	5 cm x 2 cm x
8	Temperature on user's skin	< 22°C
9	Time to turn off automatically	30- 60- ~ mnts
10	Expected life time	30- 60- ~ mnts

E. Life-Cycle: This product is expected to be replaced at term use of more than one year.
F. Human-Factors: Based on the results of benchmarking, the obtained product specifications for the design of the reading light when viewed from the user side are as follows:

1. The reading lamp should be easy to use, does not require a time-consuming learning to operate it.
2. Output lamps should be able to respond well to the input provided by the user or by the environment.

For the exploration of the concept, SCAMPER method was used. SCAMPER is a method to explore a deeper concept. SCAMPER is an acronym for Substitute, Combine, Adapt, Modify-Magnify-Minify, Put on Other Use, Eliminate-Elaborate, Reverse-Rearrange. Using this method, the following are the results of the exploration of the concept.

1. Substitute

• Replacement of cooling system with heat sink thermopaste or pasta. Thermopaste suitable for electric circuits that require small dimensions.

• Replacement of transducer input with a light sensor (ie, sensor LDR, Photo or Photo Diodes Transistor) and proximity sensor (ultrasonic, infrared and proximity)

2. Combine

• A reading lamp capable of combining the functions of automatic exposure settings (auto brightness mode) which were usually used in gadgets can be incorporated in the function of lighting by using the transducer input and output transducers and integrated circuit.
• Reading lamps also incorporate a function of distance (proximity) which is used in the 4-wheel vehicles, into a function that is able to detect the distance the object to the position of the eye and give a warning sound, so is expected to form a pattern of a healthy reading.
3. Adapt
• The shape of the reading lamp adapted the shape of headlamps that are used by people who work outdoors. By putting the light on his head, the direction of light can be adjusted to the direction of movement of the user's head.
4. Modify-Magnify-Minify
• Instead of cube shape (like the previous concept), the new shape is less weight, with rounded shape around the head, using lighter and smaller components.
5. Put on Other Use
• This product can also be used for small children who are just learning to read. Because it has a detection function which is owned product range is expected to form a pattern of healthy reading in children.
• In addition, the reading light can be used as an emergency lamp lights when service outages occur suddenly.
6. Rearrange
• Structuring the circuits in the lamp can be arranged so that there should be no separation between the resource space, a series of lights and lamps. It aims to establish the dimensions of light as small as possible.
Based on the PDS, some alternatives of concept were developed. One of the flawless of previous product is the shape of lamp and controller component. All the components were put in a box, and the box was located in the front head. This shape and position caused inconvenience for the user because the user feels there was a burden in their front head. In the proposed concept, all components were located not in the forehead, but in the surrounded of the head. Using this concept displayed in figure 2, it was expected that the weight of the product was not concentrated in one located, but it was distributed around the head.

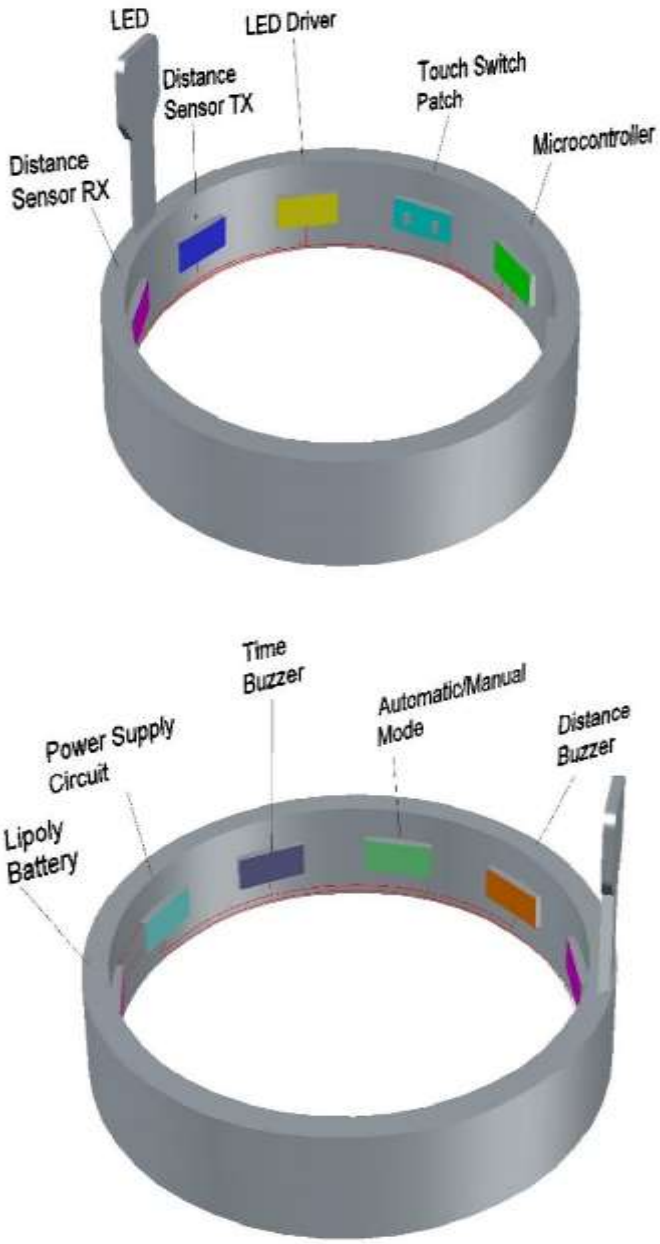

Figure 2: Proposed concept design of Sensor-based Head Reading Lamp

4. DISCUSSION

To understand how the system works precisely, it is important to know how the circuit works. Check out the schematic diagram in Figure 3. The schematic diagram is worked as the description below.

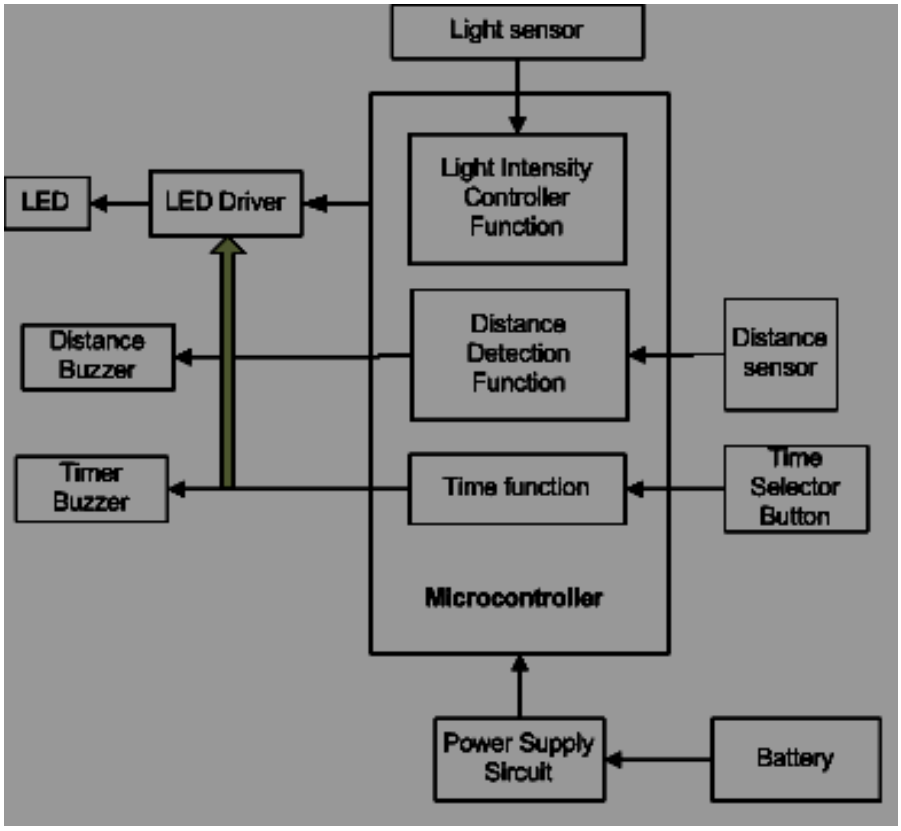

Figure 3. Schematic Diagram of Sensor-based Head Reading Lamp

1. Battery and power supply circuit was used as electric energy for every circuit system in the proposed device.
2. The Arduino was applied as a controller part of the proposed device. Adjusting the LED intensity that needed by the user was the main control function of the Arduino. Arduino read the value of the light sensor, distance sensor and used these data to perform its control function.
3. Time selector button was used as an interface to the user in selecting the time duration of reading activity and giving its information to Arduino. The Arduino produced alert sound after the time for reading activity was up.
4. Ultrasonic distance sensor was chosen as a device that used to detect the reading distance and transmitting its sensing data to Arduino. Afterwards, the Arduino used the data to active the distance buzzer when the reading distance isn't properly.
5. The LED driver was a subcircuit that used as an interface between Arduino and LED in controlling the light intensity of LED.

Using the light intensity sensor-based, this redesign lamp had the light intensity that automatically changed based on surround light intensity. Low illumination will lead to the higher light intensity of the lamp. The light intensity had been adjusted so it fits the need of reading requirement. Other feature was the distance sensor to detect reading distance. Warning light or signal was activated when the reading distance was too close.

The lamp also can turn off automatically if the reading activity was too long. All the automatic features could be deactivated if the user switched the mode to manual.

After the schematic diagram was developed, the next phase was the configuration design [11]. The configuration design phase would help to refine the components, both in terms of the technical configuration of each component and the linkages between each component. Parametric design should be done after configuration design. After all details of components are designed, a prototype would be developed. The completed embodiment design and prototyping were not presented in this paper.

5. CONCLUSION

For the proposed head reading lamp, the main requirements that were developed are a sensor for reading distance, reading time, and light intensity. Compared to the previous concept, proposed concepts reduced the dimension of the proposed device by distributing each electric circuit at the belt surface. The concept would be continued to complete the embodiment design and detail design phase.

6. ACKNOWLEDGEMENT

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