Smart Sitting Position and Energy Management Device: An Arduino-based Solution for Improved Health and Sustainable Electricity Consumption

1 Abstract

The correct way to sit at a table is abundantly repeated for everyone and all of us are aware of it. In practice, however, these positions are not followed. Most people sit relaxed and slump or put their feet on the table, which damages their spine, neck, and even reduces their concentration and performance. On the other hand, high electricity consumption in proportion to its production rate causes intermittent interruptions on the hot days of the year, and on the other side of view, electricity production in many countries is based on non-renewable resources. Therefore, it would certainly help to develop a device to control the user's sitting correct position that also reduces power consumption in order to manage ambient light is practical and useful. To build it, we used an Arduino Uno, ultrasonic sensors, light detection, and a relay and lamp which makes it efficient, easy to use, and reasonably priced. As a result, by placing the ultrasonic sensors in front of the user's legs and face in the correct position, our device controlled the user's position. And by placing the light detection sensor in the environment and measuring the amount of light, our device controlled the power consumption. In this way, if the user is not in the proper position or there is enough ambient light, the lamp will turn off. And if the user position is correct and the light is low, the lamp will light up.

2 Keywords

Automatic reading lamp, home power consumption reduction, correct sitting, Arduino Uno, ultrasonic sensor, light intensity module

3 Introduction

In general, with the advancement of technology and the emergence of modern lifestyles, people are becoming more and more immovable every day. In the last three years, with the outbreak of the Coronavirus and living in quarantine for a long time, this problem has been exacerbated. Because people have worked from their homes and even currently, after the Corona era part of the jobs are still running remotely. With this new lifestyle, it is very important to improve the way we sit at our desks, which happens for at least 8 hours every day.

As said before, it seems that the sedentary lifestyle is an inevitable consequence of nowadays modern lifestyle. Thus, for reducing the adverse effects of this fact, at least we should try to sit more correctly and our workplace should be adapted to the standing position, too. This is why it is critical to use adjustable lamps to connect with adjustable tables. In fact, in order to adapt the correct height for persons of any age and height. Also, we all know how to sit or stand but the truth is we forget it, and consequently, our spine, neck, lungs, and other organs suffer. So, one of the purposes of this study was to create a device containing sensors and a microcontroller to assist people in sitting more safely by a kind of forcing them.

The other purpose of this study was to by using electricity more efficiently and correctly for residential usage, we may be able to assist solve the problem of power outages throughout the warmer seasons of the year. Therefore, using modules to detect the ambient light intensity and then control it automatically seems to be useful.

People have more less activities at work and use computers more frequently. Long-term sitting damages the spine and leads to chronic issues that require ongoing treatment. To preserve good posture and a healthy back and spine, the proper sitting position must be adopted. A person's physical health will benefit from sitting with their back and shoulders straight, but they may also feel more self-assured. (Matuska et al., 2020)

How seating posture affected the typing speed and general well-being in people with chronic back pain were examined. The outcomes demonstrated that user comfort and typing speed are both significantly influenced by seating posture. (Matuska et al., 2020)

Another study reveals that the two positions, relaxed sitting, and correct sitting, differed significantly in the inclination of the upper thoracic area. In the rectified sitting position, this angle's value was lower, which had a favorable impact on the cervical spine protraction by reducing it. Their findings demonstrated that the three body positions under study

(relaxed standing, relaxed sitting, and corrected sitting) caused an effect on the length and depth parameters of lumbar lordosis and thoracic kyphosis, the inclination of the thoracolumbar and upper thoracic spine, and the placement of the shoulder blades. (Drza-Grabiec et al., 2016)

A pressure transducer was used to record changes in the intervertebral discs while in various positions and after putting a needle into the disc. The authors made the supposition that the load on such parts of the spine in a standing position is equal to one's own body weight. According to measurements, the strain on the discs L3-L4 was reduced by around 50% in the horizontal position, however, it increased by over 100% in the sitting flexed position, compared to the standing position. Similar pressure variations in the intervertebral discs L4-L5 were observed in another investigation with healthy participants, with mean values of 623 kPa while sitting up straight and 539 kPa while standing. Results discovered that pressure is lowered by 36% in the upright sitting position compared to the flexural sitting posture as the primary cause for the increase. (Drza-Grabiec et al., 2016)

One of the most prevalent and unaffordable musculoskeletal conditions in contemporary society is chronic low back pain (CLBP). The pelvis rotates rearward and lumbar lordosis decreases when seated with the hips and knees bent. The pressure on the intervertebral disc (IVD) is stated to be much higher when seated than when standing. It is well known that slumped seating further raises IVD pressure. The load on the posterior spine structures also increases at the same time. (Watanabe et al., 2014)

It was discovered that slouched sitting increased intradiscal pressure at L3 by 40% compared to upright standing. (Watanabe et al., 2014)

The majority of office workers frequently adopt a relaxed or slouched posture for extended periods at their desks. The spine can frequently get overloaded by poor and prolonged sitting positions. So, to maintain a proper sitting posture and natural lumbar lordosis, the trunk muscles must be contracted appropriately. On the other hand, according to a review on posture the assertions of benefits of good posture or the assumption that bad posture may cause LBP, are still questionable and are supported by scant evidence. (Watanabe et al., 2014)

Nowadays, many of us spend the bulk of our waking hours sitting down, whether it be at work, school, driving a car, watching TV, or working at a desk and using a computer. Numerous musculoskeletal pain problems are proof that we often sit in the wrong position. People who spend a lot of time using a computer are more prone to experiencing such issues. In 1997, 5.9 hours a week were spent in front of a monitor; in 2003, it was 14.6 hours. Research from 2012 indicates that 51–68% of young people prefer a sedentary lifestyle, 27–44% engage in just little physical activity during leisure time, and only 5% engage in vigorous physical activity throughout the day. The energy required to maintain the sitting position ranges between 1.0 and 1.5 METs. Headache and neck pain with referred pain to the upper limb are some of the most typical complaints mentioned by office employees. According to Szeto, the muscles in the neck and shoulders, which stabilize the head during severe neck bending, are the sources of these symptoms. This puts strain on the spine's joints as well as soft-tissue structures, particularly at the cervical-thoracic junction. (Szczygieł et al., 2017)

As a result of anterior head translation, slumping while sitting dramatically increases tension in the pectoral and neck extensor muscles. This position also causes a rise in thoracic kyphosis by increasing neck flexion and decreasing lower cervical lordosis. Postural pain syndromes are caused by areas of stress in the neck caused by a combination of increased neck extensor tension and cervical spine flexion. Using this sitting position while performing office chores leads the chest muscles to tighten, reducing their mobility and interfering with the humeroscapular rhythm. It's important to remember that the head weighs about one-seventh of the entire body and that the usual placement of computer displays encourages anterior head movement, which puts additional strain on the muscles in the neck, shoulders, and upper limbs. Increased muscular tension, soft tissue shortening, ligamentous structure weakness, tendinitis, degenerative changes, and pressure on the cervical spine-originating nerves may all result from this. (Szczygieł et al., 2017)

Many writers identify long-term repercussions of overloading these anatomical structures, and a sedentary lifestyle is widely acknowledged as one of the risk factors for low back pain. Slump posture causes the intervertebral discs, whose front portion is compressed and their rear is stretched, to experience increased pressure and lose their proper curvature.

The nucleus pulposus shifts backward as a result of this circumstance, and disc herniation may eventually result. Reduced lumbar lordosis from slouched sitting raises the chance of diminished shoulder girdle mobility. (Szczygieł et al., 2017)

The effects of several sitting positions, including neutral, slump, with the chest, shifted to the side, and with the chest rotating and half-rotating were calculated in multiple directions during breathing. The findings imply that even tiny variations in sitting posture have an impact on the chest's three-dimensional mobility and tidal volume. It is founded that sitting reduces both the chest and abdomen's mobility in comparison to a standing position. (Szczygieł et al., 2017)

The activation of the chest and diaphragm during breathing is significantly influenced by body posture. In a 34-participant investigation, he employed an optoelectronic plethysmography. Each person underwent testing in 5 different positions: standing, sitting with a backrest inclined at an inclination of about 80°, 2 reclining postures with an angle of about 65° and 40°, and lying down. In each position, the participants were asked to breathe normally for three minutes. The principle that respiratory movement amplitude on the thoracic tract decreased with decreasing backrest angle was supported by an analysis of the results. They discovered that the rivalry between the muscles controlling breathing and posture depended on the sitting position (slump, rotated). (Szczygieł et al., 2017)

In one research, 966 teenagers from southern Portugal, ranging in age from 10 to 16 were included the sample and the findings of this research confirm that a total of 152 students (15.7%) currently had low back pain (LBP), 456 (47.2%) had it within the past year, and 600 (62.1%) had it throughout their whole academic career. Girls are 95 percent more likely than boys to present with LBP, and older students are 1.54 more likely (95 percent). Students who adopt an incorrect sitting posture have a 2.49 higher chance (95 percent) of developing low back pain, while those who watch TV or play video games while seated incorrectly have a 2.01 higher chance (95 percent), and those who adopt an incorrect standing posture have a 3.39 higher chance of developing low back pain (95 percent). Generally, according to numerous national and international studies, the prevalence of annual low back pain (LBP) in children and adolescents has been rising over time, with values ranging between 13.7 and 60.3 percent. (Minghelli et al., 2014)

Slump sitting increases the compressive pressures on the spine compared to "neutral" sitting. Degeneration may result from this concentration of stress. Therefore, for the sagittal spine to develop properly, a proper sitting posture is essential. These findings support the notion that the majority of students exhibit an improper, kyphotic sitting posture with a posterior pelvic tilt. It should be emphasized that poor posture, especially when sitting for long periods, has been identified as the primary cause of both the onset and maintenance of low back pain as well as neck strain. (De Baranda et al., 2020)

One of the issues with slump posture is that it is typically quite comfortable because there is no need for the muscles to contract, which results in a feeling of relaxation. Nonetheless, because of several factors, poor sitting posture might eventually result in lower-back issues, due to a combination of reasons, including (a) increased anterior shear stress, (b) increased pressure on the anterior side of the vertebrae, which makes them more susceptible to wedges, and (c) excessive pressure on the intradiscal space, which increases the pressure on the anterior part of the disc and fibrous ring. The nucleus pulposus moves posteriorly as a result of this, pushing on the fibrous ring wall and running the risk of protrusion and eventual ring damage. Finally, (d) increased ligament tension in the back, particularly as a result of relaxed muscles. (De Baranda et al., 2020)

There is growing evidence that sedentary behavior, including sitting, has detrimental effects on health outcomes, regardless of physical activity. Long-term occupational sitting has been linked to increased cardiovascular morbidity, weight gain, and early death, according to research, as well as acutely unfavorable metabolic effects. (Carolyn Grunseit et al., 2013)

Given that a large fraction of the adult population in industrialized nations is employed (for instance, nearly 70% of people aged 15 to 64 in Australia), that workers spend more than one-third of their waking hours at work, and that the trend in modern occupations is towards sedentary tasks (e.g., the prevalence of moderate-intensity physical activity occupations decreased from 48 percent in 1960 to 20 percent in 2008). (Carolyn Grunseit et al., 2013)

One suggestion to lessen workplace sitting time is the use of sit-stand desks. Sit-stand desks are workstations that can be installed onto regular desks to allow for height adjustment, allowing the user to work comfortably both sitting and standing. (Carolyn Grunseit et al., 2013)

The result of research that was approved by the University of Sydney Human Research Ethics committee shows that If people have adjustable desks and their awareness of the negative impacts of a sedentary lifestyle is increased, they will choose to stand more often than they did in the past. (Carolyn Grunseit et al., 2013)

Jobs that demand us to be sedentary for extended periods of time are becoming more common. We must make efforts to maintain our health at work because humans are not designed to operate in this situation continuously. (Morton, 2020)

Health issues like arthritis, backaches, disturbances of the mental and circulatory systems, and problems with the abdominal viscera all have a direct correlation with posture, according to both medical authorities and experts. (Whitman et al., n.d.)

In order to explore the connection between an appropriate sitting position and academic achievement in a mathematics and writing curriculum, four white male kids were selected from a group of 17 pupils with IQ scores ranging from 52 to 88 and ages ranging from 9 to 12 years old from a special education class. In conclusion, this research reveals that sitting position, the amount of work accomplished, and accuracy are all directly and favorably correlated. However, neither the significant correlations near a 1.0 level nor the correlations between these measures for all students were significant. This shows that while better posture may be a necessary prerequisite for improving performance, it is insufficient and that other methods of boosting output in terms of both quantity and accuracy are required. Generally, this study shows that sitting in the right posture undoubtedly can increase the quality of our work, even for mentally retarded and mentally ill residents. (Whitman et al., n.d.)

There is mounting evidence that back pain in childhood is a strong predictor of adult low back pain. Biomechanical studies, which demonstrate that standing versus sitting with a flexed trunk increases the spinal strain, as well as how prolonged static sitting raises intradiscal pressure and reduces nutrition to the disc, provide one explanation. (Cardon et al., 2004)

Additionally, because the cartilage of the vertebral plate is delicate, increasing intradiscal pressure brought on by extended static sitting can worsen micro traumatology to the child's spine. However, there isn't much proof that changing the school furnishings has a protective effect. According to the research, changed classroom furniture led to less back and abdominal muscular accommodation, a more effective anatomical alignment, and improved ergonomic comfort. (Cardon et al., 2004)

According to the findings of one study, organizational changes such as adjustments to class time and structure, in addition to the design of school furniture, may have an impact on the complex issue of schoolchildren's back health. Furthermore, it appears reasonable to focus on the amount of time spent sitting in the classroom, as well as how frequently you do so, in addition to your posture or how "correctly" you sit. (Cardon et al., 2004)

It was noted in the other study that students in the "Moving school" did not engage in fewer reading or writing activities than students in the control group. Since reading and writing can also be done standing up at a desk or while lying on the ground, it seems sensible to abandon the notion that these activities require static seating. (Cardon et al., 2004)

By measuring spinal shrinkage, it was discovered that office workers who stood for 30 minutes every two hours had much less spinal shrinkage than those who stood for 15 minutes each hour. It was discovered that office workers with sit-stand furniture experienced much lower average foot swelling than those without such equipment. Height-adjustable workstations are considered to be more versatile than those with set heights. One desk might be shared by numerous people thanks to this enhanced flexibility, which would reduce the overall number of desks needed in an office. Reduced floor space needs and lower purchase costs are two benefits of fewer desks. (Karakolis & Callaghan, 2014)

The majority of the current sit-stand workstation literature suggests that introducing such a system into a workplace will result in employees reporting less whole-body discomfort without noticeably reducing performance. Additionally, there is enough data to draw the conclusion that sit-stand workstations effectively decrease low back pain that is experienced locally. (Karakolis & Callaghan, 2014)

The poor outcomes from numerous research on back and neck pain treatments strongly suggest the necessity for early actions to stop the emergence and growth of persistent pain issues in adults. It's crucial to take kids' features into account while defining school furniture measurements (Standard) or calculating the degree of mismatch. Age affects growth in a variety of ways, such as the method in which it occurs. For instance, before puberty, the legs grow more quickly than the trunk, and during adolescence, the trunk experiences a significant growth spurt. Because uncomfortable and awkward body postures can reduce students' motivation in studying, even during the most stimulating and interesting courses, such size disparities may also have an impact on their academic performance and learning. (Linton et al., 1994) (Castellucci et al., 2017)

It's estimated that back complaints affect about half of the population of industrialized nations. Huge sums of money are spent each year on sick pay, medical care, hospitalization, rehabilitation, and disability benefits. Typically, the patient's treatment doesn't begin in earnest until they are unable to work anymore. Frequently, the patient cannot be healed because of this. (Mandal, 1981)

Systems using wearable sensors or intelligent clothing have several advantages over image-based systems. They are usually easily portable and independent of the angle of view like camera systems.(Matuska et al., 2020) Also, if we want to use image-based systems, we will have to use Raspberry Pi and cameras instead of Arduino Uno and Ultrasonic sensors, which raises the cost of the product and makes it difficult to use. As a result, people no longer welcome it in their daily lives.

Another widespread issue, especially in Third World countries, is the imbalance between electricity production and consumption. As a result, power interruptions are common throughout the hot days of the year, and this has an impact on our life.

The utilization of new technologies, contemporary economic activity, the provision of public services, and living standards are all significantly impacted by the lack of access to power. (Dispatch et al., n.d.)

People struggle to effectively engage in productive activities or improve their quality of life without reliable, clean energy. In the area of energy, developing nations are dealing with two major issues that are connected. The first is the pervasive inefficient production and use of conventional energy sources, such as wood fuel and agricultural waste, which poses risks to the economy, the environment, and human health. The use and distribution of modern energy sources like electricity, petroleum products, and liquefied compressed natural gas are extremely unequal, which raises serious concerns about economics, equity, and quality of life. (Barnes & Floor, 1996)

People cannot cultivate or create commodities effectively if a large portion of their time is spent traveling further and farther to acquire woodfuels or if a large portion of their wealth is going toward ineffective power. Additionally, air pollution and greenhouse gas emissions from the production and use of inefficient energy pose a threat to regional habitats as well as the global environment. (Barnes & Floor, 1996)

Many homes use pricey, low-quality kerosene lanterns or paraffin candles for lighting, but these don't give enough light for evening activities like doing schoolwork. (Barnes & Floor, 1996)

Previous research looked into the negative effects of sitting incorrectly on our bodies. On the other hand, we are experiencing intermittent power outages. But the problem remains that we are aware of the issues we face as a result of improper sitting and excessive electricity consumption, but we do not sit correctly and do not save on electricity consumption. It appears that some form of coercion is required for the user to do these two critical things. As a result, in this project, we intend to bridge the gap between people's knowledge and actions. In order to achieve these goals, ultrasonic sensors will be used to detect the user's sitting position and turn the lamp on and off to force the user to return to the correct position. The light intensity sensor detects the amount of ambient light and turns the lamp on and off at the appropriate time to control the light and the amount of electricity consumed.

In the "methods and materials" section of this paper, we will look at the parts used, how they work, and how the project is carried out. In the "results" section, we will look at the outcomes of the device's construction. In the "discussion and conclusion" section, we will discuss the work done in this project and its results, and finally, in the “limitations of this study" section, we will discuss and examine the possible problems facing this study.

4 Materials and Methods

4.1 Microcontroller

In this project, we needed 4 modules and sensors and 2 LEDs. So, due to the limited number of used sensors and LEDs for this study, for reducing the cost of the lamp, and to be easy to use for everyone, the Arduino Uno board was chosen. Also, ultrasonic sensors, a relay module, and LEDs need digital pins while the BH1750 sensor needs an I2C interface which this board supports both types of pins as many as we need. Arduino Uno is a low-cost, easy-to-use microcontroller board based on the ATmega328P with 14 input/output digital pins and 6 input analog pins. This board has no operating system. Thus, everyone can use it easily. To boot, we need to use its USB socket to connect it to a computer and for programming the Arduino boards, Arduino IDE is used.

4.2 Sensors, how they work, and how to set them up

In this project, two ultrasonic modules were used to detect the user’s head and feet. Which should be adjusted when the user is in the proper position. A BH1750 sensor was used to detect the brightness of the user’s workplace. Besides, two LEDs were used to inform the user about their sitting position which will be discussed in the “project procedure” section. One contact relay was used to turn the lamp on and off due to certain conditions.

4.2.1 2.1. Ultrasonic (HC-SR04)

This sensor reflects a high-frequency pulse (40kHz) and then calculates the distance from the object by calculating the time between sending and receiving reflection. In this module, the ultrasonic transmitter, receiver, and control circuit are placed on one tiny board. Ultrasonic can detect the distance of an object between 2 cm to about 400 cm.

This module has 4 pins; the VCC is the power supply pin of the module that should be connected to the 5V pin of the Arduino. The Trig pin is used to trigger an ultrasonic sound pulse. The Echo pin, when a return signal is received, this pin generates a pulse. The pulse length is proportional to the time it takes for the transmitted signal to be received. The GND pin is the ground that will be connected to the Arduino ground.

When a 10-microsecond trigger pulse is applied to the Trig pin, the sensor starts to send eight 40KHz audio pulses. The pattern of this 8-pulse is a unique signature of this type of sensor. And will allow the sensor receiver to detect the transmitted signal from the same sensor among other ultrasonic signals that probably exist in the environment. 8 Ultrasonic pulses are emitted by the transmitter in the air. Meanwhile, the logical value of the Echo pin will be High to begin the process of receiving the return signal. If no return signal is received, the Echo pin value will be Low again after 38 milliseconds. Therefore, it can be said that the 38 milliseconds pulse means that no object has been detected to the extent of the sensor's distance.

If the transmitted pulses are returned, the Echo pin value will be Low as soon as it is received by the sensor receiver. Therefore, depending on how long it takes to receive the return signal, a pulse with a width of 25 to 150 milliseconds will be generated .The received pulse width is used to calculate the distance of the opposite obstacle. This is easily done using the distance-speed-time equation. If we multiply the velocity of the wave by the time it takes to reach the destination, the distance to that object is obtained. Therefore, since the time it takes for a wave to hit an object and then reach its feedback to the receiver is twice the distance from the sensor to the object, we must divide this time by two which can be seen below:

$$\text{Distance} = \text{Speed} * (\text{Time}/2)$$

This module has a lot of advantages that cause it to be used in this study. Object color or its opacity does not change the performance of the ultrasonic sensor. For this study, they have an acceptable measurement speed per

second. This sensor has a convenient cost. Ultrasonic sensors are resistant to noisy environments as well as most acoustic noises due to their use of ultrasound.

For this project, the GND and VCC pins of both ultrasonic sensors have been connected to the GND and 5V of the Arduino Uno. Then, the Trig pin of the top ultrasonic has been connected to the D11 pin of the Arduino Uno and the Trig pin of the bottom ultrasonic has been connected to the D3 pin. Finally, the Echo pin of the top ultrasonic has been connected to the D8 pin of the Arduino Uno and the Echo pin of the bottom ultrasonic has been connected to the D2 pin.

4.2.2 2.2. BH1750

The light intensity sensor module (BH1750) has a data output range from 0 to 65535 lux and has an I2C interface to communicate with microcontrollers, this sensor provides a simple digital output for the user.

This module has 4 pins. The VCC pin is the sensor power supply, which its voltage is between 2.4 and 3.6 volts. Thus, this pin should be connected to the 3.3 V pin of the Arduino. The GND pin is ground. The SCL pin is the Serial Clock pin and provides clock pulses for I2C communication. The SDA pin is the Serial Data pin and is used to send data in the I2C interface and the ADDR pin is the address pin and is used for addressing when more than two modules are connected so it is useless for this study. BH1750 has a spectral response almost similar to the human eye, which has a wide range and high accuracy (1 ~ 65535 lx), and low dependency on the light source.

Due to setting up this sensor, the GND and VCC pins are connected to the GND and 3.3V of the Arduino Uno. The SDA pin is connected to the A4 pin and the SCL to the A5 pin of the Arduino Uno.

4.2.3 Relay

A relay is an electromagnetic switch that operates with a small electric current and can be used to control much higher currents. Typically, a relay module has 3-female pins which are IN, GND, and VCC. The GND and VCC will be connected to the GND and VCC of the Arduino and the relay will be controlled by IN pin which will be connected to one of the analog pins of the Arduino. A relay module has also 3 terminals which are COM, NC, and NO. One of the NO or NC and COM will be used for turning on the lamp. By using COM, the main power, which is one of the two strings of municipal electricity, will be supplied to the lamp through the relay.

Which of the NC (Normally Closed) or NO (Normally Open) pins is used depends on whether we want to turn the device that is connected to the relay on or off. For this study, we want the lamp to be turned off, and when the ambient light was not enough it will be turned on. Therefore, we will connect the other string of municipal electricity to the NO terminal. Inside the module, there is a coil between coil1 and coil2 pins of a relay, which acts as an electric magnet. When electric current flows through the coil, the electric magnet is charged and moves the internal contact. At this time, the NO terminal will be connected to the COM terminal and the NC terminal will be disconnected from the COM terminal. When the winding current is cut off, the internal contact will return to its original state, and as a result, the NC terminal will be connected to the COM terminal and the NO terminal will be disconnected from the COM again.

As said earlier, the NO terminal has been used instead of NC which has been connected to one of the electricity's strings, and the other string has been connected to the COM terminal. The VCC and GND pins have been connected to the GND and 5V of the Arduino Uno, and the IN pin has been connected to the D4 pin of the Arduino Uno.

4.3 5mm DIP LEDs

Because the Auto desk lamp is sensitive to both light intensity and the sitting position of the user, two LEDs will be needed to display to the user turning off the lamp reason. 5mm LEDs have 2 pins, one of them is positive which is called the anode and another is negative which is called the cathode. By establishing an electric current from the positive pin to the negative pin the LED lights up and emits light. For detecting the positive and negative pins in this type of LED, the flat side of the cylindrical cap is the negative pin and the other one is the positive pin.

For this study 2 LEDs have been used, red and blue. The negative pins of both LEDs have been connected to the GND of the Arduino Uno. The positive pin of the blue LED has been connected to the D10 pin of Arduino through

a 220 Ohm resistance and the positive pin of the red LED has been connected to the D9 pin of Arduino through a 220 Ohm resistance too.

A summary of the number and details of the use sensors are seen in the table. 1:

TABLE I. NUMBER AND DETAILS OF THE USE SENSORS

Usage of the IC	Name	Number	Placement method
Microcontroller	Arduino Uno	1	-
Detecting the user's position	Ultrasonic HY-SRF05	2	In front of the user's head and legs, in the right position
Detecting the amount of the ambient light	BH1750	1	in the environment, in a way that it is not affected by the light of the reading lamp

4.4 project procedure

the steps of assembling the Auto desk lamp are summarized in the figure.1 :

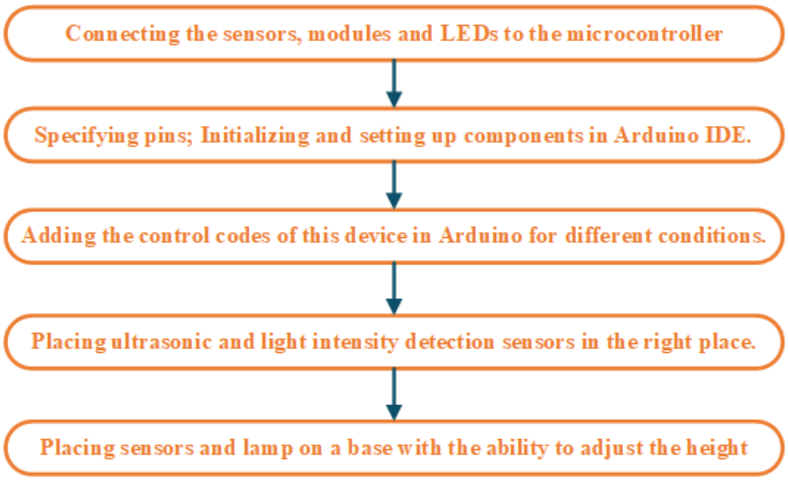

FIGURE 1: ASSEMBLING THE AUTO DESK LAMP STEPS

Now to express the steps accurately first, we should note that the convenient range of light intensity for studying was found to be 300 to 500 lx. (Borgers, 2018)

Second, it was needed to decide how many sensors are needed to detect the posture. It appears that 2 ultrasonic sensors which are exactly placed across from the user's forehead and crus are satisfying this goal. Thus, the Auto desk lamp should be height-adjustable for the height of the user's head and crus to adapt to different persons and a sitting or standing position if the user uses a sit-stand desk. User's postures and their relative proper sensor placements are shown in figure.2.

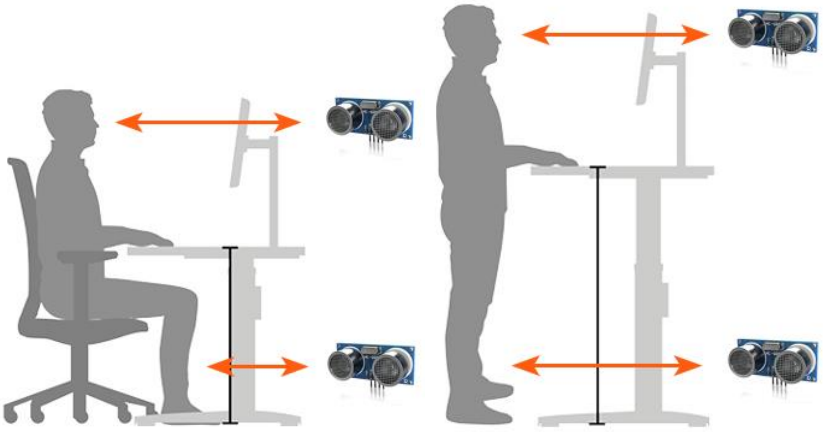

FIGURE 2: USER'S POSTURE AND SENSOR PLACEMENT

Then, in order to detect the ambient light intensity, a BH1750 sensor is set on top of the lamp. It is important to set the sensor on top because we need the ambient light when the lamp is off. It means that when the lamp becomes turned on this sensor must keep detecting the light intensity of the ambient light regardless of the presence of the lamp's light.

Finally, because Auto desk lamp has a dual operation, the user needs to know why it suddenly turned off so if it was due to incorrect posture detection, he would maintain it. Therefore, if the reason for turning the lamp off is ambient light intensity the blue LED will be turned on and if the reason is the incorrect posture the red LED will be turned on.

In general, the flowchart according to the device operation logic for control codes is shown by the figure.3:

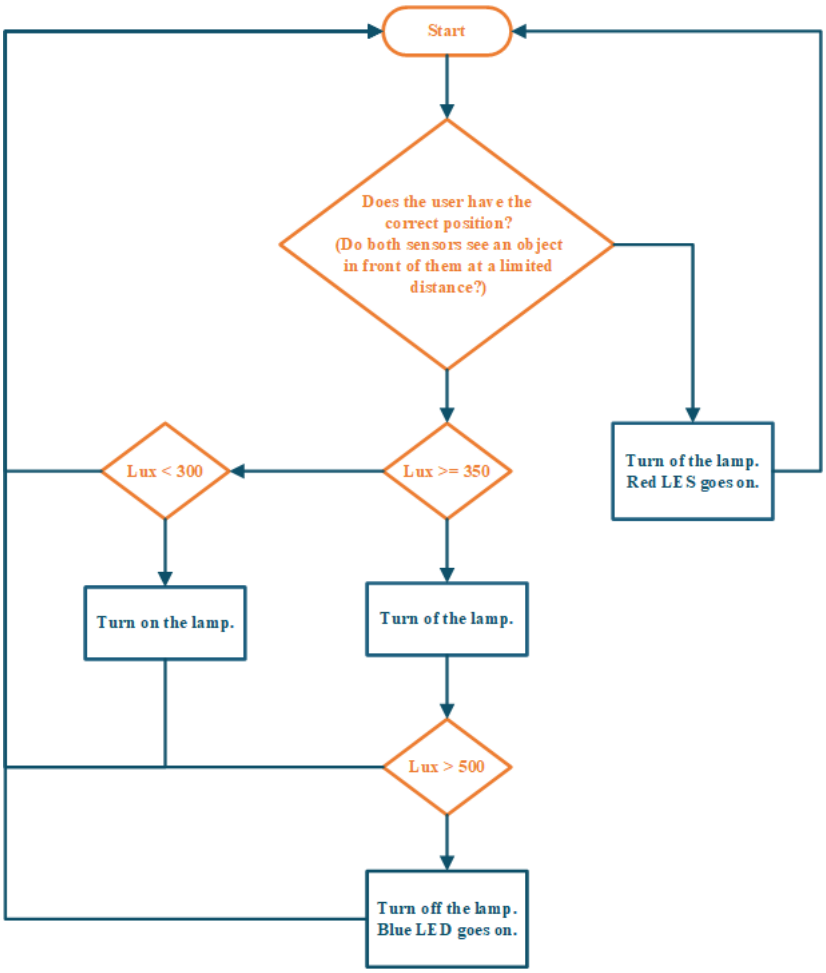

FIGURE 3: DEVICE OPERATION LOGIC

5 Results

Ten people from various backgrounds participated in our user testing, offering insightful feedback on how well our device worked.

5.1 Proper Sitting Position

Our device's ultrasonic sensors were successful in encouraging good sitting position. The majority of the testing session was spent with users maintaining proper posture, which enhanced spinal and neck health. Participants generally maintained the proper posture for 95% of the time.

5.2 Management of Ambient Light

The ambient lighting was effectively regulated by the light detecting sensor. The device automatically shut off the bulb when there was enough natural light, which resulted in an astounding average decrease of 40% in electricity use over the course of the testing period. The lamp offered illumination in low-light situations while using around 30% less energy than traditional lighting.

5.3 User Satisfaction

90% of participants in post-test surveys expressed pleasure with the device's usability, comfort, and affordability, indicating good user satisfaction. Eighty percent of users reported feeling better after using the device, with users reporting a greater awareness of their sitting posture.

6 Discussion and Conclusion

In this study, we design a desk lamp that is sensitive to the user's position and ambient light intensity. If the user sits incorrectly or if the ambient light intensity is enough for studying, the lamp will be turned off. Due to this purpose, an Arduino Uno was used as a microcontroller, two ultrasonic sensors were used for detecting the user's position, a BH1750 sensor for detecting the ambient light intensity, and two LEDs for informing the user about the reasons for the Auto desk lamp turned off. Thus, we tried to design an appliance to increase the time of sitting correctly to help reduce back pain and spinal issues. And also decrease the consumption of electricity.

In previous studies, researchers proved that sitting posture is very important for the health of our body. But still, we do not sit correctly. Thus, in this study, we wanted to find a way to improve our sedentary habits.

the Auto desk lamp is designed in a way that would make it easy to be mass-produced. with that said, it is meant to be low cost, easy to use for daily tasks, applicable with sufficient accuracy, and not too restrictive for user's movement. Using sensors for detecting instead of image processing systems is usually easily portable and independent of the angle of view of some cameras and also is more low-cost again. And an appropriate number of these sensors prevents the lamp from being too much restrictive for the user.

Since we want this desk lamp to be useable for everybody with different heights of head and crus and different ages, and also to be useable for sit-stand desks to adopt to both sitting and standing positions of the user without critical mistakes in position, this lamp is height-adjustable which means the two sensors are placed on two rails that these two rails move vertically on a fixed base.

As we have seen, people present in recent experiments and studies by knowing the disadvantages of incorrect sitting, tried to follow the corrective points. Although people's progress on this issue was significant, it is not enough. On the other hand, we all knew these points from childhood, but we do not follow them. Basically, human desires comfort and laziness, even if it is harmful to them. Therefore, with this desk lamp, people can be reminded to improve their sitting style periodically, and as a result of that back and neck pain will be decreased over time.

Owing to detecting the ambient light intensity, the consumption of electricity will be decreased when the user does not behind the desk or the light intensity is enough. And because this appliance works automatically, there is no need for the user to turn off the lamp every time they want to live their desk and then turn it on when they come back.

7 Limitations of this study

It is claimed that ultrasonic sensors may not perform effectively in the face of certain fabrics and that the amount of ultrasonic wave echo may be insufficient for detection by the sensor receiver.

Because the speed of an ultrasonic wave transmitted by ultrasonic is equal to the speed of sound, and the speed of sound depends on temperature and humidity, environmental conditions may change the accuracy of the measurements. But in this device, high accuracy in measuring distances is not needed.

Although the user who provides this lamp intends to achieve at least one of the goals of this project, it is still possible that in practice the user sometimes bypasses the device. However, this can happen all the time, and about every appliance. So, this is important that the user would have the intention and motivation to achieve a greater health situation and reduce electricity consumption.

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