Smart Workstation Integrated with Arduino and Raspberry Pi based Embedded Systems

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***Abstract*:- The Indian IT sector has had its ups and downs. According to the recent statistics, National Association of Software and Services Companies (NASSCOM) has confirmed that the industry continues to be a net hirer and reports that 2.5-3 million new jobs will be created by 2025. With a growth prediction of 8%, the Indian Information Technology-Business Process Management(IT-BPM) industry will add 1,05,000 people to the current 3.97 million workforce, in 2018, according to the latest figures published by NASSCOM. From the given statistics, we can conclude that, the number of desk jobs in India have sharply increased. Hence, the objective of this project is to develop a workstation that helps the user boost their productivity and organise their work in an efficient and simple manner.**

General Terms:- Automation, Embedded System.

Keywords:- Office automation, home automation, automation.

1. INTRODUCTION

The workstation available in the market today only provides a sturdy surface to support the user in carrying out their desired task. This table does not account for the productivity of the user. This project aims at developing an intelligent table that adapts to the user, in order to increase the productivity by eliminating minor task at the table such as maintaining proper illumination on the work station depending upon the surrounding condition and providing the user with an interface where he/she can set his goals which will be displayed to the user at certain intervals so as to keep the user focused to it. The user can keep reminder about jobs that he/she has accomplish by the end of the day. This project also aims to achieve all these goals with optimum use of electricity, which is implemented using the Smart Switch Board. The inactivity of the user will be noticed by the controller by means of the weight sensor and a long time inactivity will lead to the switching off of the peripherals and lights in order to save electricity.

2. STRUCTURE

The smart workstation has been integrated with five peripherals that together makes an intelligent system. The five peripherals are:

1) Automatic Brightness Module
2) Smart Switchboard Module
3) Password Enabled Safety Vault
4) Activity Monitoring System
5) Progress Tracking and Enhancement system.

The structure of this workstation is given in the following figure.

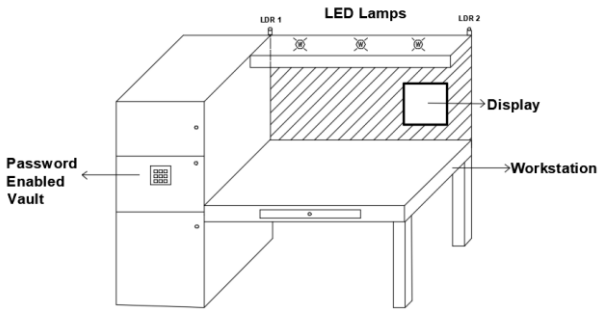

Fig. 1. Structure of Smart Workstation with the peripherals

3. AUTOMATIC BRIGHTNESS MODULE

3.1 Overview

One of the most important factor that affects the productivity at workstation is the lighting condition. In general, if we consider a room having multiple sources of illumination (E.g. Windows, Tube lights, etc.) which may vary from time to time, then it is difficult to maintain the required intensity of light at the workstation. In order to resolve this problem an Automatic Brightness Module is used so that such issues do not bother the user while working at the workstation. As per JIS Z9110-2010 (General rules of recommended lighting levels) the recommended lighting for various purpose is shown in Fig. 2. Therefore, the intensity at the workstation is maintained close to 500-700 lux, as majority of the activities carried would come under the classification of reading/studying.

Fig. 2: Recommended lighting level for various purpose

3.2 Circuit Diagram

The following items are required for setting up this module:

- LDR Module
- Arduino
- Relays
- LED Bulbs

The Fig. 3 shows the connection of the same.

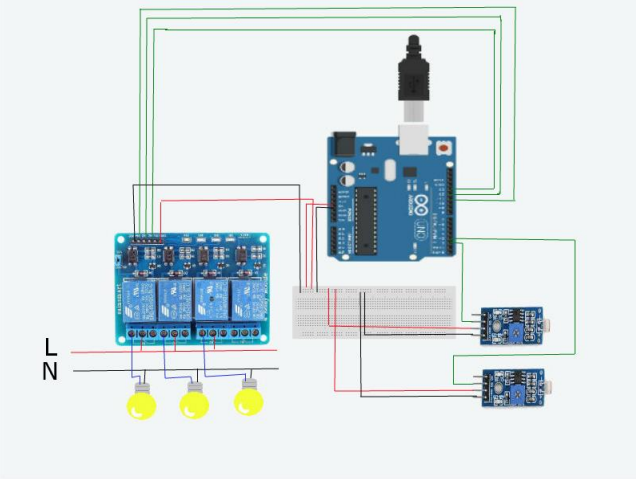

Fig. 3: Circuit diagram of Automatic Brightness Module

3.3 Working

The LDR module will be operating at analog mode and the Arduino will receive the values sent by the by this sensor. The Arduino board will compare this input value with the predetermined values and decide the number of LED(s) to be kept on and will send the signal to the relay accordingly. The block diagram shown in Fig.4 will illustrate the flow of signals in the system.

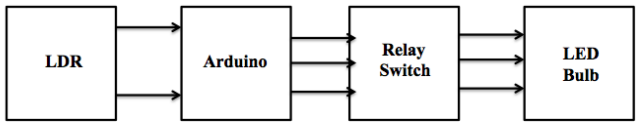

Fig. 4: Block Diagram of Automatic Brightness Module

Two LDR modules are used to sense the light intensity for redundant purpose and the highest reading amongst the two will be accepted by the Arduino in order to avoid error caused due to obstruction or shadows falling on the sensor.

4. SMART SWITCHBOARD MODULE

4.1 Overview

The smart switchboard module is an integral part of this project. This switchboard provides additional outlets for the user to input their desired appliance. The objectives of this switchboard is as follows:

i. Remote accessibility of switching ON and OFF of appliances.

ii. Time based switching ON and OFF of the appliances.

4.2 Circuit Diagram

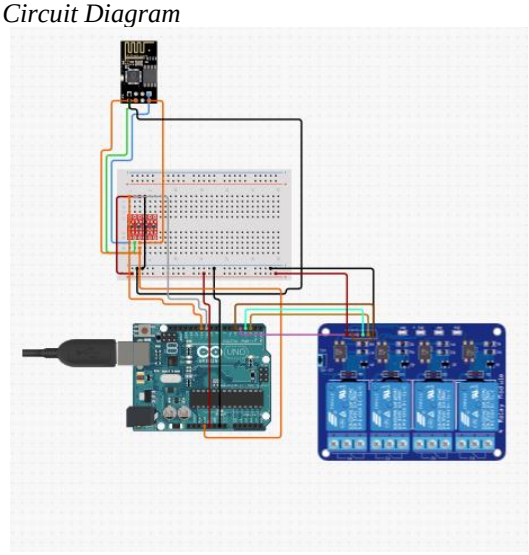

Fig 5: Circuit Diagram of Smart Switchboard Module

The following components are required for setting up this module:

i. Android Device

ii. ESP8266P – 01 Wi-Fi Module

iii. Arduino Mega/Uno

iv. Relay Module

The Android device can be used as remote controller of this switchboard. An application developed for this purpose is installed on this device. The connections of the rest of the components is shown in Fig 5.

4.3 Working

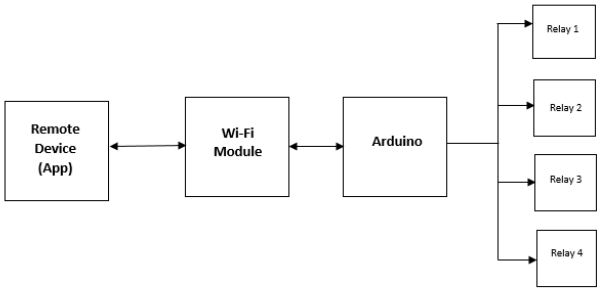

Fig. 6: Block Diagram of Smart Switchboard Module

The working of the smart switchboard is based on continuous monitoring of the state of the relay. The user must connect the remote device to the same server as that of the Wi-Fi module for the switchboard to operate. Once this connection is established, the user can now send the commands through the remote device. When the user gives a command, the signal is sent via internet to the Wi-Fi

module. The Wi-Fi module picks up this signal and feeds it to the Arduino. Based on the signal, the Arduino energizes and de-energizes the relay coils. The time based switching ON and OFF of the appliance is done via the remote device. The ON time and OFF time is taken as a parameter from the user. Based on the system time of the remote device it sends an ON signal and OFF signal at their respective times.

5. PASSWORD ENABLED VAULT

5.1 Overview

This system employs the keypad module along with the Arduino to setup a simple password enabled locking system. This system ensures the safety of the items kept within the vault and incorporates theft detection technique.

5.2 Circuit Diagram

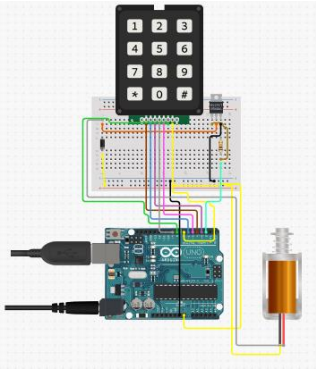

Fig. 7 Circuit Diagram of Password Enabled Vault System

The circuit comprises of a 4x3 Matrix Keypad and a solenoid lock. The connections of the same is shown in Fig.7.

The 4x3 Matrix Keypad module is interfaced to the Arduino Mega to take the input from the user. This input is then matched with the preset password to check the validity of the password. If the password is valid, the safety lock will be unlocked. If invalid, the door lock will remain locked. The 4x3 Matrix Keypad Module consists of 4 rows and 3 columns.

5.3 Working

Typically, the keypad will have seven connection wires through resistors R1, R2, R3 R4 and C1,C2,C3 representing the rows and columns respectively. The matrix encoding scheme requires fewer output pins and thus fewer connection that have to be made for the keypad to work. The password is matched with the preset password. If it is a match, the solenoid lock is actuated, and the safety lock opens. For a default value, the lock stays open for 2 mins after the lock has been opened, after which the solenoid coil is de-energised and the vault is locked.

For additional security, anti-guess element is present i.e. after 4 wrong attempts, the system is blocked and has to be reset for further use. The reset button would only be known to the primary user.

6. ACTIVITY MONITORING SYSTEM

6.1 Overview

The activity monitoring system is setup in this project to reduce the energy consumption of this model. Since this model needs to be ON throughout the span of the day, energy consumption becomes a major hindrance that needed to be addressed. The objectives of this system are:

i. Monitor the activity of the model, and turn OFF the peripherals during inactivity.
ii. Reduce the energy consumption of the model.

6.2 Sensors

The above objectives are realised using two sensors – Load Cell sensor and Limit Switch. The Load cell sensor is installed at the base of the chair to be used along with this table. This sensor will sense the presence of a user on the chair. The Limit switch is attached at the edge of cabinets to detect whether the cabinet id open or close. If the cabinet is open, and the user is away, the cabinet must be closed.

6.2.1 Load Cell Sensor

The load cell sensor is an analog device that shows the mass of an object placed on it. This module uses 24 high precision A/D converter chip HX711. It is a specially designed for the high precision electronic scale design, with two analog input channel, the internal integration of 128 times the programmable gain amplifier. The input circuit can be configured to provide a bridge type pressure bridge (such as pressure, weighing sensor mode), is of high precision, and low cost is an ideal sampling front-end module.

This sensor is used as a digital device for this model. The sensor senses the presence of the user on the chair and then sends this signal to the primary controller. If the user is not on the chair, the sensor waits for 5 minutes. In this period, if the user sits on the chair, the sensor resets else at the end of the period a signal is sent to the primary controller about the user's absence.

The primary controller in turn de-energizes the relay coils connected to all the peripherals. Consequently, the peripherals are turned OFF.

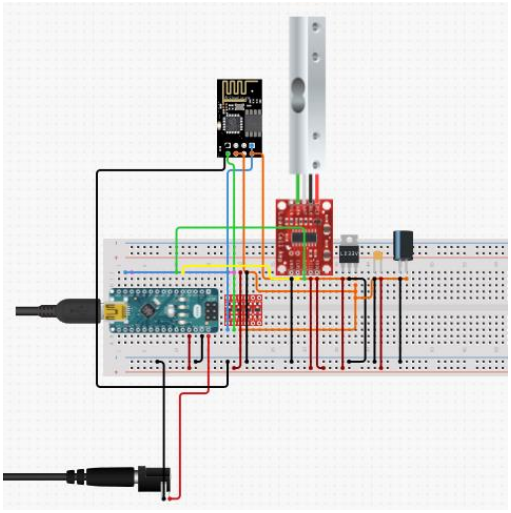

Fig. 8: Circuit Diagram of Load Cell Sensor

6.2.2 Limit Switch

The limit switch is used as sensor in order to determine the status of the door (Open/Closed). The switch has three pin common, normally open and normally closed, the arduino input pin, ground and supply will respectively be connected to these pins such that the arduino receives digital signal indicating the status of the door.

So depending upon various inputs arduino can take decision of determining the desired position of the door and then considering the current position of the door the signal will be sent to the motor whether it has to remain in the same position or it has to rotate in clockwise or anti-clockwise direction.

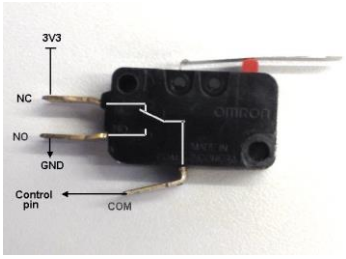

Fig. 9 Limit Switch

7. PROGRESS TRACKING & ENHANCEMENT SYSTEM

This system is solely responsible for boosting the work done by the user at the workstation. In this system the user is supposed to divide the goal in milestones and feed the daily, weekly, monthly or yearly goals through the app interface, where the app will then keep the track of your percentage progress and will give timely notifications to ensure persistent perseverance towards your goal. The Fig. 10 shows the glimpse of the app interface. The goals will also be displayed at the monitor placed on the workstation along with motivational quotes to keep the user motivated. The user can also choose the content that is to be displayed at monitor using the app interface.

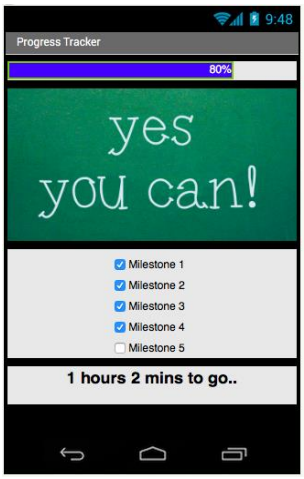

Fig. 10: App Interface of Progress Tracking System

8. REMOTE ACCESSIBILITY

This feature allows the user to remotely operate the peripherals of the table. The functionality such Smart switch board can be operated when the user is far away provided the user has access to the internet.

This can be achieved by using a Raspberry Pi, which has to be connected to the internet in order to establish communication with the remote control i.e. the app interface used by the user. The block diagram in Fig. 11 illustrates the functioning of the same.

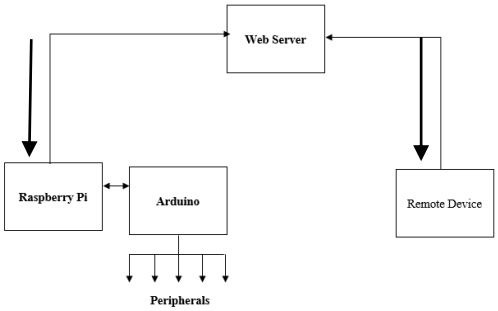

Fig. 11: Block Diagram illustrating the Remote Accessibility of this model.

9. CONCLUSION

This Smart Workstation unit is a combination of various peripherals such that they enhance the productivity of the user It provides ease of control between various peripherals and enables the user to operate the device remotely.. The progress tracking and enhancement system caters to the simple and efficient organization of the user's work by dividing a large project into smaller milestones and motivating the user to achieve goals faster. Thus, this workstation proves to get better results from the user when compared to a regular workstation.

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11. ACKNOWLEDGEMENT

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