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USER-CENTRIC DESIGN AND COMPOSITION FOR HUMAN COMPUTER INTERACTION

Thu Zar Aung(1) , Nay Zin Oo (2), Thida San(3)

(1)(2)(3)University of Computer Studies (Meiktila), Myanmar

(1)ucs.thuzaraung@gmail.com

ABSTRACT

User experience is related to wide variety of aspects for utility and ease of use to for flexible and compatible experiences through the whole-time frame where an individual is in contact with a product, system, service or object. One of the approaches to achieve a good user experience is with user-centered design and composition. In human computer interaction, human needs, user-friendly designs and customization are considered as first priority compared to other aspects such as technical specifications, and early user input. Designing digital interfaces requires writers to make rhetorical choices that are sometimes technical in nature and often correspond with principles taught in the computer science subûeld of human-computer interaction. In this paper, we present the techniques and architecture of how to decide a design patterns meet with users' requirements and HCI-techniques. The aim of this paper is to elicit critical thinking and helping the students to explore their creativity and roles as HCI designers. With those purposes, we explain methodological implications of HCI and in the meantime, we point out how the proposed system implement effectives of HCI deigns and composite designs with the help of user experience and techniques of HCI.

KEYWORDS: *human computer interaction, designs and composition, user-centered design lity*

1. INTRODUCTION

Design fictions has gained a lot of attention in Human-Computer Interaction (HCI) and design research due to its essentiality in every computer-aided applications and materials in all kinds of devices for web-based, pc-based and mobile-based applications, etc. HCI helps non-existing devices and services, created in order to facilitate connectivity and reflection of the political and/or social impacts of new technologies. For example, this method has been used to point out the presuppositions regarding the design of technologies for behavioral and response changes of the users for the design and customization impacts and self-tracking [1] [2]. Nonetheless, design fictions have been commonly developed by UI/UX designers who both created fictional prototypes and commented on them, to offer a critical point of view to the HCI research and HCI methodologies. Therefore, capability of generating reflection on relevant technology issues, has been interested in the studies of HCI researchers and research communities.

From HCI perspective, composite designs can help students for more understandability and accessibility, not only to create theoretically and also practically student's matters and subjects when it comes to combine with technology-based classrooms and laboratories. This HCI-based software brings two advantages not only in academic area but also other areas such as medical, agricultural, etc because today world is changing to devices-based world with the help of HCI interaction between users and devices. In this case, the two advantages that HCI introduced was in what follows.

The first one is that it can remind students about the rhetorical nature of technologies when they first see technology-based lectures and experiments while the later one is that it can leverage the current work done by the HCI ûeld, to have flexible and adaptable design and customization with newest advanced technologies so that we can provide students with solid principles for the effective design of digital texts, visual aids and interfaces.

Due to above-inspirations of current HCI challenges regarding academic works for both teachers and students, in this paper, we aim to present HCI designs and composition methodologies and practical issues with the following contributions and presentations.

First, we will show how design and composition concepts can be used in an educational context by students with no design/HCI background. The purpose is to introduce them regarding not only the design process and also motivate them critically to reflect on current cutting-edge technology. Second, some of the ways in which HCI principles are introduced to pave the way for an HCI-informed software. These two steps are considered based on assignments, student responses and questionnaires of the students from the classroom events where an HCI-based designs and composted devices.

The rest of the paper is organized as follows. Related work is described in Section 2. Section 3 comes for presenting our proposed steps by providing detailed explanation and some scenarios. The experiment is described as Section 4 and the paper is concluded in Section 5.

2. RELATED WORK

Designing digital interfaces needs human writers to make rhetorical choices that are sometimes technical in nature and often correspond with principles taught human-computer interaction, as a sub-field of computer science. Although it has many ways to do research in design and composition field, it is hard for the students to understand the relationship between the developers who created texts/interfaces for their applications and the users because there is a variety of human creations such as beliefs, attitudes, values, demographics, etc and computer capabilities such as the software, hardware and other types of mediation instead of focusing on what matters most in interaction between the two.

Paula et al assume that an HCI-informed writing pedagogy can complicate for both writing and university students[4]. The important role of the scientists is to design traditional and digital interfaces. Reducing the user's cognitive load, and testing and repetitive reediting and redecorating, software development may serve as a model for a newer type of writing pedagogy. This pedagogy leverages the research being done in HCI on user-centered design and composition. In addition to this, it offers strategies and approaches that could be used when composing digital as well as traditional paper-based interfaces. Furthermore, they ûnd that an HCI-inûuenced writing pedagogy can be used in science classrooms in the way of reminder to the students that the design of digital interfaces demands attention and their practice as well.

Boštjan et al proposed HCI-based motor disabilities in their interaction with standard computer interfaces[5]. The contemporary human computer interfaces have allowed for the development of innovative solutions for hands-free Human Computer Interaction (HCI), which can improve the quality and accessibility of Information and Communication Technology (ICT) for motor-impaired users. The objectives of this study were to design, develop and evaluate a solution for a hands-free HCI, based on the Emotive EPOC+ device, and control they system with facial expressions and motion sensors. The enabled adults and disabled eight adults participated in an experiment to evaluate the proposed HCI solution. The main purpose of this study is to help motor-impaired users who need innovative solutions for interacting with ICT. Their system enables them to use computers independently with the help of user-friendly designs and compositions without need to touch the computers or LCD displays. This study highlights a lot of potential for future research not only academic area but also Hands-free Human Computer Interaction researches. The results of the data analysis and comparison between non-disabled and disabled users showed that the disabled users performed very similarly to non-disabled users while using the proposed EPOC+ solution for the first time.

In study, they explored three different research themes. First of all, they investigated whether fictional designs are able to investigate the students' thinking about technology to reflect on the potential long-term and implications of HCI technology. Second of all, they tried to understand whether design fictions are capable of helping students unveil the presuppositions that lie behind current cutting-edge technologies. It resulted that fictional designs may enable the students to identify the theoretical categories that frame our understanding of technology and its design. Lastly, they discovered that design fictions may reveal ethical reflections, unpacking the potential moral implications of design work. By manipulating their fictional characters and seeing problems through their eyes, the students not only imagined how individuals could subjectively live the technology they envisioned, but also explored moral dilemmas from the first experienced users' perspective [6].

Apart from other attempts of fictional design with students, we showed that this method can serve educational goals, by allowing "non-expert" students to learn fundamentals of design/HCI and critically reflect on them [7] [8][9]. On the other hand, differently from traditional experiential methods of teaching HCI, which focus on present, we showed that design fictions may encourage students to go beyond the short-term implications of design and think of the broader impacts of technology development[10][11][12].

The recent scholar works paid attention to deûning new media, multimedia, or multimodal writing and digital literacy and developing corresponding digital pedagogies. Other scholarship has also argued that only deûnition of writing has changed to include intellectual activities that previously belonged to the realm of computer science, such as creating interactive databases and dynamic web content, making decisions about which kinds of software or hardware appliances to use, or identifying appropriate search terms that audiences would ûnd meaningful and useful tasks[13][14].

In our paper, we mainly focus on HCI based designs and methodologies which targets to academic related tasks such as assignment and tutorial, etc. We finally student attention more acutely to various audience-related technical and rhetorical interface design choices.

3. USER CENTRIC DESIGNAND COMPOSITION

3.1 HCI principles and techniques of participatory design and evaluation

There are some significant principles that the designer should know for the applications they target. They should understand very well and pay attention to create a successful HCI-based designs and compositions. In this paper, we explain some of design related rules and regulations that need to be considered in every HCI-based designs and composition processes in the field of academic and pedagogy.

The first principle of good design is to be aware of differences between users of a proposed computer interface such as mobile-based, web-based or another electronic device. Furthermore, knowing the user's education level, such as primary, high education or college education aids to complete design transitions for the developers.

The second principle to do brainstorming, a speciûc process of logical thinking search for ideas that can reflect the actual image of the applications, the user targets.

The next principal is walking through the design that allows the designers to quickly define and check to be sure that the suggested design meets the users' requirements and demands.

3.2 Proposed design methodologies for HCI

Thinking of our expertise we a tendency to see five main processes in style fictions creation so as to introduce basic parts of HCI designs and obtain student's reflections on technology: characteristic a design drawback, generating ideas, making designs layouts and discuss the results.

The first stage is that the identification of a style downside, deciding what the attention-grabbing challenge to tackle the problem because designation and stylish work try to provide a solution in computer-based applications.

The second stage is that the generation of multiple concepts. Here, students are invited to know their ideas and opinions. We tend to detect that the primary concepts generated are more related to this technology landscape and layout structure because the students were asked to outline multiple ideas by letting them use the design and their understandability.

The next stage is planning the fictional example, inserting it into a style fiction. The designer should pay attention to style activity, tracing back all the generated ideas to one design: they may realize it troublesome to mix completely different concepts into a coherent and plausible style, and assistance.

The next stage is that it needs to focus on one or more main characters and a conflict that they may experience: conflict represents the driving force of the narrative and can be actualized in an internal struggle.

As final step, it needs to polish fictional prototype at designing stage which polishes the fictional prototype, the designers should consider the interior aspects of user experience.

With the steps mentioned above, in this paper, we execute how HCI-based design and composition in designs and templates of software and applications related to academic projects. The overall design is illustrated in Figure 1. Traditionally, most of HCI-based questionnaires provide only text-based questions to the users who participate their experiments. This may lead to confusion and unclear understanding among the information providers who are the students in the system. Therefore, in this system, we provide both text-based questionnaires and sample designs and templates regarding academic fields.

3.3. Proposed system's architecture

In our proposed system, there are three main components, which are data collection and analysis, design analysis using HCI-based tools and techniques and output. The overall system is illustrated in Figure 1.

In data collection and analysis, we first ask questionnaires to the selected participants, who are students in this paper. After getting the answers from the users, we then perform HCI principles and techniques as explained in Section 3.1. The major tool of this step is to get user experiences upon the proposed design in the aspect of design walkthrough, brainstorming and evaluation metrics such as usability, dependability, etc.

The major second component is the core part of the system, which analysis the designs patterns and their composite designs are analyzed in three different functions. The first function is to utilize five stages of proposed design methodologies for HCI applications and designs.

The second part is analyzed the design patterns from the aspects of key features such as design usability, novelty which is significant and compatible with current designs, and attractiveness to the users, etc.

The last part of this component is to find the differences between people's choices and their results obtained from HCI-based techniques decisions. After fusion all of those techniques-based and user-based preferences, the final decision, such as accepting design pattern, changing according to meet user's requirements or HCI-based techniques-based assessments, etc.

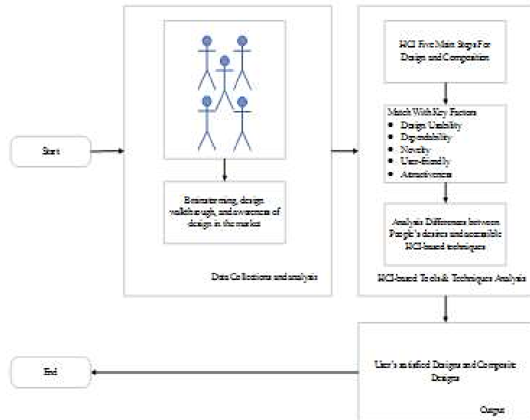

Fig.1. Proposed System Architecture

4. Experimental Results

In order to prove that how proposed system can effectively work in choosing the design patterns with the user's experiences and HCI-techniques, we perform numerical experiments. WE first select 40 volunteers from the students in both computer universities and other university because we would like to have with or without IT related backgrounds. We then give them some questionnaires that includes which kinds of color, what kinds of layout patterns, and their preferred designs and composite functions and designs of different kinds of applications such as web-based, pc-based, mobile-based applications and so forth. For the domain, we selected education-based design patterns such as stackoverflow.com, techcrunch.com, tech2.com, etc. Depending on those education websites, we develop different design patterns using photoshop software so that the users can have different looks with different colors and layout choices.

Having collected the results from the students as well as the decision in accordance with proposed HCI-techniques and tools, we analyze how many designs are finally satisfied by the users (no participants of this experiments). The table showed the results with and without HCI-design analysis on the tested designs and composite designs.

As can be seen in the table, the mixture consideration of both users' experiences and analysis techniques of HCI can outperform the others in all types of application types, namely web-based, PC-based and mobile-based applications. Therefore, we can exclaim that our proposed system achieves better user satisfaction level on design choices.

Table 1. User's satisfied Percentages for test cases

Application Types	With user experience (1)	With HCI-tools and techniques (2)	Combination of 1 and 2
Web-based	78%	87%	95%
PC-based	77%	86%	92%
Mobile-based	83%	86%	97%

5. CONCLUSIONS

As digital interfaces exponentially increase access to information, the design of these interfaces becomes increasingly important. Designing digital interfaces requires writers to make rhetorical choices that are sometimes technical in nature and often confuse with principles taught in the computer science. In this paper, we introduced HCI principles and user experiences to take into account of creating and introducing the designs to the users. According to the results, our proposed methodologies achieve more promising results in the area of designs and composite design selection for different kinds of software and applications with academic backgrounds.

As future work, we plan to extend this system with more efficient HCI techniques in order to reveal more effective UI/UX designs for both web and mobile based applications.

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MICROCONTROLLER BASED HUMIDITY AND TEMPERATURE MONITORING SYSTEM

Thu Zar Aung [1], Nyein Nyein Hlaing [2],Tint Tint Oo[3]

[1] [2] [3]University of Computer Studies (Meiktila), Myanmar

[1]*whiteangel.tza@gmail.com*

ABSTRACT

Arduino is associate open supply hardware and software. Arduino hardware, a motherboard , is employed in order to create interacting objects with appropriate computer programing Integrated Development surroundings (IDE). The aim of the paper is to create Associate in Nursing Arduino-based embedded device for observance environmental variables like wetness and temperature. The performance in numerous temperature and wetness is additionally studied. within the paper, the device was engineered by victimisation the Arduino microcontroller board(Uno) and sensors, which may sense the temperature and quantity of wet within and outdoors a building. within the implementation, info is showed each on a serial monitor and on a liquid display.

KEYWORDS: *Arduino, microcontroller, monitoring, IDE, codes.*

1. INTRODUCTION

Arduino,a microcontroller board, functions as a small pc. On this platform , interacting objects may be created and developed with needed programming code within the paper, the project is made as associate Arduino primarily based embedded device to build watching system of environmental variables temperature and humidness and study the characteristics of its performance. To study its performance characteristics, Arduino was tested in 2 completely different temperature and humidness conditions. The different environmental conditions were created by victimization the device in traditional temperature and wetness and out of doors temperature and wetness. There are a unit some sensible steps to follow to developed the device which may measure temperature and wetness within the building or close and show readings in a very liquid show (LCD) and serial monitor moreover victimization Arduino board and sensors. The developed system is helpful in watching 2 variables temperature and wetness in an exceedingly building, laboratory and greenhouse, etc.

2. RELATED WORK

Temperature and Humidity Monitoring and Control System Based on Arduino and SIM 900 A GSM SHTELD by JAYP.SIPANI, this system operates the Wireless Sensor (WS) data communication using DHT 11, Arduino, SIM 900 A, GSM module, a mobile device, and liquid crystal display (LCD). Experimental setup include the heating arrangement of DHT 11 and transmission of its data using Arduino and SIM 900 A, GSM shield. The mobile device receives the data Arduino, GSM shield and display it on LCD too. Heating arrangement is used to heat and cool the temperature sensor to study its characteristics.

Arduino Based Weather Monitoring System by Plus Uagbae Ejodamen, February 2018. Use the Arduino to develop a weather monitoring system based on temperature and humidity variables obtained from a DHT 11 sensor. The system, when tested was able to report if weather is Hot, Normal, or Cold based on the exact temperature and relative humidity whithin a 20 meter areas, we also demonstrate the recycling of plastic foam to be used as an insulator and casing for electronic components. Plastic foam, which is a waste material, greatly contributes to the Global Warming Potentials (GWP) when discarded improperly.

IOT based Temperature and Humidity Monitoring system using raspberry pi, by S Praveen Kumar, Raspberry pi temperature and humidity sensing DHT 11 sensor for measurement and it is distinctive. Python language is used in this system.

3. MATERIALS AND METHOD

3.1 Arduino

Arduino Uno board , a microcontroller board, relies on Atmel Atmega328 8-bit micro-processor. it's area unit fourteen digital input and output pins and six of which might be used as pulse-width (PWM) outputs. There are a unit six Analog inputs and a sixteen megacycle per second quartz or generator.

Arduino Uno board may be connected to a laptop by mistreatment universal serial bus(USB) cable . It conjointly includes a power jack, AN ICSP (In Circuit Serial Programming) header and a push [1]. The Arduino Uno board is that the 1st during a series of USB Arduino boards.

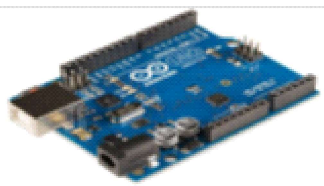


Fig 1 Arduino Uno

3.2 Sensors

A sensor, Associate in Nursing device , converts a amendment in natural phenomenon into Associate in Nursing electrical signal. It will send the knowledge to electronic devices or computers. Sensors area unit utilized in several objects and places. Touch-sensitive phone screen, motion sensitive light-weight switch and a number of other applications area unit sensors. the utilization of sensors has been swollen wide with the event of microcontrollers like in AI, airplanes and region, cars and plenty of alternative applications [2].

The sensors that is employed during this work is DHT11(temperature and humidness sensor). The DHT11, AN Analog device, was designed to sense the natural process in heat and wetness once exposed in air with appropriate wiring and programming. the utilization of DHT11 device will be applicable like dominant temperature and humidness in home appliances, medical and plenty of alternative sector [1]. The Figure a pair of shows the DHT11 temperature and humidness device. The device DHT11 has following performance vary and accuracy.

Measurement range:

Temperature: 0 to 50°C

Humidity: 20 to 90 % RH

Accuracy:

Temperature: ±2 %

Humidity: ±5 %

Where the operating Voltage remains between 3V to 5.5V [1].

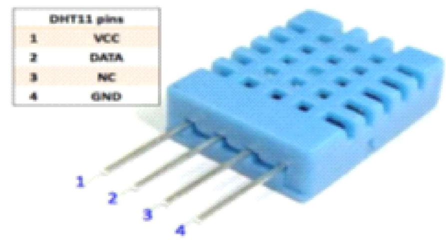


Fig.2. DHT11 Sensor

The sensor used in the project, DHT22, is designed to measure humidity in terms of relative humidity (RH). Relative humidity (RH) is the ratio of the amount of water vapour content of the air to the saturated moisture level at the same pressure or temperature:

$$RH = \frac{\rho w}{\rho s} \times 100\%$$

Where,

RH = relative humidity

ρw = the density of water vapour

ρs = the density of water vapour at saturation.

4. SYSTEM DESIGN

Arduino is the heart part of the building monitoring system. The brain part of the building monitoring system is the Arduino IDE. DHT11 is used for input data and LCD for display. Buzzer is used for alarm system. The diagram of hardware connection is shown in the following figure.

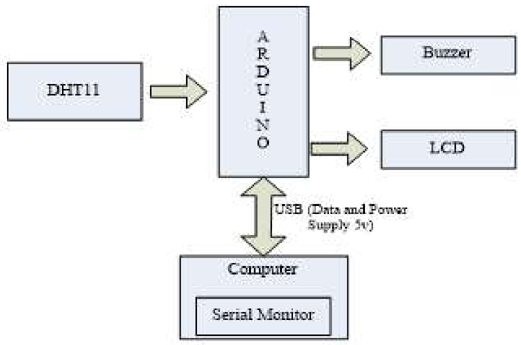


Fig 3The diagram of hardware connection

As soon as the system is started, all the required parts are checked in initial stage. Data are read by sensor and sent to controller. If the sensor value is greater than threshold value, the alarm will be given from buzzer. Figure 4 shows flow chart of humidity and temperature monitoring system.

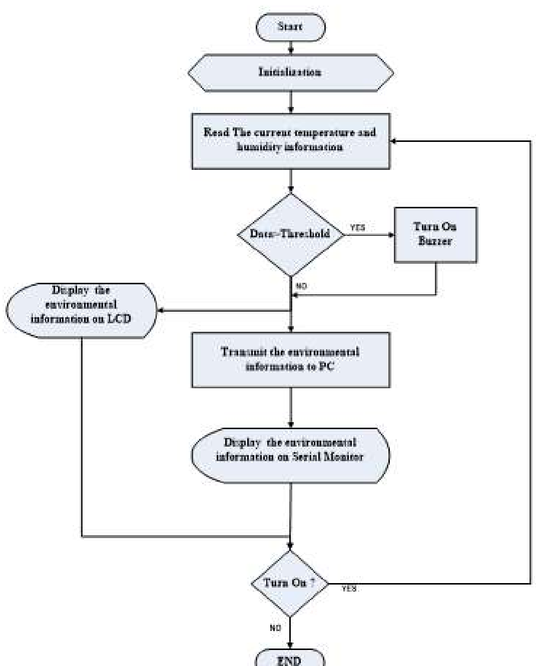


Fig 4 Flow Chart of the System

The data are shown in LCD and sent to the PC. On the serial monitor, the data are also being displayed. The system will be looped until turning off.

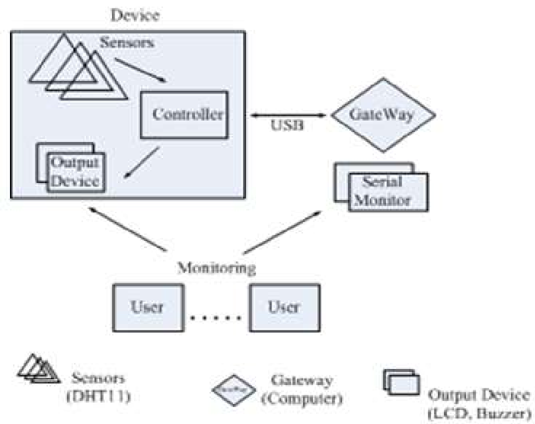


Fig 5 Device to Gateway Connection of the System

Device to Gateway of the system is shown in figure5.The system is intended to be used as IOT system. Device to gateway connection is common used. User can monitor the data not only on LCD but also on serial monitor by passing Gateway (computer).

5. IMPLEMENTATION

The typical circuit diagram for DHT11 is shown in Figure 6.

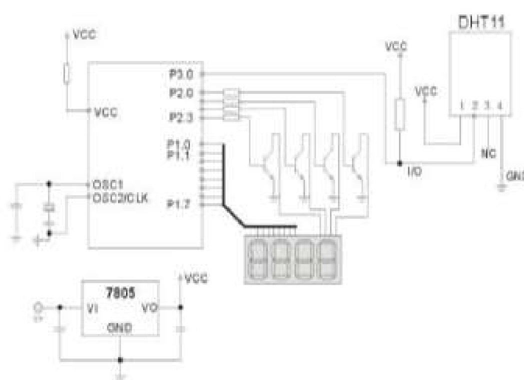


Fig 6 Circuit diagram for DHT11

Schematically, the connections for LCD display and DHT11 sensor with Arduino Uno can be shown as in following Figure 7 [3].

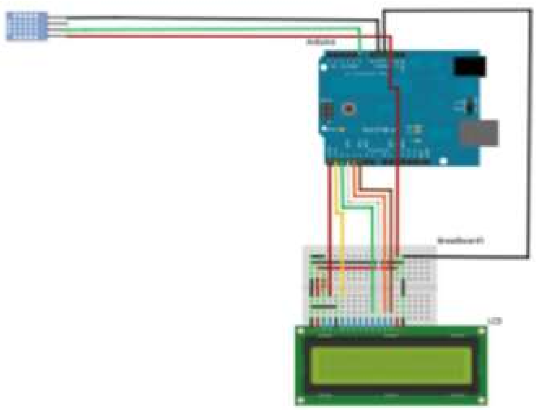


Fig 7 Wiring DHT11 Sensor and LCD display to Arduino Uno

After doing the connections and wiring, the code should be written in IDE. The codes written in IDE tell the Arduino to function so that the measurement obtained from sensor can be read in LCD display. When writing the code is done, they should be verified by IDE. When the verification completes, the program is ready to be uploaded in Arduino. While the program is running, the LCD display shows the reading as shown in Figure 8.

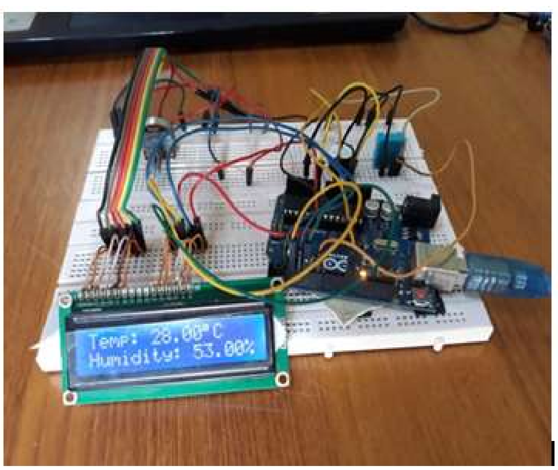


Fig 8 Temperature and Humidity display in LCD

Some values of temperature and humidity can also be monitored on the Serial Monitor. These results are shown in figure 9.

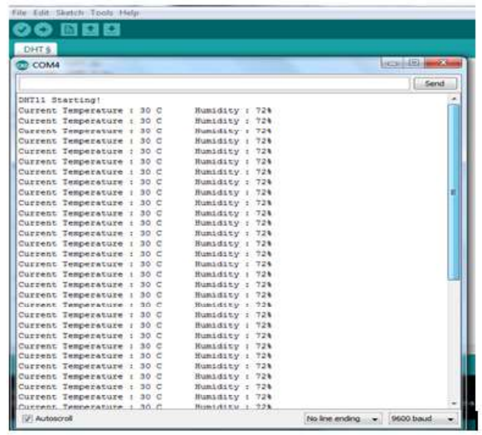
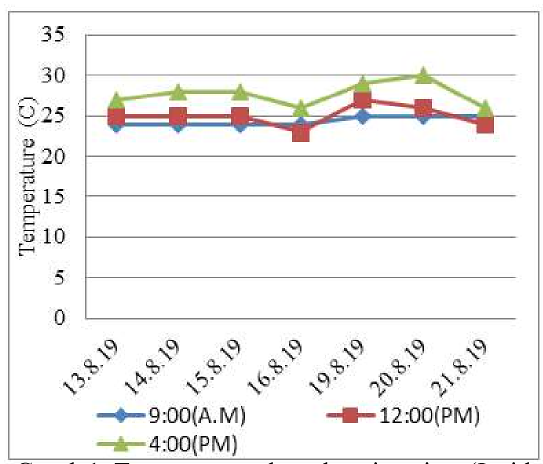


Fig 9 values of temperature and humidity on serial monitor

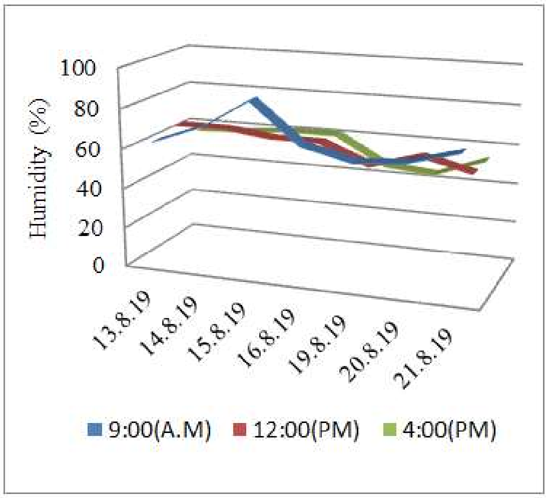
6. RESULT AND ANALYSIS

After wiring and writing the code, the program was run and the built device was successful in measuring humidity and temperature. The LCD display and serial monitor readings are shown in respective graphs. These data are read inside the building by using the device. To study the performance characteristics of the built system, the tests were done in two different conditions. The first test was done inside a room and the other was done outside building, respectively.



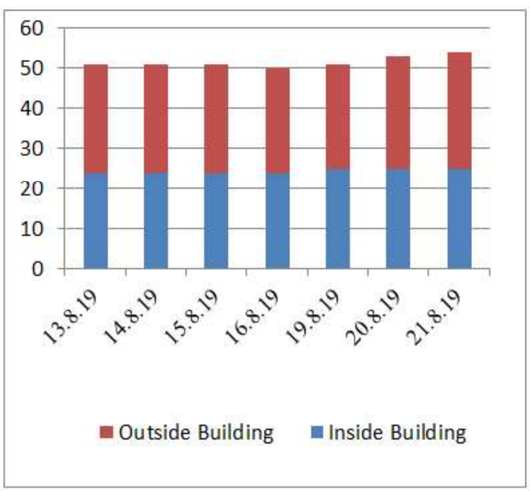
Graph 1: Temperature plotted against time (Inside the building)

The sensor was again used to measure humidity inside of the building and the measurement results plotted against date and time are shown below.

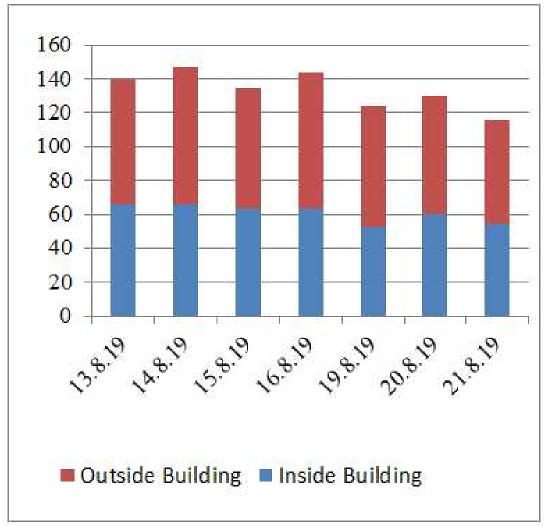


Graph 2: Humidity plotted against time (inside the building)

Data from outside building are collected from www.worldweatheronline.com at 12 pm. They can be compared with data read by the device. The following graphs show comparison of the respective data.

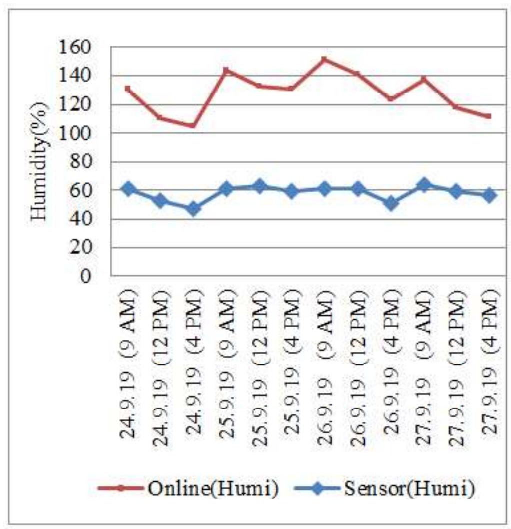


Graph 3: Comparison temperature between inside and outside the building



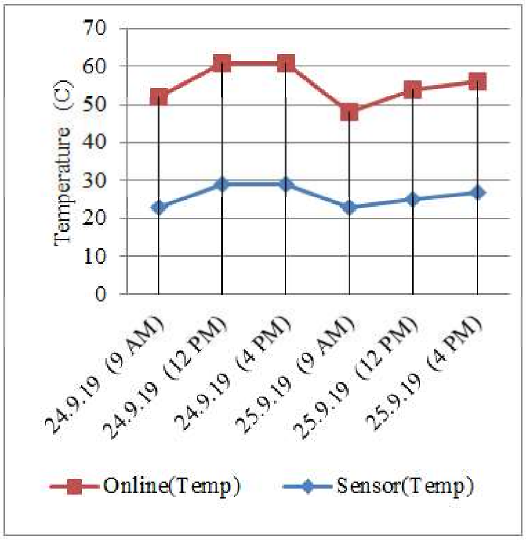
Graph 4: Comparison humidity between inside and outside the building

In experiment, the environmental variables measured by the device and variables got from online weather station are not very same. Humidity data are shown in the graph 5.

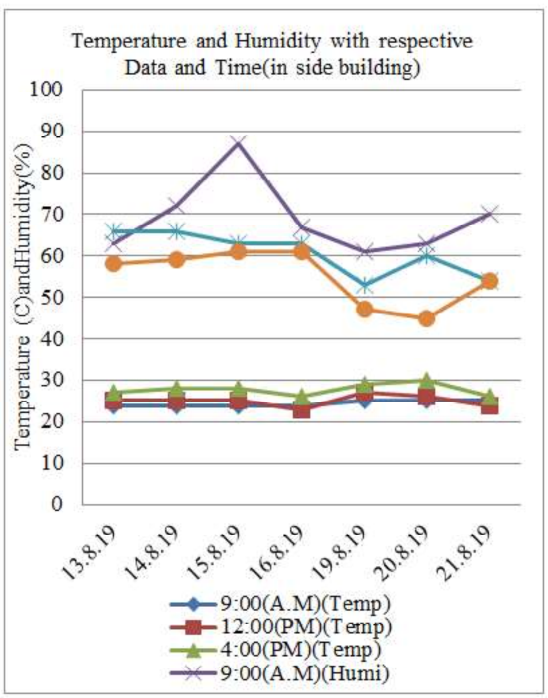


Graph 5: Comparison humidity outside the building from device and online

The temperature data measured by DHT11 and data from online weather station are shown in the graph 5 with respective date and time.

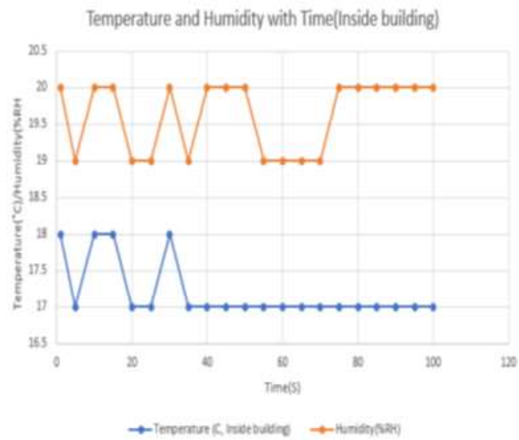


Graph 6: Comparison temperature outside the building from device and online



Graph 7 show Temperature and Humidity Plotted against time in this system (inside building)

Graph 7 and Graph 8 compare this system's result with other researcher result



Graph 8 show Temperature and Humidity Plotted against time in other researcher (inside building)

7. DISCUSSION

The device is upgradable as IOT based mostly system. The pressure sensing element may be enclosed so as to urge a lot of environmental data. It may be programmed to figure offline exploitation Arduino protect. The measure knowledge may be accessible in different, analyzing and programming tools (Excel, MATLAB). The Arduino microcontrollers' platform of development has created a rising of innovations that has resulted within the handiness of a lot of advanced Arduino boards and its clones. The measure was compared to accessible knowledge and the way correct and reliable it's. the value of the project may be reduced a lot of.

8. CONCLUSION

The work was successful in building a monitoring device which works as a thermometer for measuring temperature and humidity inside a building. It is capable of measuring humidity and temperature outdoors. Data from online weather website are compared. But data of outside a building is little different from other weather station. The Arduino based monitoring system successfully reduces the power consumption, cost and complexity of the process. In the paper, the Project will be a platform to advance the technique of research, tests.

9. Limitation and Further Extension

Microcontraller based humidity and temperature, monitoring system, operates to a typical voltage of 5 V, min voltage of 3V and max voltage of 5.5V. If it is above 5V, the system will be demaged. The use of this system can be extended at mini weather station. This system operates at a temperature range of 0℃ - 50 and at 20% to 90% relative humidity.

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MEASURING SYSTEM OF RESISTANCE AND CAPACITANCE BY USING MICROCONTROLLER

Nwe Nwe Win (1), Nwe Ni Soe(2), Lae Lae Khine(3)

(1)(2)(3)Technological University (Thanlyin), Myanmar

nwenwewin676@gmail.com

ABSTRACT

Measuring instruments are widely used in everyday process, research and development filed. Among them measurements of resistance and capacitance are quite pronounced not only for teaching and research field but also for industrial one. Resistance and capacitance measurements can be made by using instrument which can be built with a lot of principles. In this paper, the measurement of resistance and capacitance were made by using microcontroller. The values of unknown resistance and capacitance were measured, and the single slope integrating converter was used to monitor the charging time, and then the required calculations were performed by microcontroller, having the versatile properties of PIC 16F877A. The results can be stored and displayed on personal computer monitor and can also be displayed on LCD screen. It is found that the constructed meter is a reliable one for wider range compared to the usual meters. Although this constructed meter was designed and built with available components, its performance can be good quality as other imported ones.

KEYWORDS:*resistance, capacitance, charging time, microcontroller, constructed meter, fluke meter*

1. INTRODUCTION

For microcontroller based resistance and capacitance measuring system, the measured quantities rely on the wide range of the terms such as accuracy, precision, sensitivity, resolution, error, range and span of the instrument. Moreover, the microcontroller gives the information about the timing, internal voltage reference and comparator to measure charge/ discharge time. The next important procedure is to compare the charge time of known component and the unknown one to determine the value of the unknown component. And the output of the voltage reference is to know the values of resistance and capacitance with high accuracy in order to compare the marked and the calculated values. By using software written in visual basic language on PC, resistance coming from serial port and values of capacitance will be mentioned on monitor and displayed on LCD screen. [1]

2. MEASUREMENTS

2.1. Measurable Quality

2.1.1. Resistance Measurement

According to the above procedure, the unknown resistance values can be obtained by the use of charging time. So to have this function, it is necessary to use standard known resistance and capacitance. To measure the resistance of unknown resistor, the following steps have to be done.

If this cycle is completed, the processor can manage the required functions and give out the results.[2]

The followings are the four phases that have to be done:

Phase(1) - Discharging the known capacitor:

It has to be done to ensure complete discharge of the capacitor used.

Phase(2) - Charging the known capacitor through unknown resistor:

This is required because it is needed to record the charging time for charging the known capacitor up to reference voltage level.

Phase(3) - Discharging the known capacitor:

This has to be done again because it is necessary that the capacitor must be completely discharged just before next charging process is started. Otherwise, error for next charging time will encounter.

Phase(4) - Charging the known capacitor through unknown resistor:

The charging process will be done up to reference voltage level too. The values of known resistor relate to the recorded charging time.

Since equation for charging time through unknown resistor is

$$T_{UNK} = R_x C \ln \frac{V_{DD}}{V_{DD}-V_{REF}} (1)$$

and that for charging time through known resistor is

$$T_{KN} = RC \ln \frac{V_{DD}}{V_{DD}-V_{REF}} (2)$$

Unknown resistance R_x can be calculated by the following equation.

$$R_x = \frac{T_{UNK}}{T_{KN}} \times R (3)$$

This equation will be used in PIC programming for the calculation of unknown resistance.[3]

2.1.2. Capacitance Measurement

Precise known resistor can be required to know unknown values of capacitance. In this processes, four phases similar to the measurements in unknown resistance are also used. Only difference is using known resistance value instead of known capacitance. After completion of that four sequences, the processor will manipulate required calculations, and the result will be given off.

The respective phases for this sequential process are described as follows:

Phase (1) - Discharging the known capacitor:

After required connections have been made, initially the known capacitor must be completely discharged. It must be done to avoid the error for next charging time.

Phase (2) - Charging the unknown capacitor through known resistor:

It has to be done to record the charging time for charging the unknown capacitor up to reference voltage level.

Phase (3) - Discharging the known capacitor:

This has to be done again because it is necessary that the capacitor must be completely discharged just before next charging process is started. Otherwise, error for next charging time will encounter.

Phase (4) - Charging the known capacitor through known resistor:

The charging process will be done up to reference voltage level too. Since equation for charging time through known resistor is

$$T_{UNK} = RC_x \ln \frac{V_{DD}}{V_{DD} - V_{REF}} (4)$$

and that for charging time through known resistor is

$$T_{KN} = RC \ln \frac{V_{DD}}{V_{DD} - V_{REF}} (5)$$

Unknown resistance R_x can be calculated by the following equation.

$$C_x = \frac{T_{UNK}}{T_{KN}} \times C (6)$$

This equation will be used in PIC programming for the calculation of unknown capacitance.[4]

2.1.3. Measuring the Charge Time

It can be said that resistance or capacitance measurement procedures are the same but to control RC networks, the use of I/O pins will be different. This procedure can be applied for known or unknown component measurements. Timer "0" can be used to measure the unknown RC network charge time. In order to obtain the unknown resistance or capacitance values, the used of RC network charge time can be required. Then the known RC networks charge time is monitored.

$$R_{UNK} = \frac{T_{UNK} \times R_{KN}}{T_{KN}} (7)$$

$$C_{UNK} = \frac{T_{UNK} \times C_{KN}}{T_{KN}} (8)$$

R_{UKN} and C_{UKN} are the unknown resistor and capacitor values. R_{KN} and C_{KN} are the known resistor and capacitor values. T_{UKN} and T_{KN} are the charge times for the unknown and known components.[5]

2.1.4. Testing of Constructed PIC Based Resistance and Capacitance Meter

After completion of design and construction of PIC RC meter, it is necessary to test and calibrate the meter. To do so the capacitors and resistors having various values have been used. The marked values with tolerance, measured values measured by Fluke meter, which are used as standard values, measured values measured by constructed meter, and mean values which are calculated based on constructed meter and mean values which are calculated based on constructed RC meter are tabulated. By using standard deviation and MATLAB software, the relation between mean values, marked values and measured values can be obtained. [6]

The standard deviation is a good way for grouped data analysis so that it can be recorded precision measurements. The standard deviation is given by

$$s = \sqrt{\frac{\sum (x^{-} - x_i)^2}{n}} (9)$$

The tables (1) and (2) show the marked values and the measured values of constructed RC meter.

Table 1. Resistance data Measured with the Constructed Circuit

Marked Values R=1e3	First Measurement 11.062	Second Measurement 1.065	Third Measurement 1.065	Fourth Measurement 1.065	Fifth Measurement 1.065
1.2	1.248	1.247	1.248	1.247	1.248
1.5	1.559	1.558	1.557	1.558	1.558
1.8	1.862	1.860	1.860	1.861	1.857
2	2.045	2.047	2.048	2.047	2.047
2.2	2.248	2.250	2.250	2.252	2.247
2.7	2.806	2.803	2.812	2.812	2.713
3.3	3.333	3.605	3.333	3.333	3.397
3.9	3.928	3.925	3.923	3.925	3.926
4.7	4.736	4.738	4.739	4.733	4.740
5	5.057	5.069	5.063	4.070	5.063
5.6	5.598	5.603	5.604	5.607	5.598
6.8	6.794	6.793	7.073	7.071	7.059
8.2	8.223	8.214	8.488	8.219	8.220
10	10.026	10.039	10.037	10.048	10.021
12	11.955	11.977	11.976	11.986	11.969
15	14.947	14.965	14.937	15.513	15.845
18	17.743	17.775	17.779	17.766	17.754
20	20.010	19.761	19.771	19.787	19.766
22	22.153	21.835	21.856	21.870	21.829
24	24.212	23.896	23.921	23.958	23.916
27	26.797	26.787	26.786	26.814	26.799
30	29.886	29.943	29.907	29.945	29.917
33	32.713	32.793	32.762	32.792	32.729
39	38.817	38.994	39.062	39.048	39.019
47	47.098	46.624	46.776	46.834	46.808
50	50.072	50.066	49.936	49.996	49.951
56	56.872	56.950	56.891	56.931	56.853
68	68.043	68.160	68.118	68.180	68.027
82	82.417	82.529	82.642	82.670	82.882
100	97.922	98.162	98.109	98.495	98.050
150	149.123	149.435	149.276	149.446	149.166
180	179.723	178.664	178.495	178.738	178.711

200	197.836	198.424	198.571	198.771	198.088
220	222.569	222.984	222.877	23.026	222.837
240	241.020	241.650	241.330	241.615	241.363
270	268.496	269.501	269.503	269.182	269.269
300	300.204	300.698	300.727	300.818	300.866
330	336.884	337.979	337.364	337.985	337.384
390	390.107	390.675	390.352	390.831	390.881
470	465.267	465.814	465.537	466.167	466.491
500	507.517	507.870	508.398	508.917	509.447
560	571.294	572.071	572.323	572.352	571.552
680	694.940	695.993	695.348	696.389	694.852
820	798.716	800.699	799.571	800.723	799.295

Resistance Measured with Fluke meter

Rfluke = 1e3* [0.991,1.175 ,1.483 ,1.785, 1.971, 3.841 4.65, 4.98, 5.51, 6.7 8.11, 9.92, 11.84, 14.81, 17.6, 19.6, 21.69, 23.75, 26.59, 29.7, 32.55 38.75, 46.4, 49.7, 56.5, 67.7, 82.1, 97.4 ,148.4 177.5, 196.9, 221.5, 239.8, 267.4, 298.4 , 335.2 ,388, 462, 505, 568 ,691, 795]';

Table 2. Capacitance data Measured with the

Marked Values R=1e3	First Measurement 11.062	Second Measurement 1.065	Third Measurement 1.065	Fourth Measurement 1.065	Fifth Measurement 1.065
c=1e-9	1.065	1.100	1.065	1.505	1.249 ; ...
1.5	1.557	1.562	1.815	1.516	1.365 ; ...
1.8	1.897	1.921	1.901	1.325	1.836; ...
2.2	1.924	2.122	2.176	2.158	2.248; ...
2.7	2.590	2.616	2.846	2.852	2.790; ...
3	3.245	3.228	3.255	3.540	3.287; ...
4.7	4.665	4.683	4.914	4.675	4.594; ...
5.6	5.877	5.903	5.896	6.238	5.740; ...
6.8	6.879	6.873	6.878	7.098	7.167; ...
7.5	8.653	8.667	8.608	9.975	8.248; ...
8.2	8.467	8.514	8.466	8.051	8.713; ...
10	9.859	9.950	10.311	10.315	10.526; ...
10	10.467	10.454	10.730	10.159	10.075; ...
15	15.420	15.429	15.401	15.907	15.205; ...
18	18.810	18.881	18.838	18.434	18.683; ...
20	20.960	20.960	20.596	20.758	21.013; ...
22	22.037	22.321	22.045	21.880	21.860; ...
33	33.613	33.650	33.560	33.804	33.345; ...
47	51.095	51.145	51.120	50.683	49.792; ...
68	70.698	70.674	71.224	71.519	71.262; ...
100	99.642	99.660	99.614	99.178	99.950; ...
150	154.457	155.678	156.335	156.317	156.453;
220	219.354	219.672	219.359	221.305	220.552;
330	310.981	311.045	310.699	310.121	310.428;
470	477.522	477.649	477.567	478.031	478.474;
680	699.108	699.139	698.820	698.377	699.963;

Capacitance values measured with Fluke meter,

Cfluke = 1e3* [1.36, 1.86, 2.16, 2.39, 2.79, 3.59, 4.86, 6.08, 7.14, 8.93, 8.73, 10.75, 10.72 , 15.69, 19.32 , 21.27 ,22.44, 33.92, 51.52 , 71.52 ,, 101.8 157.7, 222.9, 312.9 , 481.2, 703.9]';

The tables (3) and (4) show the marked values, Fluke meter values, mean values and standard deviation of the resistance and capacitance.

Table 3. Resistance Data Table

Marked value	Fluke Meter	Mean Value	Standard Deviation
1.0000e+003	991.0000e+000	1.1178e+003	120.8665e +000
1.2000 e+003	1.1750e+003	1.2476 e+003	547.7226e -003
1.5000 e+003	1.4830e+003	1.5580 e+003	707.1068e-003
1.8000 e+003	1.7850e+003	1.8600 e+003	1.8708e+003
2.0000e+003	1.9710e+003	2.0468 e+003	1.0954e+000
2.2000 e+003	3.8410 e+003	2.2494 e+003	1.09494e+000
2.7000e+003	4.6500e+003	2.7892e+003	42.7750e+000
3.3000e+003	4.9800e+003	3.4402e+003	146.8169 e+000
3.9000e+003	5.5100e+003	3.9254e+003	1.8166 e+000

4.7000e+003	6.7000e+003	4.7372e+003	2.7749 e+000
5.000e+003	2.1730e+003	4.8648e+003	444.3278e+000
5.6000e+003	2.7310e+003	5.6020e+003	3.9370e+000
6.8000	3.2500e+003	6.9580e+003	150.2631e+000
8.2000	8.1100e+003	8.2728e+003	120.3441e+000
10.0000	9.9200e+003	10.0342e+003	10.7564e+000
12.0000	11.8400e+003	11.9726e+003	11.5456e+000
15.0000	14.8100e+003	15.2410e+003	415.7571e+000
18.0000	17.6000e+003	17.7634e+003	14.9097e+000
20.0000e+003	19.6000e+003	19.8190e+003	107.2171e+000
22.0000e+003	21.6900e+003	21.9086e+003	137.6056e+000
24.0000e+003	23.7500e+003	23.9806e+003	131.2814e+000
27.0000e+003	26.5900e+003	26.7966e+003	11.3270e+000
30.0000e+003	29.7000e+003	29.9196e+003	24.9359e+000
33.0000e+003	32.5500e+003	32.7582e+003	36.7655e+000
39.0000e+003	38.7500e+003	38.9880e+003	99.1388e+000

Table 4. Capacitance Data Table

Marked value	Fluke Meter	Mean Value	Standard Deviation
1.0000e-009	1.3600e-009	1.1968e-009	188.2982e-012
1.5000e-009	1.8600e-009	1.563e-009	161.9830e-012
1.8000e-009	2.1600e-009	1.7760e-009	254.1122e-012
2.2000e-009	2.3900e-009	2.1256e-009	121.6832e-012
2.7000e-009	2.7900e-009	2.7388e-009	126.6381e-012
3.0000e-009	3.5900e-009	303110e-009	129.8056e-012
4.7000e-009	4.8600e-009	4.7062e-009	121.4278e-012
5.6000e-009	6.0800e-009	5.9308e-009	184.1567e-012
6.8000e-009	7.1400e-009	6.9790e-009	142.2515e-012
7.5000e-009	8.9300e-009	8.8302e-009	662.7463e-012
8.2000e-009	8.7300e-009	8.4422e-009	241.1985e-012
10.0000e-009	10.5700e-009	10.1922e-009	278.5224e-012
10.0000e-009	10.7200 e-009	10.3770e-009	263.3277e-012
15.0000e-009	15.6900 e-009	15.4724 e-009	259.8592e-012
18.0000e-009	19.3200e-009	18.7392e-009	160.5979e-012
20.0000e-009	21.2700e-009	20.8574e-009	175.6952e-012
22.0000e-009	22.4400e-009	22.0286e-009	184.6248e-012
33.0000e-009	33.9200e-009	33.5944e-009	166.3980e-012
47.0000e-009	51.5200e-009	50.7670e-009	377.2257e-012
68.0000e-009	71.5200e-009	71.0754e-009	373.2409e-012
100.0000e-009	101.8000e-009	99.6088e-009	276.4764e-012
150.0000e-009	157.7000e-009	155.8480e-009	834.7059e-012
220.0000e-009	222.9000e-009	220.0434e-009	856.1246e-012
330.0000e-009	312.9000e-009	310.6548e-009	386.3278e-012
470.0000e-009	481.2000e-009	477.8486e-009	403.1753e-012
680.0000e-009	703.9000e-009	699.0814e-009	580.0330e-012

The figures (1) and (2) show the comparisons of the mean values measured with constructed circuit and the marked values of resistance and capacitance.

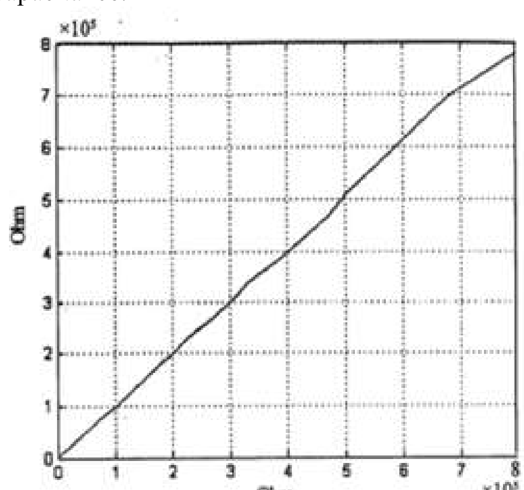

Figure1. Mean Resistance Measured with Constructed Circuit against Marked Value

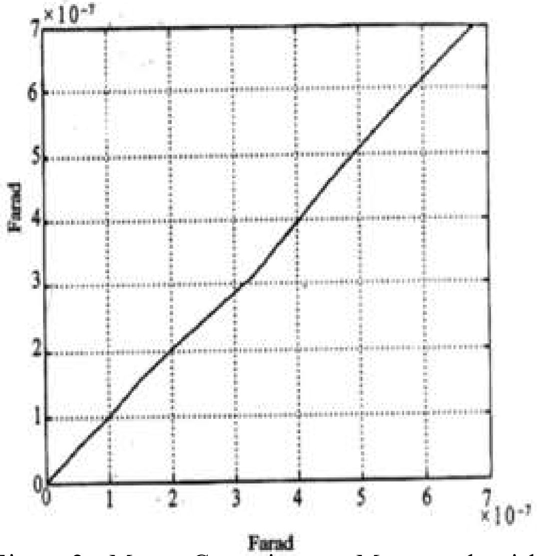

Figure2. Mean Capacitance Measured with Constructed Circuit against Marked Value

The figures (3) and (4) show the comparisons of the mean values measured with constructed circuit, and the measured values by Fluke meter of resistance and capacitance.

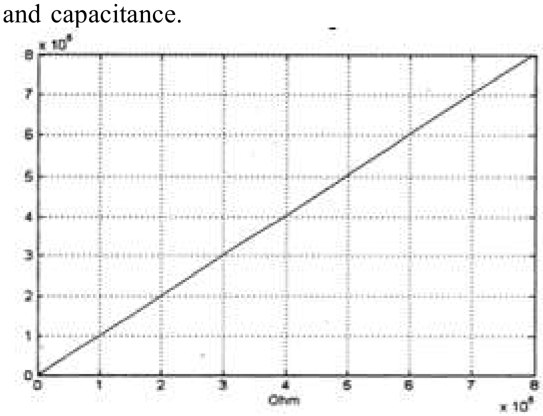

Figure3. Mean Resistance Measured with Constructed Circuit against Measured Value by Fluke Meter

3. RESULTS AND DISCUSSION

The obtained results have been shown in previous sections. The nature of the graphs are found to be almost straight line and passing through the origin. Moreover, the slope of each graph is also found to be unity. Since the two axes have

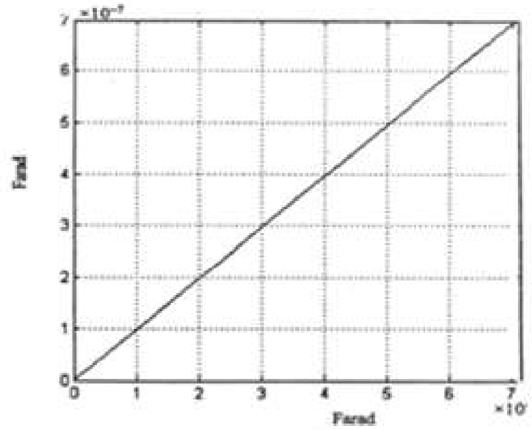

Figure 4. Mean Capacitance Measured with Constructed Circuit against Measured Value by Fluke Meter

been selected with the same scale, it can be proved that the measured mean values and respective marked values are the same for tested resistance and capacitance samples.

However, the graphs are not perfect straight lines, the data may have some errors. These can be due to the precision of the constructed meter. Range of resistance is 1k&! to 999k&! and range of capacitance in 1nF to 999nF. It was found that for the low resistance values, the accuracy of the meter was poor. And less accurate results are obtained when measuring the large capacitance values. Low resistance and large capacitance can be measured by using more current from PIC ports. For this large current, more loading can be caused and the output voltage can be decreased.Moreover, larger standard deviation errors are found on the table for low resistance values and large capacitance values. These errors could be much lower if output buffers were added.

Although there were some errors, the circuit was found satisfactory, and worked well as expected.

4. CONCLUSION

It can be calculated that the resistance is the range between 1kW and 999kW and the capacitance is between 1nF and 999nF. It can be seen that high error percentage can be obtained for the low resistance and the low error percentage obtained for high resistance values. On the other hand, for capacitors, the high error percentage will link to the large capacitance values. In short, the larger standard deviation errors are closely connected to low resistance values and large capacitance values. Although there are meters to measure resistance and capacitance, the ability of calculations by using microcontroller and monitoring on PC can give enlargement of many applications with capacitance sensors.

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ELEVATOR CONTROLLER BASED FINITE STATE MACHINE USING HARDWARE DESCRIPTION LANGUAGE

Sandar Moe

(1)University of Computer Studies (Hpa-an), Myanmar

moesatt04@gmail.com

ABSTRACT

This paper presents elevator controller based finite state machine to give fast response by using Hardware Description Language.This system describes the operation and implementation of a service elevator controller for a four-story building (floor1, floor2, floor3 and floor4). This system consists of two mainly components.The two mainly components are current floor state and next floor state. They are determined by up_down and stop input signals. The output logic is displayed by 4bits length. This controller can be implemented for an elevator with the required number of floors by simply changing a control variable in the HDL code. This approach is based on an algorithm which reduces the amount of computation required, by focusing only on the relevant rules that improves the performance of the group of elevator system.

KEYWORDS*: Elevator, Finite State Machine, VHDL, Moore Machine*

1. INTRODUCTION

An elevator is vertical transport equipment used to take luggage or passengers between floors of a building. Elevators plays vital role in both commercial as well as residential locations. Traditional elevator control systems are mainly based on relay logic, PLC and microcontroller but the major disadvantage of these systems is that they have reduced number of inputs and outputs. An elevator can be considered as a complex reactive system which requires parallel event processing with a number of inputs and outputs. Therefore FPGAs make a better solution for implementing an elevator controller with added advantages of re-configurability, less power consumption, low response times and flexibility in expansion of designs [1]. The elevator control system is basically a finite state machine (FSM).FSM is a digital sequential circuit that consists of different defined states that are controlled by inputs. The given elevator control system is based on Mealy machine in which the output values are determined by its current state. This system developed an elevator algorithm for an elevator with any number of floors. VHSIC (VeryHighSpeedIntegratedCircuit) HDL was used due to its syntactical familiarity. VHSIC is a hardware description language (HDL) which is commonly used to describe digital circuits in a textual manner in designing [2].

2. RELATED WORK

This system can further extend by using fixed-function logic devices, a PLD programmed with a VHDL code, or a programmed microcontroller or microprocessor.The controller consists of logic that controls the elevator operation, a floor state that determines the floor at which the elevator located at any given time. This implementation can extend on FPGA, which can be used for a building with any number of floors; FPGAs can be reprogrammed for desired functionality requirements after manufacturing [3].The advantages of FPGA over ASIC include the ability to update its functionality after shipping, partial reconfiguration of a portion of the design and the low non-recurring engineering costs [4].

3. BACKGROUND THEORY

In this elevator controller system, it is implemented with VHSIC Hardware Description

Language (VHDL) and Finite State Machine. Elevator controller algorithm is explained in detailed in the following sections. The elevator system in VHDL operates under the control of a Finite State Machine (FSM) as follows:

3.1 State Diagram

A state diagram represents the states as circles and the transitions between them as arrows annotated with inputs and outputs.

- The machine is in only one state at a time – the current state.
- It can change from one state to another when initiated by a triggering event or condition – the transition.
- Have limited memory – which is limited by the number of states.

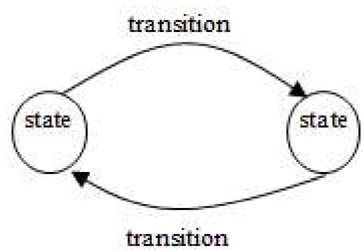

Fig 1: State Diagram

3.2 Finite State Machine

A finite-state machine (FSM) or simply a state machine is used to design both computer programs and sequential logic circuits. It is conceived as an abstract machine that can be in one of a finite number of user-defined states. The machine is in only one state at a time; the state it is in at any given time is called the current state. It can change from one state to another when initiated by a triggering event or condition; this is called a transition. A particular FSM is definedby a list of its states, and the triggering condition for each transition. The state machines are modeled using two basic types of sequential networks- Mealy and Moore. In a Mealy machine, the output depends on both the present (current) state and the present (current) inputs. In Moore machine, the output depends only on the present state.To add more states, simply declare the new transition method and update the lookup table; the main function will be the same.

3.3 Mealy Machine

Mealy machine is a state machine in which the outputs depend on both the internal present state and on the inputs.

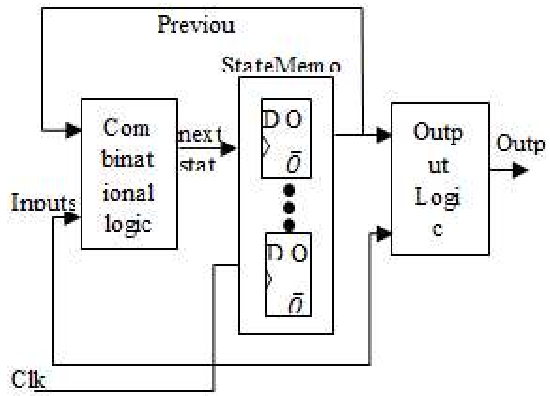

Fig 2: Mealy Machine

3.4. Moore Machine

The outputs of a Moore machine depend only on the present state and not on the inputs.

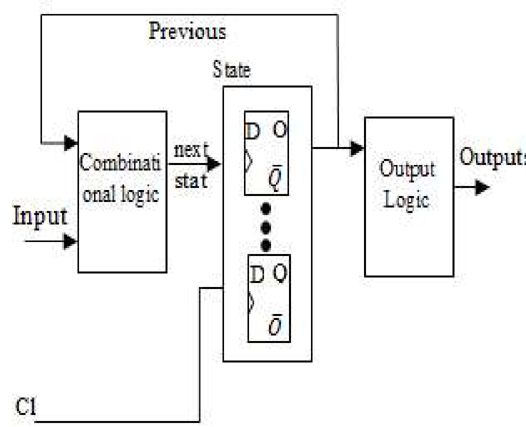

Fig 3: Moore Machine

3.5. Hardware Description Language

VHDL is the VHSIC Hardware Description Language and which is used for creating digital logic for integrated circuits. VHSIC is an abbreviation for Very High Speed Integrated Circuit. It is used to describe the behavior and structure of electronic systems/circuits. Documentation, simulation and synthesis are the main motives of emerging VHDL. VHDL was initiated by the US Department of Defense around 1981. VHDL is one of a few HDLs in widespread use today. VHDL is recognized as a standard HDL by the Institute of Electrical and Electronics Engineers. VHDL divides entities (components, circuits, or systems) into an external or visible part (entity name and connections) and internal or hidden part (entity algorithm and implementation). The cooperation of companies such as IBM and Texas Instruments led to the release of VHDL's first version in 1985. Xilinx, which invented the first FPGA in 1984, soon supported VHDL in its products. Since then, VHDL has evolved into a mature language in digital circuit design, simulation, and synthesis. It can describe the behavior and structure of electronic systems, but is particularly suited as a language to describe the structure and behavior of digital electronic hardware designs, such as PLD, ASICs and FPGAs as well as conventional digital circuits. VHDL is a hardware description language which uses the syntax of ADA [5]. Like any hardware description language, it is used for many purposes.

- For describing hardware.
- As a modelling language.
- For simulation of hardware.
- For early performance estimation of system architecture.
- For synthesis of hardware.
- For fault simulation, test and veriûcation of designs. etc.

VHDL is an international standard, regulated by the IEEE. The definition of the language is non-proprietary. VHDL is not an information model, a database schema, a simulator, a toolset or a methodology. However, a methodology and a toolset are essential for the effective use of VHDL.

3.6 VHSIC (Very High Speed Integrated Circuit)

VHSIC is a very high-speed computer chip that uses large-scale integration (LSI) and very large scale integration (VLSI) technology. LSI circuits include that a level of fixed-function IC complexity in which there are from more than 100 to 10000 equivalent gates per chip. VLSI circuits include that a level of IC complexity in which there are from more than 10000 to 100000 equivalent gates per chip. Large Scale Integrated circuit chip would have the ability to perform a very complex logic function, or a large number of simple logic functions. VLSI is a successor to large-scale integration (LSI), medium-scale integration (MSI) and small-scale integration (SSI) technologies. VLSI is an implementation technology for electronic circuitry analogue or digital. It is concerned with forming a pattern of interconnected switches and gates on the surface of a crystal of semiconductor devices. VLSI is one of the most widely used technologies for microchip processors, integrated circuits (IC) and component designing [6]. It was initially designed to support hundreds of thousands of transistor gates on a microchip which, as of 2012, exceeded several billion. All of these transistors are remarkably integrated and embedded within a microchip that has shrunk over time but still has the capacity to hold enormous amounts of transistors. Very-large-scale integration (VLSI) is the process of creating an integrated circuit (IC) by combining thousands of transistors into a single chip. VLSI began in the 1970s when complex semiconductor and communication technologies were being developed. The microprocessor is a VLSI device. Before the introduction of VLSI technology most ICs had a limited set of functions they could perform. An electronic circuit might consist of a CPU, ROM, RAM and other glue logic. VLSI lets IC designers add all of these into one chip. Figure 4 shows VLSI chips.

Fig 4: VLSI chips

4. SYSTEM DESIGN BY FINITE STATE MACHINE

In this elevator controller system, elevator service is between four floors only. Elevator's doors closed/opened automatically. In this system, it mainly consists of four processes:floor1, floor2, floor3 and floor4. Figure 5 shows elevator controller system of state diagram. The next state and current processes are using Moore state machine.

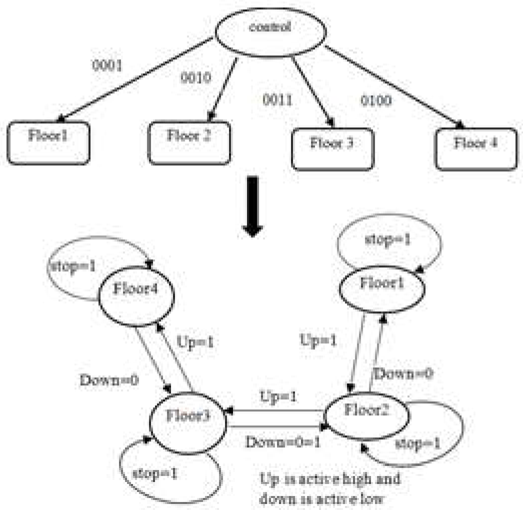

Fig 5: Elevator Controller System of State Diagram

In this system, up input is processed with active high and down input is processed with active low. Initially, the current floor is floor1. In floor1 process, if the up_down is 1 and stop is 0, the floor_state is floor2. If not, next state is floor1. In floor2 process, if up_down is set to "go up" and stop is 0, the next state is floor3. If up down and stop are 0, the next state is floor1. Otherwise, they are going to stay at floor2. In floor3 process, if up down and stop are 0, the next floor state is floor2. If up down is 1 and stop is 0, the next floor state is floor4. If not, the next is floor3. In floor4 process, if up down and stop are 0, the current floor is floor3 and else it is floor4. If reset is active high, the floor will return to the elevator floor1. And the output floor is displayed by 4 bits length.

4.1. System Flow Diagram

Figure 6 shows the elevator controller block diagram, which consists of controller logic, a floor counter, and a floor number. Assume that the elevator is on the first floor in the floor1 state. The floor counter contains 0001, which is the first floor code. Since up_down=1/0, the controller issues floor2/floor1 state to the elevator motor and elevator moves up/down. When the second/first floor reached and stop=1, the controller logic will stay the second/first floor. The process is repeated for an up_down and stop input.

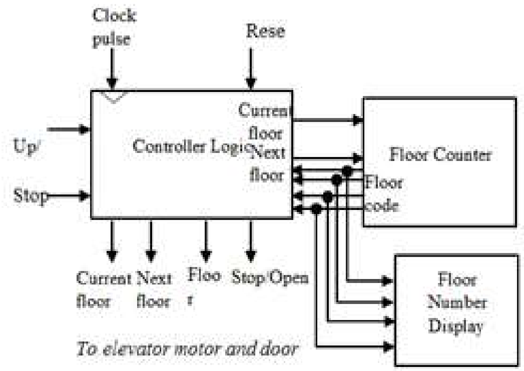

Fig 6: Elevator Controller Block Diagram

5. SIMULATION RESULTS

This section describes simulation results for implementation of elevator controller system. Firstly, in floor1 state, it occurs if the up_down is 0 and stop is 1. Otherwise the next state is floor2. In floor2 process, it occurs if the stop is 1. And, the next floor is floor3 if the up_down is 1 and stop is 0. And the next floor state is floor4 when up_down is 1 and stop is 0. If stop=1 and up_down=0, it is still floor4.And if up_down=1 and stop=0, it is re-arrival floor1 state.

5.1. Experimental Result-1

Figure 7 shows the simulation result of the reset input is active high. The elevator state will return the elevator to floor1 although up_down input is 1 and stop input is 0.

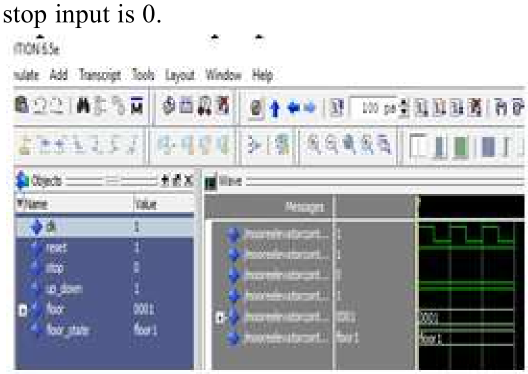

Fig7: Simulation Result for the reset input is active high.

5.2. Experimental Result-2

Figure 8 shows the simulation result of the up_down input is active high and stop input is 0.

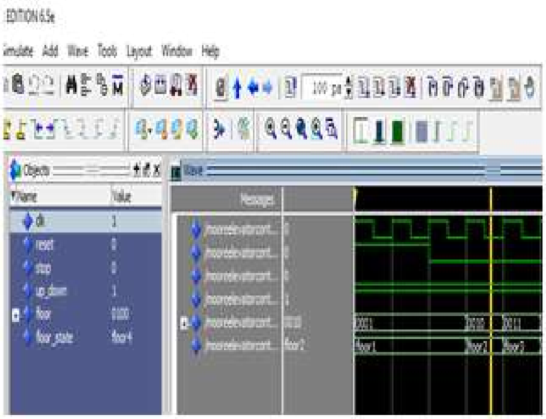

Fig8: Simulation Result for up_down input is active high and stop input is 0.

5.3. Experimental Result-3

Figure 9 shows the simulation result of the up_down input is active low (0) and stop input is 0.

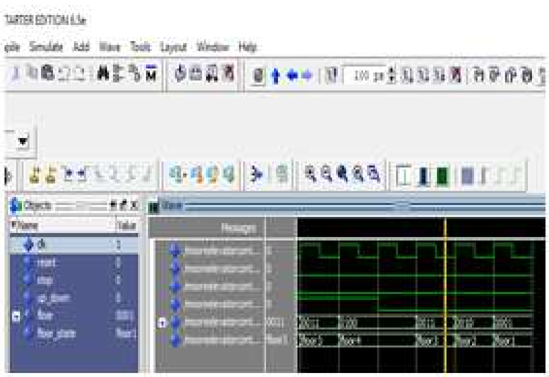

Fig9: Simulation Result for up_down input is active low and stop input is 0.

5.4. Experimental Result-4

Figure 10 shows the simulation result of the up_down input is active high and stop input is 1. And the next floor state is going continuous to stay at floor3 from previous state floor3.

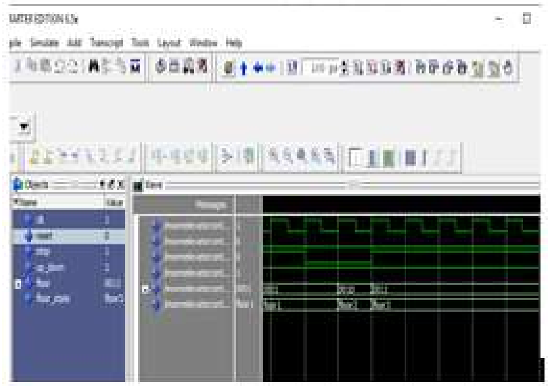

Fig10: Simulation Result for up_down input is active high and stop input is 1.

5.5. Experimental Result-5

Figure11 shows the simulation result of the data flow for the elevator controller system while up_down input is 1 and stop input is 0.

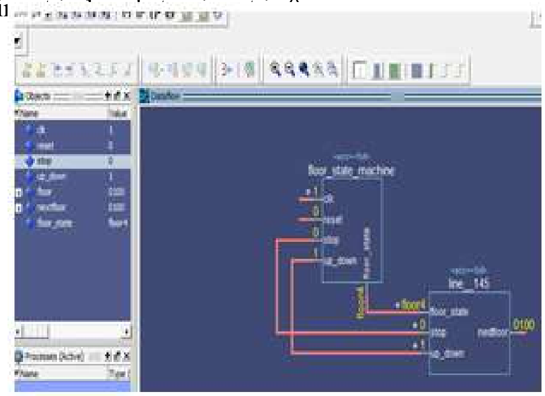

Fig 11: Data flow for the system in simulation

6. CONCLUSION

The present four floors elevator controller system is implemented using VHDL with the help of Finite State Machine. Thesystem always begins in the floor1 state on the floor until last serviced. When up_down signal and stop signal are received, the control logic determines the state of the floors (floor1, floor2, floor3, floor4). And the output is displayed on the floor output. The first approach is used for the implementation of a finite state machine for elevator group control system by using VHDL.In second approach, four types of dispatching algorithms were implemented for elevator system by using VHDL, generating data flow review, verifying the vector waveform by modelsim software.

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OBSTACLE DETECTION SYSTEM FOR UNMANNED GROUND VEHICLE

Nay Kyi Tun

University of Technology (Yatanarpon Cyber City), Myanmar

nwenayne@gmail.com

ABSTRACT

The distance detection system is consisted of two sections. The first section is hardware implementation of system. This section consists of electronic devices such as microcontroller, infrared distance sensors (IR), servo motors and a few passive components. Microcontroller plays as the heart of system and it handles communication and control processes of the system. The second system is firmware implementation. In this section, the required control data acquired with the help of analog to digital converter (ADC) and the communication between the two systems are provided by using universal asynchronous receiver transmitter (UART) communication protocol. The whole firmware is designed and programmed by using mikroC PRO compiler.

KEYWORDS: *Serial Communication, Infrared Distance Sensor, Servo Motor, Microcontroller*

1. INTRODUCTION

Nowadays, the technology in robotics and artificial intelligence have achieved great heights, the application of these technologies vary from micro technologies to building huge integrated devices. The UGV is an unmanned ground vehicle, which consists of the number of sensors, which helps to collect and navigate the data from the surrounding environment. Navigation and real time obstacle avoidance are the main fields of autonomous vehicle. An unmanned ground vehicle will automatically avoid the obstacle and navigate itself, or provide control towards the human operator. The primary requirement of this project is to create autonomous environment and control the UGV without human intervention. Vehicle can start when it is in contact with ground without human presence. Unmanned ground vehicles are actively developed for military purpose, spying, and dangerous works where humans do not have easy access.

The overall project is divided into two parts. The first part is sensor detection where the use of the UGV system. The second part is the operation of servo motor control. The whole circuit module was assembled on a special design of the printed circuit board. The PIC microcontroller was preprogrammed with a source code. The source code was written in MikroC programming language.

1.1 System Overview

The general function of the system is to control the servomotor with the help of infrared distance sensor. The infrared distance sensor module 1 is placed in center of the front of UGV. It is to measure the straight-line distance between obstacles and UGV. It receives the distance data sends to the microcontroller.

For the front of UGV, the left infrared distance sensor module 2 is used. It was fixed on the left servo motor. The microcontroller drives the stationary position 90 degree to 0 degree for the left servo motor. If the sensor does not find the obstacle, the servo motor has the stationary position 90 degree.

The infrared distance sensor module 3 is used in the right size of the UGV front. It was fixed on the right servo motor. It is measured distance between obstacles and UGV and then it receiving data sends to the microcontroller. The right servo motor rotates the stationary position 90 degree to 180 degree.

The microcontroller sends the distance data to the main processor. The detection system and main processor are connected with the Controller Area

Network (CAN) driver. If the sensor does not find the obstacle, the microcontroller sends normally state to the computer. The generic block diagram of the detection system is shows in figure 1.

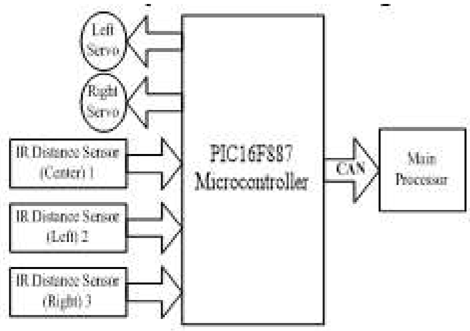

Fig1. Generic block diagram of the detection system.

2. HARDWARE COMPONENTS

In this section, the mainly components and modules of system are described with detail explanations.

2.1 PIC16F887 Microcontroller

The PIC16F887 is one of the latest products from Microchip. It features all the components, which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc [1]. Figure 2 show the photograph of PIC16F887 microcontroller and pin diagram.

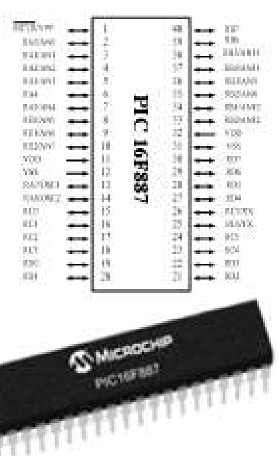

Fig2. The PIC16F887 microcontroller and pin diagram.

2.2 Servo Motor

A servo is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. As the coded signal changes, the angular position of the shaft changes. In practice, servos are used in radio controlled airplanes to position cars puppets, and of course, robots [2].

Fig3. The photograph of Servo Motor.

2.2.1 SG 5010 Servo Motor

SG 5010 servo motor is a high torque standard servo motor. The servo can rotate 180 degrees approximately (90 degree in each direction). The servo motor used is programmer friendly as who can use any servo code, hardware or library to control these servo motors.

2.2.2 Specifications of SG 5010 Servo Motor

The specifications of the servo motor SG 5010 are as following:

(a) Power: 4.8V - 6V DC max (5V works well).

(b) Average Speed: 0.2sec/60degree (4.8V), 0.16sec/60degree (6V).Weight: 39g.

(c) Torque: At 5V, 5.5kg-cm / 76oz-in, and at 6V 6.5kg-cm.

(d) Size mm: (L x W x H) 40 x 20.0 x 38 mm.

(e) Size in: (L x W x H) 1.60x.79x1.50.

(f) Spline Count: 25.

2.3 GP2Y0A21YK IR Distance Sensor

In this paper have been used GP2Y0A21YK IR (Infrared) distance sensors to measure the obstacles for the UGV. For measuring the distance to an object there are optical sensors using triangulation measuring method. Company "Sharp" produces most common infrared (IR) wavelength using distance sensors, which have analogue voltage output. The sensors made by "Sharp" have IR LED equipped with lens, which emits narrow light beam. After reflecting from the object, the beam will be directed through the second lens on a position-sensible photo detector (PSD).

The conductivity of this PSD (Position Sensible Photo Detector) depends on the position where the beam falls. The conductivity is converted to voltage and if the voltage is digitalized by using analogue digital converter, the distance can be calculated. The output of distance sensors is inversely proportional, this means that when the distance is growing the output is decreasing. Exact graph of the relation between distance and output is usually on the data-sheet of the sensor. All sensors have their specific measuring range where the measured results are creditable and this range depends on the type of the sensor.

Maximum distance measurement is restricted by two aspects: the amount of reflected light is decreasing and inability of the PSD (Position Sensible Photo Detector) registering the small changes of the location of the reflected ray. When measuring objects, which is too far, the output remains approximately the same as it is when measuring the objects at the maximum distance. Minimum distance is restricted due to peculiarity of Sharp sensors, meaning the output starts to decrease (again) sharply as the distance is at certain point. This means that to one value of the output corresponds two values of distance. This problem can be avoided by noticing that the object is not too close to the sensor [3, p. 2]. Figure 4 shows the photograph of GP2Y0A21YK IR distance sensor.

Fig4. Photograph of GP2Y0A21YK IR distance sensor.

2.3.1 Feature of GP2Y0A21YK IR Sensor

Feature of the GP2Y0A21YK IR distance sensor are as follows:

(a) Less influence on the color of reflective objects, reflectivity.

(b) Analog output type.

(c) Distance measuring range: 10 cm to 80 cm.

(d) Consumption current type: Typ.30 mA.

(e) Supply voltage: 4.5 to 5.5.

(f) Package size: 29.5 x 13 x 13.5 mm.

3. SYSTEM DESIGN

In this system are using three ADC (Analog to Digital Converter) input channels. The first input channel is RA0 pin (pin 2), the second input channel is RA1 pin (pin 3) and the third input channel is RA2 pin (pin 4). That input channels are connected with the IR distance sensor modules. The output ports are RB0 to RB7 pins. The output devices are two servo motors, four LEDs and PC display. The left servo motor is connected to the RB0 pin (pin 33). The right servo motor is connected to the RB1 pin (pin 34). The four indicator LEDs are connected with the RB4 to RB7 pin (pin 37, 38, 39, 40). The microcontroller of transmitter pin and receiver pin are connected with the CAN (Controller Area Network) communication driver shown in figure 5.

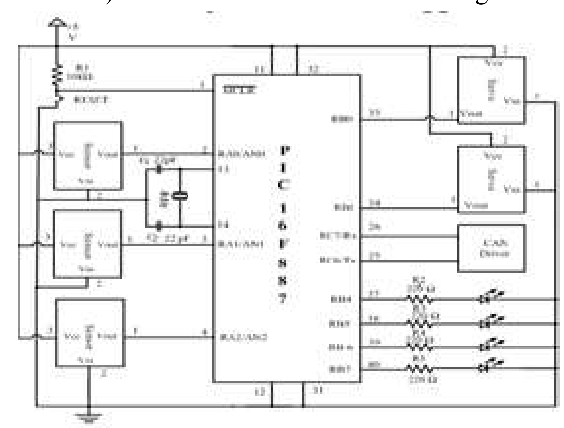

Fig5. Schematic diagram of the detection system.

3.1 Firmware Implementation

The program is first initialized all the I/O (input/output) port according to the schematic diagram and initialize the PWM module, ADC (Analog to Digital Converter) module and servo motor. The left servo and the right servo have the stationary 90 degree.

The channel (0), channel (1) and channel (2) of ADC is used to measure the distance between vehicle and obstacles.

If the centre sensor ensures that the path is clear, the LED light of that sensor will turn on. If not, the left servo will rotate from stationary 90 degree to 0 degree and check whether the path is clear or not. As soon as the clear result comes out, the left LED shows a green light. The consequence of unclear result makes the right servo to turn form stationary 90 degree to 180 degree and the left servo will turn back to its stationary position, 90 degree.

When the right sensor does the same way as the left and centre sensors do. After getting a clear path, the right LED turns on. If no clear path is found out, the right servo will turn back to its stationary position, 90 degree, and an alarm light of the error indicator will appear. The figure 6 shows the flowchart diagram of the detection system.

3.2 Printed Circuit Board Design

The printed circuit board (PCB) for the complete circuit was made by using PC (Personal Computer) based printed circuit board drawing software. It is Nichie PCB Designer software. The drawing was printed on a thin art paper by using laser printer. Then the carbon track lines on the art paper were copied onto the copper side of the PCB board by ironing method. Figure 7 shows the printed circuit board design of detection system.

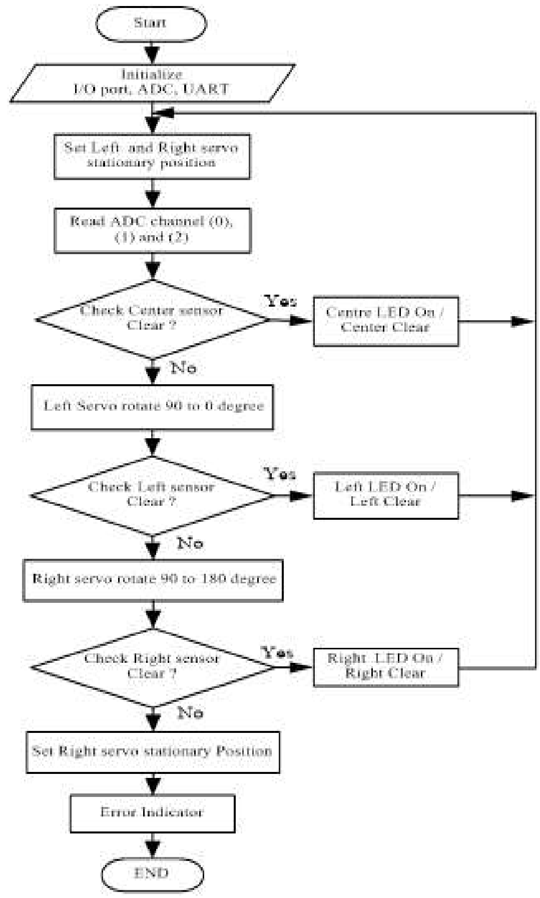

Fig6. The flowchart of the detection system.

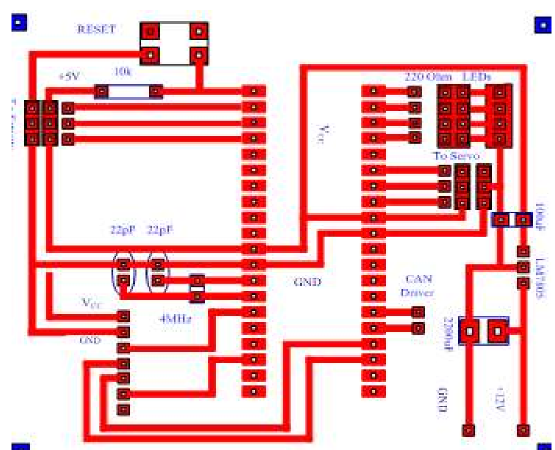

Fig7. The printed circuit board design of detection system.

4. RESULTS

The result section described the simulation and practical results.

4.1 Simulation Results

This paper is built by the PIC16F887 microcontroller component. The microcontroller controls the speed of servo motor with the help of sensor. The schematic diagram of the main components of the distance detection system including the microcontroller circuit is drawn in the Proteus 8 software and then run the simulator program. Simulation result of the system is shown in figure 8.

In this schematic diagram, the distances 80 cm of the sensors showed 73 cm on the virtual terminal display. The two servo motors have the stationary position 90 degree from the distance above of 73 cm of the sensors and the LED of RB4 is on state. The left servo motor rotates0 degree from the distance below 72 cm of the left sensor. The right servo motor rotates 180 degree from the distance below 72 cm of the right sensor. At this time, the LEDs are off state. The virtual terminal is to show the distance for the sensors. To show the distance of the sensors are using the virtual terminal.

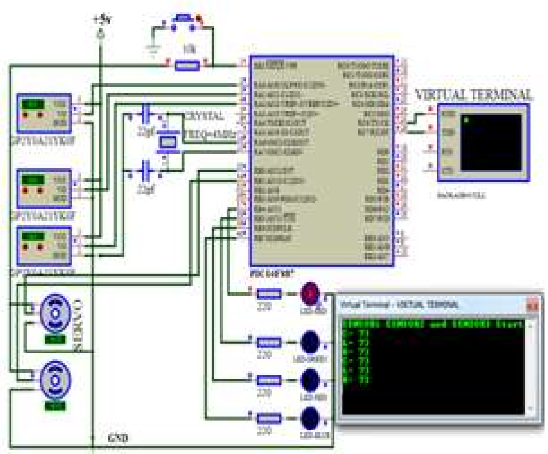

Fig8. Simulation Result of UGV Detection System.

4.2 Practical Results

The result on test running of the whole circuit is described with photos. Before, inserting the PIC microcontroller, the power supply and soldering shorts are checked, with a multi-meter. The power supply pins of each integrated circuit (IC) sockets and terminals obtain +5V DC power supply. Then the integrated circuits are inserted and tested.

In the initial testing, the serial communication pins are connected with PC and the testing was made for the circuit board itself. The maximum detection range of the sensors defined the distance 80 cm and minimum range is 1cm.The normally state of the sensors are the distance above of 80 cm. At this time, the two servos have the stationary position 90 degree and the red light of LED is ON shown in figure 9.

When the sensors find the obstacles in the below range of 80 cm, the right servo rotates 180 degree. The right sensor check the path and if does not find the obstacle, the green light of LED is ON state. If that find the obstacle, the left servo rotates 0 degree. The left sensor check the path and if does not find the obstacle, the green light of LED is ON and the right servo turn back stationary position 90 degree shown in figure 10.

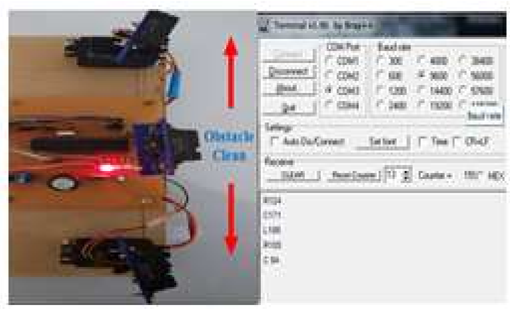

Fig9. The photograph of normally state of the detection system.

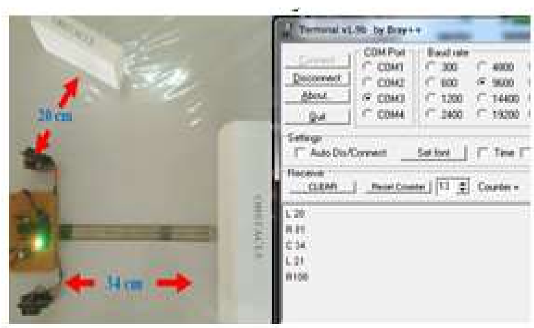

Fig10. The photograph of test detection of obstacles ranges.

4.2 Limitations

(a) If the focus detection ranges of the sensors short, the reflection beams of the signal are complex.

(b) In the practical result, the operations of two servo motors are delayed 6 seconds.

5. CONCLUSION

The main objective of this study is to design and construction of obstacle detection system by using the IR distance sensor for UGV. In this study, the infrared distance sensor modules have been used to measure the distance between the vehicle and obstacles. Initially it is tested on virtual simulation model by using proteus simulation software. Then it is tested on the hardware. Infrared distance sensor module helps to detect obstacle more efficiently and effectively. But the system still required to solve some arguments and limitations.

In future, the sensing range can be increased by increasing the sensor quality with the help of ultrasonic sensor or the infrared signal spread all over the provide area.

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DANCING ROBOT USING ARDUINO

Kyi Kyi Khaing (1), Tin Tin Nwet (2), Thiri Naing (3)

(1) Myanmar Institute of Information Technology (Mandalay), Myanmar

(2)University of Computer Studies (Sittwe), Myanmar

(3)University of Information Technology (Yangon), Myanmar

(1)kyi_kyi_khaing@miit.edu.mm

ABSTRACT

This paper attempts to achieve dancing robot by using Arduino UNO, Arduino Nano and Bluetooth as a main processor. In this system used seven major components which are Arduino Uno, Nano Board, HC-05 Bluetooth Module, Servo motor, 8x8 dot matrix, MP3 module and DC Buck Converter. The system is implemented on an embedded platform and is equipped with a Bluetooth module (HC-05) which gives the required input for operation. The main objective of this paper is to **dance according to our commands** using Bluetooth module via Arduino.

KEYWORDS: *Aurdino UNO, Aurdino Nano, HC-05 Bluetooth Module, Servo motor, 8x8 dot matrix and MP3 module.*

1. INTRODUCTION

The proposed system is Dancing Robot using Arduino. Internet of Things has emerged as one of the most promising technologies for the future [1]. This field is actively researched, and different solutions have been proposed to address the challenges in this area, such as limited amount of energy and cost-efficiency [2]. One of the most discussed topics in IoT is the Home Automation, developing an inexpensive and safe system for indoor use has been a widely researched area which has brought advances in technology and availability of small, flexible, and smart systems.

This system proposed a low-cost system using Bluetooth which can make our daily life happy and enjoyable by spending our time with this little robot.

2. Background theory

A brief introduction about Bluetooth and Arduino is presented. These components are the main parts of the proposed system design. Microcontroller can be regarded as a single-chip special-purpose computer dedicated to execute a specific application. As in general purpose computer, microcontroller consists of memory (RAM, ROM, and Flash), I/O peripherals, and processor core. However, in a microcontroller, the processor core is not as fast as in general purpose – computer, the memory size is also smaller.

Microcontroller has been widely used in embedded systems such as, home appliances, vehicles, and toys etc. There are several microcontroller products available in the market, for example, Intel's MCS - 51 (8051 family), Microchip PIC, and Atmel's Advanced RISC Architecture (AVR). Arduino UNO and Bluetooth module are discussed in this section.

This design is based on both hardware and software. For the design to be implemented, we will be using an ATMega328 Microcontroller, interface with some other hardware components.

2.1 Hardware Components

The circuit diagram of the dancing robot is as shown in Fig 1 and hardware components are shown in Table 1.

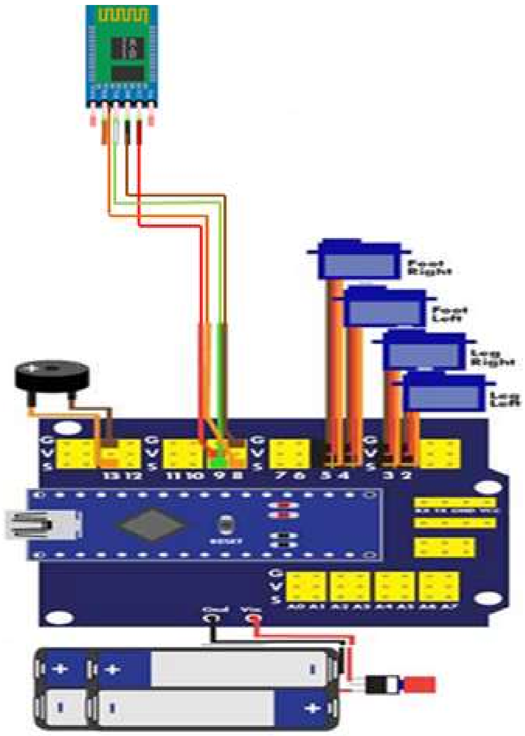


Fig1. Circuit Diagram of Dancing Robot

Table 1. Hardware Components

No.	Part Name	Specification	Quantity
1.	Arduino	UNO	1
2.	Arduino	Nano	1
3.	Bluetooth module	HC-05	1
4.	8x8 dot matrix (with module)	MAX 7219 CWG	1
5.	MP3 module	JQ8400-FL-10P	1
6.	Servo motor	MG996R	4
7.	Speaker	8 Ω, 0.5 W	1
8.	Battery (Rechargable)	12 V, 3000 mAh	1
9.	Battery	9 V	1
10.	DC Buck Converter	LM2596S	1

2.1.1 Arduino

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board we can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

2.1.1.1 Features of the Arduino UNO Board

Arduino is a USB interface like a serial device. The board directly plug in to the computer so it is easy and comfortable to interface with the computer. It is an open source device and very easy to debug the problem so it is more advantages between the large community peoples. In order fast up for application it has 16 MHz clock.

It has inbuilt in voltage regulation in order to manage power inside and can be directly powered by USB without any external power. This board has 13 digital and 6 analog pins to connect the hardware with the external environment. With the help of these pins we can directly plug in the real-world data. This board has a ICSP connector which is necessary to re bootload our chip and has 32 KB of flash memory for storing our code. An on board LED and reset button is attached in order to make debug process easy.

2.1.1.2 Arduino Nano

The *Arduino Nano* is a compact board similar to the UNO. The *Arduino Nano* is a small, complete, and breadboard-friendly board based on the ATmega328P (*Arduino Nano 3.x*).

It has more or less the same functionality of the *Arduino* Duemilanove, but in a different package.

2.2 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It has the footprint as small as 12.7mmx27mm.

2.3 DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators[3].

2.4 Interfacing 8x8 LED Matrix with Arduino

LED matrix displays can be used to display almost anything. Most modern LED sign board's uses various types of matrix boards with controllers. 8×8 matrix consists of 64 dots or pixels. There is a LED for each pixel and these LEDs are connected to total of 16 pins. The pin out and circuit diagram of it using the following Fig 2. In Fig 2, **C1 to C8 are Column pins and R1 to R8 are Row pins.**

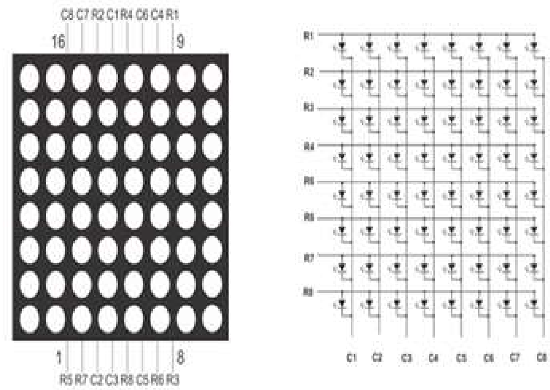


Fig2. **8x8 Matrix Pin out**

We can see all anodes of same row are connected to one pin and all cathodes of same column are connected to another pin. We have 8 row pins and 8 column pins. If a positive voltage is applied to R1 pin and negative to C1, we can see that the first pixel turns on. If we apply negative to C2 then the second pixel turns on. Like this we can turn each pixel by hanging the supply pins. However we have 64 supply combinations, and doing it manually is practically impossible. In this paper, the 8x8 dot matrix demonstrates the face of the dancing robot.

2.5 Servo Motor

A servo motor is a rotary actuator or motor that allows for a precise control in terms of angular position, acceleration and velocity, capabilities that a regular motor does not have. It makes use of a regular motor and pairs it with a sensor for position feedback. The controller is the most sophisticated part of the servo motor, as it is specifically designed for the purpose. Servo Motors are employed for the movement of the robot. Two servos at both the feet help the robot turn [4].

3. PROPOSED SYSTEM

In this paper, dancing robot was designed and implemented using Arduino microcontroller devices which is programmed by open source IDE and uses 4 servos for balancing. The functional block diagram of the design is shown in Fig 3. This design is in seven modules; Bluetooth module (HC-05), servo motor, 8x8 dot matrix, MP3 module, DC Buck Converter, Arduino UNO and Nano modules. While the Arduino UNO forms the main control element, the Bluetooth module is connected with other hardware components. After connecting successfully, **according to our commands** to dance the robot.

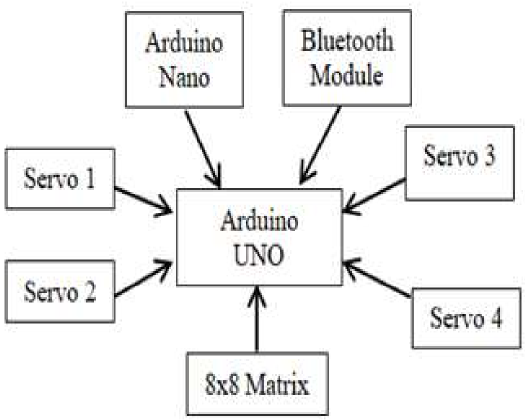


Fig 3. Functional Block Diagram of the Design

4. Operation of the system

The Arduino program controls the movement of the servo motor with music. The robot starts dancing as soon as the music has begun. The MP3 module helps that process. The servo motors control the movement of robot. Moreover, when a speech signal (a string of characters) is given to it, it translates into ROBOT LANGUAGE. Bluetooth is used to give command to the robot. In this paper, the 8x8 dot matrix demonstrates the face of the robot.

Arduino UNO is used to control the 4 servo motors and Nano for sound functions and 8x8 matrix LED display. These 2 microcontroller boards are connected by 3 digital pins; 1 pin for 'Enable' and 2 pins for choosing one out of the four main functions.

4.1 User Interface

In this design, four main functions (string commands) are applied. These functions are 'HELLO', 'music 1', 'music 2' and 'GOODBYE' function. In these function, 3 digital pins (en, s1, s0) are used.

"Hello! I'm Dante. And I am dancing robot. Welcome to my show". This is the sentence come out from the robot when we give the string command 'HELLO'.

```
while (voice! = nextvoice)
 {
  if (voice == "HELLO")
   {
    digital Write (en, 1);
    digital Write (s1, 0);
    digital Write (s0, 0);
    delay (200);
    digital Write (en, 0);
    delay (100);
   }
```

We added 2 parts of songs to the MP3 module. It has a memory chip around 4 MB of data size. It is short music since the music module which supports an SD card utility is not yet available here.

String command 'music1' switch on the song no.1 by Arduino Nano and 'music2' for song no.2.

```
if (voice == "music1")
   {
    digitalWrite (en, 1);
    digitalWrite (s1, 0);
    digitalWrite (s0, 1);
    delay (100);
    digitalWrite (en, 0);
```

```
 digitalWrite (s0, 0);
 delay (10);
 Tune1 ();
 normalPOS ();
}
if (voice == "music2")
{
 digitalWrite (en, 1);
 digitalWrite (s1, 1);
 digitalWrite (s0, 0);
 delay (100);
 digitalWrite (en, 0);
 digitalWrite (s1, 0);
 delay (10);
 Tune2 ();
 normalPOS ();
}
```

It's ending sentence "Thanks for watching my show. Have a nice Day. Good Bye!" will come out when 'GOODBYE' string is sent to Arduino through Bluetooth.

```
if (voice == "GOODBYE")
{
 digitalWrite (en, 1);
 digitalWrite (s1, 1);
 digitalWrite (s0, 1);
 delay (100);
 digitalWrite (en, 0);
 digitalWrite (s1, 0);
 digitalWrite (s0, 0);
 delay (10);
}
```

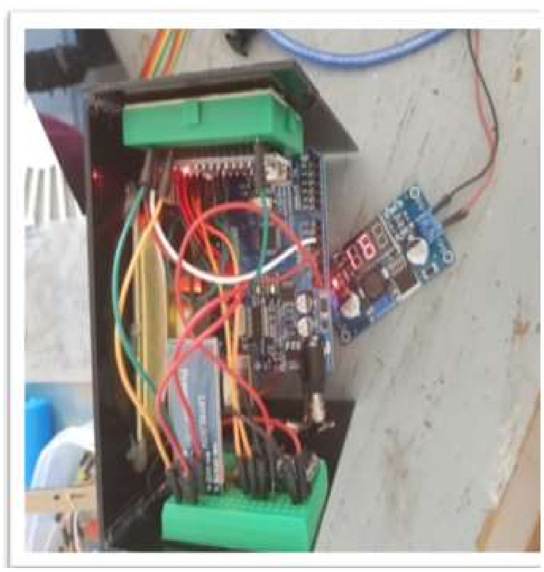
4.2 Software Modules

The library files additionally used in our Arduino programs are Servo.h and MaxMatrix.h.

4.3 Step by Step Construction of Robot

The step by step construction of the dancing robot is shown in Fig 4.

(a)

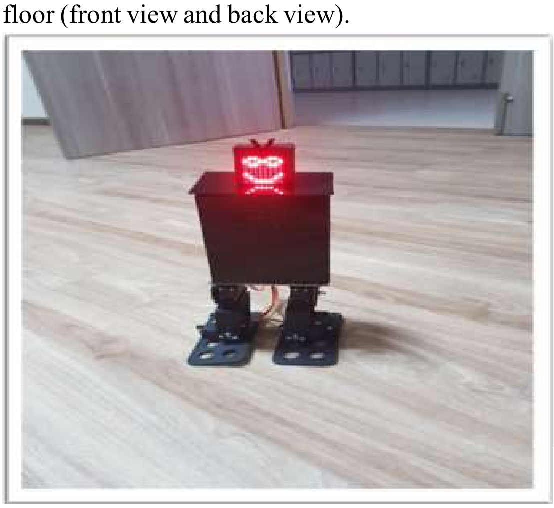


(b)

(c)

Fig 4. Step by Step Construction of Dancing Robot

After upload the program through the Arduino, demonstrates programming of a simple robot motion. Finally, the robot is placed on a table or on the floor; their program starts are synchronized by a function; and the dancing music is started. While dancing, the robot demonstrates various motions. Fig 5 is a photograph showing the robot dancing on the lab floor (front view and back view).



Front view

Back view

Fig 5. Dancing Robot (Front View and Back view)

5. CONCLUSIONS

The purpose of this paper is to learn how to connect simple. This robot has only 2 legs. No more leg needed but 2 hands are necessary to be dancing much more efficiently. Micro-servos with metal gears are okay for them and one more servo at the neck is recommended for the best performance.

Significantly good looking functions can be added if sound encoder for Arduino is available. Suppose the robot can hear a song from beginning to end. Then the robot should be able to sing the vocal of the whole song when we give a specific command to the robot.

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