Sudan University of Science and Technology

Collage of Graduate Studies

A Microcontrooller-Based Weather Prediction System using the Sliding Window Algorithm

نظام تنبؤ للطقس يعتمد على المتحكم الدقيق باستحدام خوارزمية النافذة المنزلقة

A Research Submitted in Partial Fulfillment for the Requirement of the Degree of M.Sc. in Electronic Engineering (Computer and Network Engineering)

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الإستهلال

قال تعالى :

(أَلَمْ تَرَ أَنَّ اللَّهَ يُزْجِي سَحَابًا ثُمَّ يُؤَلِّفُ بَيْنَهُ ثُمَّ يَجْعَلُهُ رُكَامًا فَتَرَى الْوَدْقَ يَخْرُجُ مِنْ خِلَالِهِ
وَيُنَزِّلُ مِنَ السَّمَاء مِن جِبَالٍ فِيهَا مِن بَرَدٍ فَيُصِيبُ بِهِ مَن يَشَاء وَيَصْرِفُهُ عَن مَّن يَشَاء
يَكَادُ سَنَا بَرْقِهِ يَذْهَبُ بِالْأَبْصَارِ)

سورة النور(43)

DEDICATION

The sake of Allah, my Creator and my Master, my great teacher and messenger, Mohammed (May Allah bless and grant him), my supervisor Dr.Alaa Eldeen Awouda the stature teacher who did not skimp on his knowledge and advice throughout the whole period of project, to the pure soul of my father, to my beloved mother the crown of my head, to my husband beloved journey partner, to my children is the fruit of my life, to my brothers and sisters the symbol of love and giving.to my girlfriends who encourage and support me,

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In the Name of Allah, the Most Merciful, the Most Compassionate all praise is to Allah, the Lord of the worlds; and prayers and peace be upon Mohamed His servant and messenger.

Primary I would thank god almighty for being able to complete this project with success. Then I’m heartily to my supervisor Dr. Alaa Eldeen Awouda encouragement guidance and support in the initial towards the final level enabled me to build up awareness from the project.

Then I would like to thank my mother and my husband and all family and my friends who have helped me with their valuable suggestions and guidance has been very helpful in various phases of the completion of the project.

ABSTRACT

Weather forecasts are made by collecting as much data as possible about the current state of the atmosphere (particularly the temperature, humidity and wind) and using understanding of atmospheric processes to determine how the atmosphere evolves in the future.

Weather forecasting is important in all walks of life and it enters agriculture, aviation, traffic, torrential floods and floods.

Design weather temperature forecasting and implemented by using a sliding window algorithm applying it by Arduino, using DHT-11 sensor to measure the temperature and fed it into Arduino as input, keypad 4x4 fed it into Arduino as input to enter the temperature degrees that needed by Sliding Window Algorithm.

The comparison of weather condition variations using sliding window approach has been found to be highly accurate except for the months of seasonal change where conditions are highly unpredictable, here using Sliding Window Algorithm it to predicted temperature for next day and LCD16X2 to display temperature degree for current day and predicted next day.

The results are being computed for four cases for two year getting samples 4 months to check the predictable temperature weather.

المستخلص

التنبؤ بالطقس يتم عن طريق جمع أكبر قدر ممكن من البيانات حول الحالة الراهنة للغلاف الجوي (وخاصة درجة الحرارة والرطوبة والرياح) واستخدام فهم العمليات الجوية لتحديد كيفية تطور الغلاف الجوي في المستقبل.

التبنؤ بالطقس مهم فى شتى مناحي الحياه فيدخل في الزراعه وحركه الطيران والسير والسيول والفياضانات .

للتنبؤ بدرجة حرارة الطقس لليوم التالي تم باستخدام نهج خوارزمية النافذة الإنزلاقية التي تتسم بدقة عالية باستثناء أشهر التغيير الموسمي حيث تكون الظروف غير متوقعة بدرجة كبيرة.

صمم نظام للتنبؤ لدرجة حرارة الطقس وذلك بإستخدام خوارزمية النافذة الإنزلاقية وتطبيقها بالمتحكم , يتم إستخدام الحساس لقياس قيمة درجة الحرارة و من ثم تغذية القيمة المقروءة للمتحكم ,يتم إستخدام لوحة المفاتيح 4*4 وربطها مع المتحكم ويتم عن طريقها إدخال كل قيم درجات الحرارة اللازمة للتنبؤ بدرجة حرارة اليوم التالي بإستخدام الخوارزمية ويتم عرض درجة حرارة اليوم الحالي ودرجة الحرارة المتوقعة لليوم التالي في شاشة العرض .

تم حساب النتائج لأربع حالات درجة حرارة لعامين وذلك أخذ 4 أشهركعينات للتحقق من درجة حرارة الطقس المتوقعة.

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LIST OF ABBREVIATIONS

ADC	Analog to Digital Converter
AVR	Advance Virtual RISC
H	Hertz
I/O	Input/output
LCD	Liquid Crystal Display
USB	Universal Serial Board
SWA	Sliding Window Algorithm

CHAPTER ONE

INTRODUCTION

1.1 Overview

The monitoring of weather is really helpful in various applications like in critical scientific systems or for simulation purposes.In other fields like agriculture, disaster management and medical suited environments.

Many of the traditional sources of weather information are not sufficient for agricultural applications because of the long distances between weather stations, meaning the data is not always local and applicable for on-farm evaluation and resulting operational decision processes. The second constraint with traditional weather information is the timeliness of the data. Most delivery systems are designed on a one-hour time step, whereas many decisions in agriculture are based on minute-by-minute weather conditions, good weather station can be helpful to properly plan farm operations , crop growth is closely related to the weather, help to define the right time of sowing and harvesting .

1.2 Problem statement

Suffering off Weather prediction represent a challenging for scientists And engineers to determine outside weather fluctuation which is had direct impact on our lives.

1.3 Propose solution

Design a system that could predict temperature with the help of past data
Using Sliding Window Algorithm.

1.4 Aim and objectives

- The main aim is to design a control system that can predict weather parameters.
- To achieve this aim weather prediction system had been proposed.

1.5 Scope

This research covers the area of control system specially Arduino microcontroller along with website.

1.6 Methodology

The project collects the value of weather Temperature by temperature sensor to sense the temperature gives out the value sends data in form of pulse train of specific time period is connected to input of the Arduino, the Arduino
Get the value from sensor each specific periods, calculate the specific value of temperature, entering temperature (needing for prediction) by Keypad which is connected to Arduino, then predicted temperature for next day by applying *Sliding Window Algorithm* (SWA) and then displayed current and predicted temperature.

1.7 Thesis outline

The thesis is reported in five chapters:

1. Chapter one includes: Introduction, problem statement, proposed solution, objectives and methodology.

2. Chapter two: Literature Review.

3. Chapter three: Design description.

4. Chapter four: Result and Discussion.

5. Chapter five: Conclusion and Recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

Weather forecasting is mainly concerned with the prediction of weather condition in the given future time. Weather forecasts provide critical information about future weather. There are various approaches available in weather forecasting, from relatively simple observation of the sky to highly Complex computerized mathematical models. The prediction of weather condition is essential for various applications. Some of them are climate monitoring, drought detection, severe weather prediction, agriculture and production, planning in energy industry, aviation industry, communication, pollution dispersal, and so forth, Accurate prediction of weather conditions is a difficult task due to the dynamic nature of atmosphere. The weather condition at any instance may be represented by some variables. Out of those variables, one found that the most significant are being selected to be involved in the process of prediction. The selection of variables is dependent on the location for which the prediction is to be made. The variables and their range always vary from place to place. The weather condition of any day has some relationship with the weather condition existed in the same tenure of precious year and previous week {some relationship with the weather condition existed in the same tenure of precious year and previous week.

Accurate prediction of weather conditions is a difficult task due to the dynamic nature of atmosphere. The weather condition at any instance may be represented by some variables like maximum temperature, minimum temperature, rain fall, snow fall, etc. The selection of variables is dependent on the location for which the prediction is to be made. The variables and their range always vary from place to place. The weather condition of any day has some relationship with the weather condition existed in the same tenure of previous year and previous thirty days [1].

2.2 Related Work

The authors in[2] proposed system taking readings from various sensors at different pins in Arduino microcontroller. For this purpose they used an Arduino compatible Wi-Fi shield stacked upon to Arduino microcontroller which adds up extra functionality to Arduino board , they used DHT11 temperature sensor to get the temperature and humidity readings, raindrop sensor module is attached to detects either there is any rain or not , BMP185 pressure sensor module is also attached to get the pressure readings in an environment, soil moisture sensor module which when dipped within a humid wet or dry soil fluctuates accordingly, wireless connectivity attached Wi-Fi shield over the Arduino to connect it to the local internet connection providers and connect. Its job is to transmit the data to a website.

The authors in [3]there brain of the prototype is the ESP8266 based Wi Fi module Nodemcu (12E). Four sensors are connected to the NodeMCU namely temperature and humidity sensor (DHT11), pressure sensor (BMP180), raindrop module, and light dependent resistor (LDR). Whenever these values exceed a chosen threshold limit for each an SMS, an E-mail and a Tweet post is published alerting the owner of the appliance to take necessary measures. The authors in [4]proposed system makes use of 3 sensors to measure the weather/environment factors such as temperature, humidity, light intensity, dew point and heat index. The values read from the sensors are processed by the Arduino micro-controller and stored in a text file which can be processed upon to derive analysis. The readings are also displayed on an on-board LCD for quick viewing. All these readings can be analyzed to get the weather characteristics of a particular area and record the weather pattern. These recorded parameters are essential and vary from places to places. All these requirements are fed into the database and these values are essentials and recorded over time. The authors in[5] design and construction of a low cost weather station which makes weather related data available for different purposes such as agriculture, aviation weather forecasting, etc. The design is made up of an outdoor module which measures four weather elements (temperature, atmospheric pressure, relative humidity and wind speed) through their respective sensors. This module transmits the sampled data wirelessly through radio frequency (RF) to an indoor module which receives the data and automatically logs the data to a database. The authors in[6] proposed the weather monitoring system contains DHT sensor by which temperature and humidity will be monitored. The data from the sensors are collected by the micro controller and also micro controller sends the sensors data in to the Arduino Software (IDE) by using the Serial Communication. The system is used for maintaining the temperature and humidity in a room.

The authors in[7] the prediction is made based on sliding window algorithm. The month wise results are being computed for three years to check the accuracy. The results of the approach suggested that the method used for weather condition prediction is quite efficient with an average accuracy of 92.2%.

The authors in [8] for predicting the next day's weather in the present year they compare the previous year's data (weather data) with the current year's data to obtain the trend (pattern) of the previous years that matches with the current year's trend (pattern) (that is followed by the day subjected to prediction) to the highest extent. By 'trend' they mean a sequence of daily weather data that adequately supplies information of weather data fluctuation in a region , The notion of using data of previous year comes from the assumption that the trend in this year may be delayed or lead from its exact position in the calendar .

In [1]To predict the future’s weather condition, the variation in the conditions in past years must be utilized. The probability that the weather condition of the day in consideration will match the same day in previous year is very less. But the probability that it will match within the span of adjacent sixty days of previous year is very high. A Sliding window algorithm is emerging as a leading methodology for the application of weather prediction. So, the prediction is made based on sliding window algorithm. So, sixty days are considered for previous year a sliding window is selected of size equivalent to fifteen days. Every thirty days of sliding window is then matched with that of current year’s thirty days in consideration. The best matched window is made to participate in the process of predicting weather conditions. The month wise results are being computed for four months to check the accuracy. The experimental results demonstrate that the applied technique gives better predicted weather conditions are quite efficient with an average accuracy of 94.21%, the algorithm has been executed and tested in Matlab2009b version. Thus, in the algorithm in consideration the previous year’s data is being utilized for predicting the weather conditions.

In[9] for predicting the next day's weather in the present year they compare the previous year's data (weather data) with the current year's data to obtain the trend (pattern) of the previous years that matches with the current year's trend (pattern) (that is followed by the day subjected to prediction) to the highest extent. By 'trend' they mean a sequence of daily weather data that adequately supplies information of weather data fluctuation in a region. The recorded data of the years were used to make predictions. Therefore, to predict time on the day after this year compared to previous year's data (meteorological data) with current year data for the trend (pattern) of previous years, which coincides with the trend of the year in progress followed by the forecasted day) to a greater extent. "Trend" means a sequence of weather data each day to adequately provide information on weather fluctuation data in a region. Data recorded over the years have been used to make predictions.

The authors in[10] embedded system programmers and designers be provided a microprocessor that can only be programmed in assembly and has no existing framework or should an Arduino be provided that has a high-level compiler, a large community, and existing examples available on the Internet.

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software.

Arduino can come in a number of form factors. For example, the Arduino
Uno consists of an ATmega328 microprocessor, a USB to serial chip, and an ACto DC power converter. The Uno can either be built by hand or can be bought premade from a seller. The Arduino software platform is written in Java and is based, mainly, on Processing the IDE is installed on a machine and then can program the UNO over the USB. The base IDE includes a number of examples for blinking LEDs, making noises, etc. The Uno is only one type of Arduino kit and others exist such as the Nano.

The major benefits for using Arduino in an educational setting that we have identified are:

- Ease of setup - plug and play
- Many examples for controlling peripherals – preloaded in the IDE
- Many open source projects
- Works on Windows, Linux, and Mac
- Low cost hardware - build or purchase prebuilt
- Low cost software - free
- Low maintenance cost - Destroyed microprocessors can
be replaced for approximately 4 USD
- Students can prototype quickly
- Can be programmed in a number of languages
including C.

In[11] Arduino is used for building different types of electronic circuits Easily using of both a physical programmable circuit board usually microcontroller and piece of code running on computer with USB connection between the computer and Arduino. Programming language used in Arduino is just a simplified version of C++ that can easily replace thousands of wires with words.

In [12] One of the advantages of the proposed architecture is the huge quantity of sensors developed for its usage. The principle followed is to configure Raspberry as a collector for measures obtained from Arduino, transmitting occurs via USB; meanwhile, Raspberry broadcasts them via a web page. For such activity is possible thanks to Raspbian, a Linux-based operating system. It has a lot of libraries and resources available, among them Apache Web Server, that gives the possibility to host a web-page. On it, the user can observe temperature, humidity, solar radiance, and wind speed and direction. Information on the web-page is refreshed each five minute; however, measurements arrive at Raspberry every ten seconds. System stores all information on the log file, this gives the possibility for future analysis and processing

Arduino is an open-source physical computing platform based on a simple microcontroller board and a development environment for writing software for such board. Arduino web-page released an integrated development environment (IDE). It is based on C and C++ programming languages, and probably its ace up the sleeve for Arduino, a software library is called “Wiring”, and it makes simpler the communication with extension boards.

The author In [12] proposed to comparative analysis of the environment system was applied in a sample agricultural farm. This prototype system was

Found to be comfortable for farmers for effectively monitoring the farm anywhere at any time, which results cost reduction, asset saving, and productive management in farming. The prototype system is developed using open source hardware Raspberry PI and WIFI which proves cost effective and having low power consumption. The sensors gather the data of various environmental parameters and provide it to Raspberry PI which act as a base station. The Raspberry PI then transmits the data using WIFI and the processed data will be displayed on laptop through accessing the server that is on the receiver side

2.3 Data Mining Techniques used for weather prediction

Data mining is an interdisciplinary subfield of computer science. It is the computational process of discovering patterns in large data sets

2.3.1 Feedforward Network

A feed forward neural network has layers of processing elements. The first step in training is to create network object. A feed-forward network has

More layers that is used to learn complex relationships more quickly. Feed-forward network has no feedback. FFN allows signal to travel one way only. Feed-forward ANN are straight forward network that uses inputs with outputs. To create a network, typical input and output values that initialize weight and bias values are provided and determine the size of the output layer. In the training process, the weights are adjusted so that to achieve desired result. This architecture consists of three layers, such as input layer, hidden layer and output layer.

2.3.2 Backpropagation Network

A back propagation neural network uses a supervised learning. It has very good application potential and has its own limitations. It has been applied to a wide range of practical problems and has successfully demonstrated its power.

In the year 1986, Rumelhart, Hinton and Wilham presented the concept of the back-propagation algorithm. Back propagation is a general-purpose learning algorithm. It is one of the powerful and expensive in terms of computational requirements for training. In backpropagation algorithm, there are two phases in its learning cycle one to propagate the input patterns through the network and other to adapt the output by changing the weights in the network. It is a supervised learning method. It requires a dataset of desired output for many inputs, making up the training set. It is more useful for feed-forward networks. The back propagation is a gradient descent method. This method adjusts the weights according to the error function. The term back propagation refers to the manner in which the gradient is computed for nonlinear multilayer networks.

2.3.3 Sliding Window algorithm

In this work, a day’s weather conditions are forecasted. For this, the previous seven days weather is taken into consideration along with fortnight weather conditions of past years. In this work, the four major weather parameters will be taken into consideration, which is, maximum temperature, minimum temperature, Humidity and Rainfall [13]

2.3.4 Naive Bayes Algorithm

Naive Bayes algorithm belongs to the family of probability-based Classifiers and revolves round the concept of Bayes theorem. The probabilistic Model consists of vector containing features with a probability assigned to it. The estimation of class condition probability is done by the classifier with the assumption that attributes are conditionally not dependent on each other. Construction of classifier model is done by combining the probability-based model with decision rule.

2.3.5 C4.5 Decision Tree

Unlike Naive Bayes, the C4.5 is a classification algorithm used to generate decision tree for the given dataset. It is based on the information entropy concept. Construction of the decision tree is done by selecting the best possible attribute that will be able to split set of samples in most effective manner. The attribute having the highest entropy difference or normalized information gain is selected as the splitting criteria for that particular node. Similar fashion is followed and nodes are added to the decision tree. Each penultimate node carries the last attribute or multiple attributes for making the final decision of the problem.

2.3.6 Time Series Analysis

Time Series Analysis captures the data groups and data variables in the specified time. Experimental results obtained using the proposed network and generalization capacity of model. The forecasting reliability was evaluated by comparing the actual and predicted temperature values. The results show that the network can be an important tool for temperature forecasting.

2.4 Sliding window algorithm

The work proposes to predict a day's weather conditions. For this the Previous seven days weather is taken into consideration along with fortnight Weather conditions of past years. Suppose we need to predict weather of 23rd August 2013 then we will take into consideration the weather conditions of 16th August 2013 to 22nd August 2013 along with the weather conditions prevailing in the span of 16th August to 29th August in past years. Ten the day by day variation in current year is computed. The variation is also being computed from the fortnight data of previous year. In this work the four major weather parameters will be taken into consideration, that is, maximum temperature, minimum temperature, Humidity and Rainfall. Hence the size of the variation of the current year will be represented by matrix of size 7 × 1. And similarly for past year the matrix size would be 14 × 1. Now, the first step is to divide the matrix of size 14×1 into the sliding windows. Hence, 8 sliding windows can be made of size 7×1 each.

Sliding Window Concept where W1, W 2 …, W 8 Represents Window Number 1, 2 ...8. Show Figure 2.1.

Now the next step is to compare every window with the current year's variation. The best-matched window is selected for making the prediction. The

Euclidean distance approach is used for the purpose of matching. The reason for taking Euclidean distance is its power to represent similarity in spite of its simplicity.

2.4.1 Mean

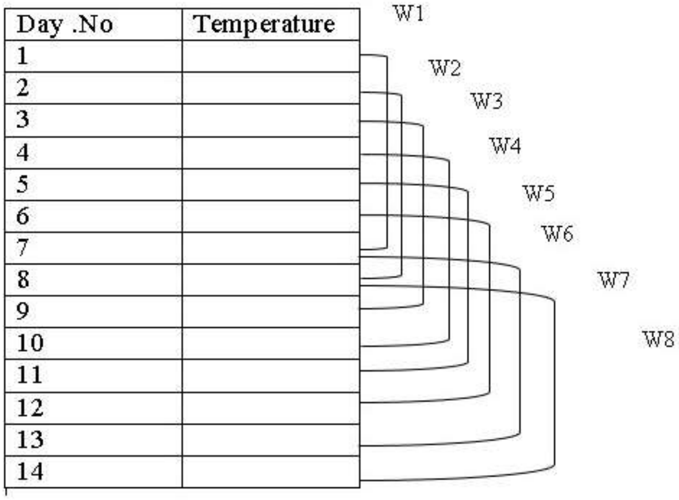
Mean of day’s weather conditions, that is, maximum temperature, minimum temperature, humidity, and rainfall. After adding each separately, and divide by total day’s number. Mean =Sum of parameter/ number of days.

2.4.2 Variation

Calculate day by day variation after taking difference of each parameter. This tells how the next day’s Weather is related to previous day’s weather.

2.4.3 Euclidean distance

It compares data variation of current year and previous year.



Day .No	Temperature
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	

Figure 2.1: Sliding Window Concept for Windows

By this we are able to mathematically model the aforesaid defined dependencies. Tat the relationship between previous year and previous week Data is being defined mathematically can be used to predict the future conditions.

The main logic behind using sliding window approach is that the weather

Conditions prevailing at some span of day in the year might not have existed in the same span of days in previous year. For instance, the weather condition in first week of February 2010 might not have existed in the first week of February in 2009. The similar weather conditions might have prevailed in previous year but not necessarily in same week but in some days. The probability of finding the similar weather conditions are maximum at the considered fortnight spam[7].

Sliding Window Algorithm proposes to predict a day's weather conditions. To predict the day's weather conditions will take into account the conditions prevailing in previous week, that is, in last seven days which are assumed to be known. Also, the weather condition of seven previous days and seven upcoming days for previous year is taken into consideration and the steps of proposed algorithm is:

Step 1. Take matrix "CD" of last seven days for current year's data of size 7×1

Step 2. Take matrix "PD" of fourteen days for previous year's data of size 14×1 .

Step 3. Make 8 sliding windows of size 7 × 1each from the matrix "PD" as W1, W2, W3,…, W8.

Step 4. Compute the Euclidean distance of each sliding window with the matrix "CD" as ED1, ED2, ED3, . . . , ED8

Step 5. Select matrix W_i as

W_i = Corresponding Matrix (Min.(ED_i))

$\forall_i \in [1, 8]$

Step 6. For k = 1 to n

(i) For WC_k compute the variation vector for the matrix “CD” of size 6 × 1 as “VC”.

(ii) For WC_k compute the variation vector for the matrix “PD” of size 6 × 1 as “VP”.

(iii) Mean1 = Mean (VC)

(iv) Mean2 = Mean (VP)

(v) Predicted Variation “V” = (Mean1 + Mean2)/2

(vi) Add “V” to the previous day’s weather condition in consideration to get the predicted condition. Step 7. End[7].

Sliding window using pseudo code

```
Int current-year [7]; int previous-year [14]; int w1 [7], w2 [7]….w8 [7];
W1= [previous-year [1], previous-year [2]… previous-year [7]];
 W2= [previous-year [2], previous-year [3]… previous-year [8]];
W3= [previous-year [3], previous-year [4]… previous-year [9]];
W8= [previous-year [8], previous-year [9]… previous-year [14]];
Int ED1, ED2… ED8;
Y=min [ED1, ED2…ED8];
Int z = [ED1, ED2 … ED8]; i= 0;
While (y!= z[i])
{ i++;
}
Y = z[i];
Int Vc[6] , Vp[6];
```

```
For (i=0,i<=6,i++)
{
Vc[i] = current-year [i+1] – current-year [i];
Vp[i] = previous-year [i+1] – previous-year[i];
};
Int mean1 = mean (Vc);
Int mean2 = mean (Vp);
Int V = mean1 +mean2/2;
Int current day weather = 36; // as example
Int predicted-day = V+ current day weather;
```

2.5 Sensors

A **sensor** is a device that measures physical input from its environment and converts it into data that can be interpreted by either a human or a machine. Most **sensors** are electronic (the data is converted into electronic data), but some are more simple, such as a glass thermometer.

2.5.1 DHT11

This module features a humidity and temperature complex with a calibrated digital signal output means DHT11 sensor module is a combined module for sensing humidity and temperature which gives a calibrated digital output signal. DHT11 gives us very precise value of humidity and temperature and ensures high reliability and long term stability. This sensor has a resistive type humidity measurement component and NTC type temperature measurement component with an 8-bit microcontroller inbuilt which has a fast response and cost effective and available in 4-pin single row package.

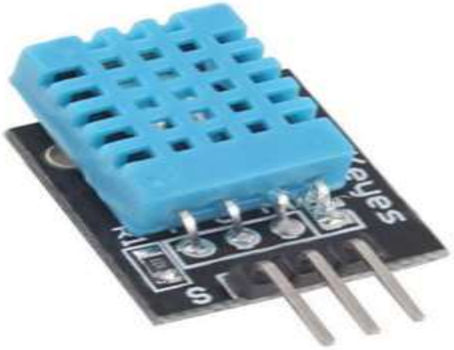


Fig-2.2: DHT11 Sensor [13]

DHT11 module works on serial communication i.e. single wire communication. This module sends data in form of pulse train of specific time period. Before sending data to Arduino it needs some initialize command with a time delay. And the whole process time is about 4ms. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request[14].

2.5.2 LM35

LM35 is measuring the temperature since it is an analog and linear Temperature sensor which has a linear relationship between output voltage and Temperature changes (°C). Besides, the LM35 does not require external calibration to deliver the accuracy of ± (1/4) °C at room temperature or ± (8/4) °C at the temperature range of -55°C to +150°C [10]. Due to its low-input impedance, linear output, and accurate inherent calibration of LM35, it does make the sensor's readout and control circuitry interfacing become easy. The device is usually used with single power supply or with plus or minus supplies. It can receive an input range of -2V up to 35V and result the output voltage range of -1V to 6V. Figure 2.2 displays the LM35 sensor which is used to measure the temperature for this project.

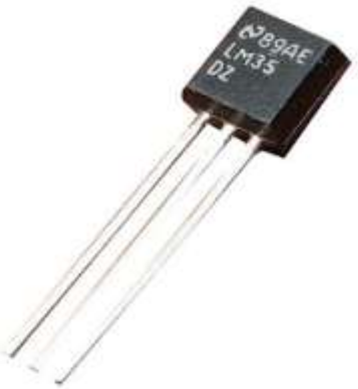


Figure 2.3: LM35 sensor by Texas Instrument.

2.6 4x4 Matrix Keypad

This 16-button keypad provides a useful human interface component for microcontroller projects. Convenient adhesive backing provides a simple way to mount the keypad in a variety of applications, show figure 2.3.

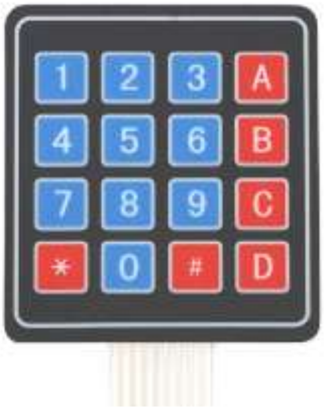


Figure 2.4: Keypad 4X4[15]

2.6.1 Features

- Ultra-thin design
- Adhesive backing
- Excellent price/performance ratio
- Easy interface to any microcontroller
- Example programs provided for the BASIC Stamp 2 and Propeller P8X32A microcontrollers

2.6.2 Key Specifications

- Maximum Rating: 24 VDC, 30 mA
- Interface: 8-pin access to 4x4 matrix
- Operating temperature: 32 to 122 °F (0 to 50°C)
- Dimensions:

  Keypad, 2.7 x 3.0 in (6.9 x 7.6 cm)
  Cable: 0.78 x 3.5 in (2.0 x 8.8 cm)

2.6.3 How it Works

Matrix keypads use a combination of four rows and four columns to Provide button states to the host device, typically a microcontroller. Underneath each key is a pushbutton, with one end connected to one row, and the other end connected to one column [15].

2.7 Arduino

Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code known as the Arduino IDE (Integrated Development Environment). Built up with the 8-bit Atmel AVR microcontroller's that are manufactured by Atmel or a 32-bit Atmel ARM, these microcontrollers can be programmed easily using the C or C++ language in the Arduino IDE. Unlike the other microcontroller boards in India, the Arduino boards entered the electronic market only a couple of years ago, and were restricted to small scale projects only. People associated with electronics are now gradually coming up and accepting the role of Arduino for their own projects. This development board can also be used to burn (upload) a new code to the board by simply using a USB cable to upload. The Arduino IDE provides a simplified integrated platform which can run on regular personal computers and allows users to write programs for Arduino using C or C++.

The elements of an Arduino Board can be done into two categories:

•Hardware

• Software

2.7.1 Hardware

The Arduino Development Board consists of many components that together makes it work. Here are some of those main component blocks that help in its functioning.

• Microcontroller: This is the heart of the development board, which works as a mini computer and can receive as well as send information or command to the peripheral devices connected to it. The microcontroller used differs from board to board; it also has its own various specifications.

• External Power Supply: This power supply is used to power the Arduino development board with a regulated voltage ranging from 9 – 12 volts.

• USB plug: This plug is a very important port in this board. It is used to upload (burn) a program to the microcontroller using a USB cable. It also has a regulated power of 5V which also powers the Arduino board in cases when the External Power Supply is absent.

• Internal Programmer: The developed software code can be uploaded to the microcontroller via USB port, without an external programmer.

• Reset button: This button is present on the board and can be used to resets the Arduino microcontroller.

• Analog Pins: There are some analog input pins ranging from A0 – A7 (typical). These pins are used for the analog input / output. The no. of analog pins also varies from board to board.

• Digital I/O Pins: There are some digital input pins also ranging from 2 to 16 (typical). These pins are used for the digital input / output. The no. of these digital pins also varies from board to board.

• Power and GND Pins: There are pins on the development board that provide 3.3, 5 volts and ground through them.

2.7.2 Software

The program code written for Arduino is known as a sketch. The software used for developing such sketches for an Arduino is commonly known as the Arduino IDE. This IDE contains the following parts in it:

•Text editor: This is where the simplified code can be written using a simplified version of C++ programming language.

• Message area: It displays error and also gives a feedback on saving and exporting the code.

• Text: The console displays text output by the Arduino environment including complete error messages and other information.

• Console Toolbar: This toolbar contains various buttons like Verify, Upload, New, Open, Save and Serial Monitor. On the bottom right hand corner of the window there displays the Development Board and the Serial Port in use.

2.7.3 Features of Arduino IDE

• The project file or the sketches for a project are saved with the file extension.

• Features such as cut / copy / paste are supported in this IDE.

• There also is a facility for finding a particular word and replacing it with another by pressing the Ctrl + F buttons on the keyboard.

• The most basic part or the skeleton of all Arduino code will have two functions

2.7.4 Programming Basics

Now we’ll discuss about the programming techniques of Arduino sketch in the Arduino IDE. There are two main parts every sketch will always have, they are:

•void setup ()

• Void loop ()

1) Void setup ()

This is the first routine that begins when the Arduino starts functioning. This function is executed only once throughout the entire program functioning.

The setup function contains the initialization of every pin we intend use in our project for input or output.

2) Void loop ()

This function is the next important function in the Sketch. It consists of that part of the code that needs to be continuously executed unlike the part of the code written in the setup function.

2.7.5 Types of Arduino Board

A) Arduino Uno

Processor: ATmega328 (8- bit CPU, 16MHz clock speed, 2KB SRAM, 32KB flash storage).

Features: 14 digital I/O pins, 6 analog input pins, removable microcontroller.

Advantage: Microcontroller can be removed and replaced from the socket in case of breakdown.

Limitation: Doesn’t have a lot of SRAM or flash memory that limits the kinds of programs you can load on the chip.

B) Arduino Leonardo

Processor: ATmega32u4 (8- bit CPU, 16MHz clock speed, 2.5KB SRAM, 32KB flash storage).
Features: 20 digital I/O pins, 12 of which is used as analog inputs, native USB support Advantage: ATmega32u4 has built -in USB communication (compatibility) eliminating the need for secondary processor. Leonardo to interface with PC, which sees it as a generic mouse or keyboard. It also has a few extra analog input pins. Limitation: Still has a few bugs that need ironing out and isn’t quite as beginner friendly as the Uno.

C) Arduino Due

Processor: Atmel SAM3X8E ARM Cortex-M3 (32-bit CPU, 84MHz clock speed, 96KB SRAM, 512KB flash storage).
Features: 54 digital I/O pins, native USB port, 12 analog input pins, 2 analog output pins.
Advantage: The Due is primarily for more complicated projects that can make use of its muscular processor, otherwise that needs more I/O pins than are found on the smaller Arduino boards.
Limitation: It operates at 3.3 volts that limits the add-on hardware that’s compatible with the Arduino Due-if an add-on board tries to send a 5-volt signal to the Due’s I/O pins, it would damage the microcontroller.

D) Arduino Micro

Processor: ATmega32u4 (8- bit CPU, 16MHz clock speed, 2.5KB SRAM, 32KB flash storage).

Features: 20 digital I/O pins, 12 of which is used as analog inputs, native USB support.

Advantage: Includes all of the power and functionality of a full- sized Arduino Leonardo board in a much smaller form factor. It is designed to easily slot into a bread board, for faster prototyping.

Limitation: Due to the small form factor, Arduino Micro will not work with many add-on boards[13]

E) Arduino ESPLORA

Processor: ATmega32u4 (8- bit CPU, 16MHz clock speed, 2.5KB SRAM, 32KB flash storage).

Features: Lots of built-in input and output hardware.

Advantage: A whole bunch of I/O hardware soldered directly to the board. On input side you get a joystick, four buttons, a linear potentiometer (slider), a microphone, a light sensor,

a temperature sensor and a three-axis accelerometer. For outputs, you get an RGB led, a buzzer and a TFT display connector to attach an LCD screen (not included).

Limitation: The tradeoff is that you do not get the standard set of digital and analog I/O pins, which allows you to wire up all sorts hardware to your Arduino board.

f) Arduino Yun

Processor: ATmega32u4 (8- bit CPU, 16MHz clock speed, 2.5KB SRAM 32KB flash storage), Atheros AR9331 system on the chip.

Features: Wi-Fi enabled Linux based system on a chip, 14 digital, analog I/O pins, and 12 of which can be used as analog inputs. Native USB.

Advantage: It is easier to connect to cloud-based services from the Arduino platform. It features a separate Linux-based system-on-a chip on the motherboard.

Limitation: The low-bandwidth, low memory, microcontrollers have a hard time handling the verbose protocols used to access those services.

g) Arduino Pro mini

Processor: ATmega168, Clock speed 8MHz (3.3v model) or 16MHz (5v model), SRAM-1 KB, Flash Memory-16 KB.

Features: Operating voltage-3.3V or 5V, Input Voltage-3.3V- 12V, Digital I/O pins-14, Analog Input pins-8.

Advantage: Rather than requiring a physical press of the reset button before an upload, the Arduino Pro Mini is designed in a way that allows it to be reset by software running on a connected computer.

Limitation: The Arduino pro mini is compact in size. Its size is about 1.3*0.70".

h) Arduino Robot

Processor: 2 x ATmega32u4 (8-bit CPU, 16MHz clock speed, 2.5KB SRAM, 32KB flash storage).

Features: Wheels, 8 analogue input pins, 6 digital I/O pins, LCD screen.

Advantage: A little robot composed of two separate boards (a control board and a motor board) that each feature the Leonardo's ATmega32u4 processor. Though it's designed with room to add your own custom hardware

Limitation: More expensive than other Arduino boards on account of having two separate boards.

i) LilyPad Arduino

Processor: ATmega328 (8- bit CPU, 16MHz clock speed, 2KB SRAM, 32KB flash storage).

Features: 14 digital I/O pins, 6 analog input pins

Advantage: Basically, designed for wearables and e -textiles (fabric-based projects).

Limitation: 2 x ATmega32u4 (8-bit CPU, 16MHz clock speed, 2.5KB SRAM, 32KB flash storage)[13]

j) Arduino Nano

Processor: ATmega328, Architecture AVR, Operating Voltage 5 V, Flash Memory32 KB of which 2 KB used by bootloader, SRAM2 KB

Clock Speed16 MHz

Features: Digital I/O Pins14 (of which 6 provide PWM output), Analog Input Pins 8. From the types of Arduino boards, we are choosing Arduino Nano. Figure 2.2 show types of Arduino boards.

2.7.6 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.
- At mega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series

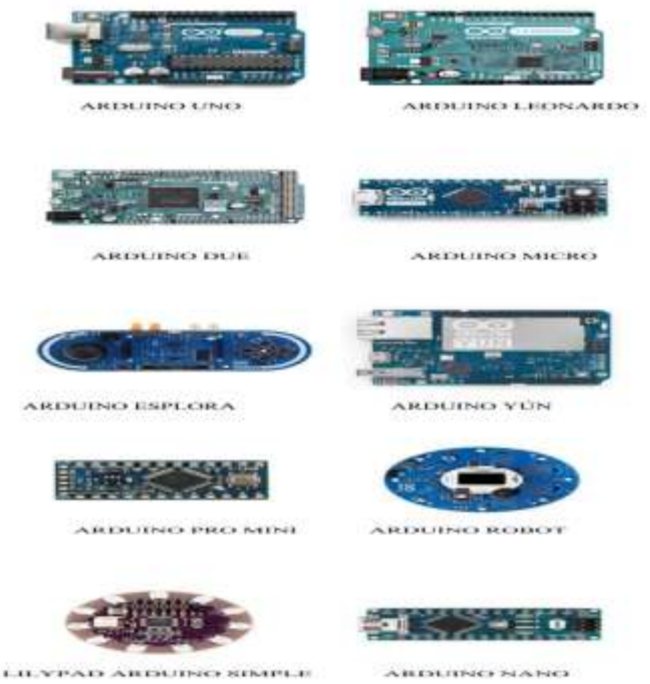


Figure2.4: Arduino Boards[13]

of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

Specifications:

Table 2.1: show Specifications for Arduino Uno

Microcontroller	ATmega328
Operating Voltage	5V
InputVoltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

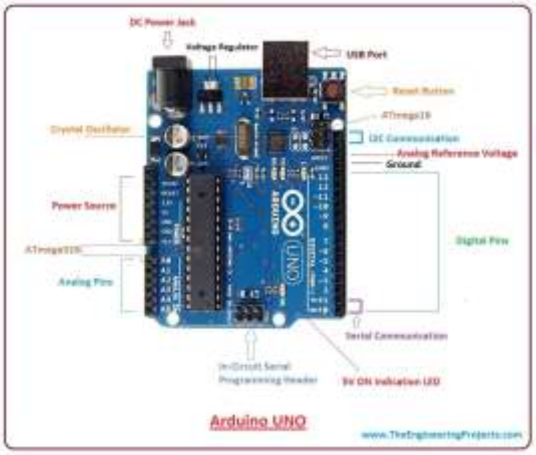


Figure 2.5: Arduino Uno

CHAPTER THREE

SYSTEM DESIGN

3.1 Overview

The system consists of Arduino Uno, DHT-11 sensor, Keypad 4X4and LCD 16X2, the temperature degree is pickup by DHT-11 sensor which it sends value in form of pulse train of specific time period to Arduino, the prediction temperature degree for is calculated by applying Sliding Window Algorithm by getting data (last previous seven days (current year), 14 last previous days (previous year)) by Keypad and then the temperature degree for current and next day predicted is displayed at LCD.

The system hardware is shown by figure 3.1:

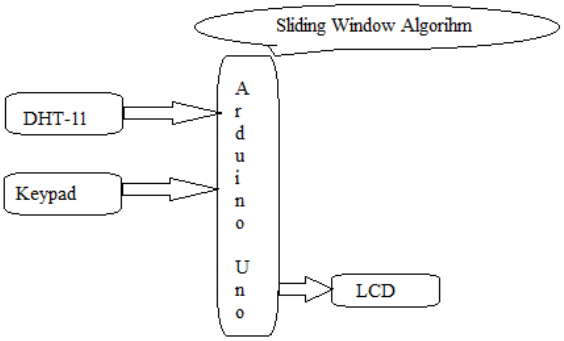


Figure 3.1: Block diagram of the system

3.2 DHT-11 Sensor Circuit

The DHT-11 is a digital-output relative humidity and temperature sensor.
It uses thermistor to measure the surrounding temperature air, DHT-11 have three pins Vcc (+5v), GND(ground)and Data.

The Vcc end of DHT-11 sensor is connected to of Arduino, A pull-up resistor 4.7K Ohms is connected (required to keep the data line high and in order to enable the communication) between the Data pin of sensor and the Arduino Board pin A0; While the other end is connected to GND, show figure 3.1.

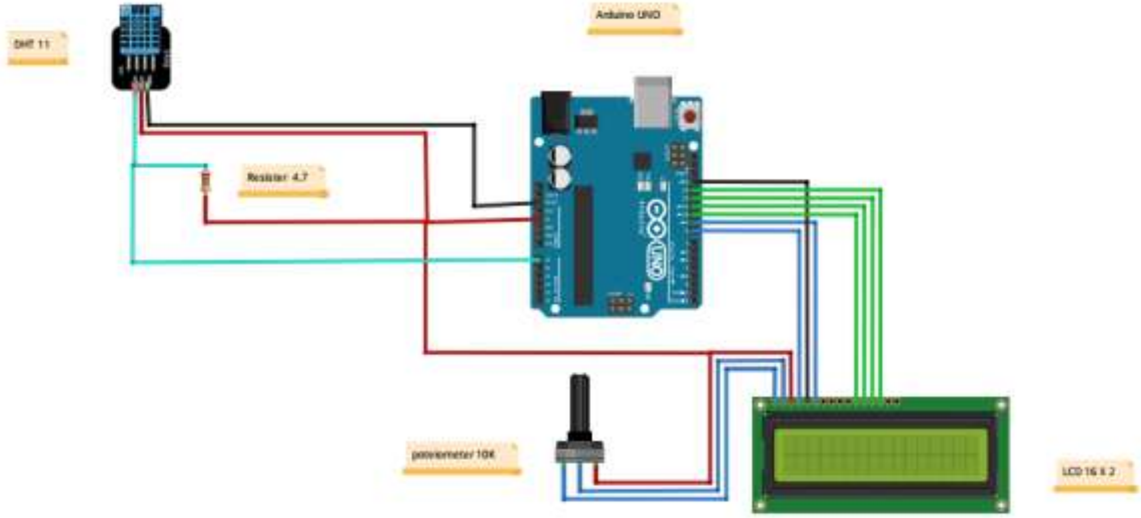


Figure 3.1: DHT-11 sensors circuit

3.3 Keypad Circuit

This 4x4 matrix keypad has 16 built-in pushbutton contacts connected to row and column lines, these lines connected to Arduino to be scanned to Determined button-pressed state, the lines is connected as input to Arduino to pins (A4, A5, 2, 3) for rows, for (4,5,6,7) columns.

Then, it read a row lines and sets it high. After that, it checks the column lines one at a time which it normal input of these line is Low when not key pressed.to determine which key is pressed, if the column connection stays low, the button on the row has not been pressed. If it goes HIGH, the Arduino knows which row was set HIGH, and which column was detected HIGH when checked. Figure 3.2 connection Keypad with Arduino.

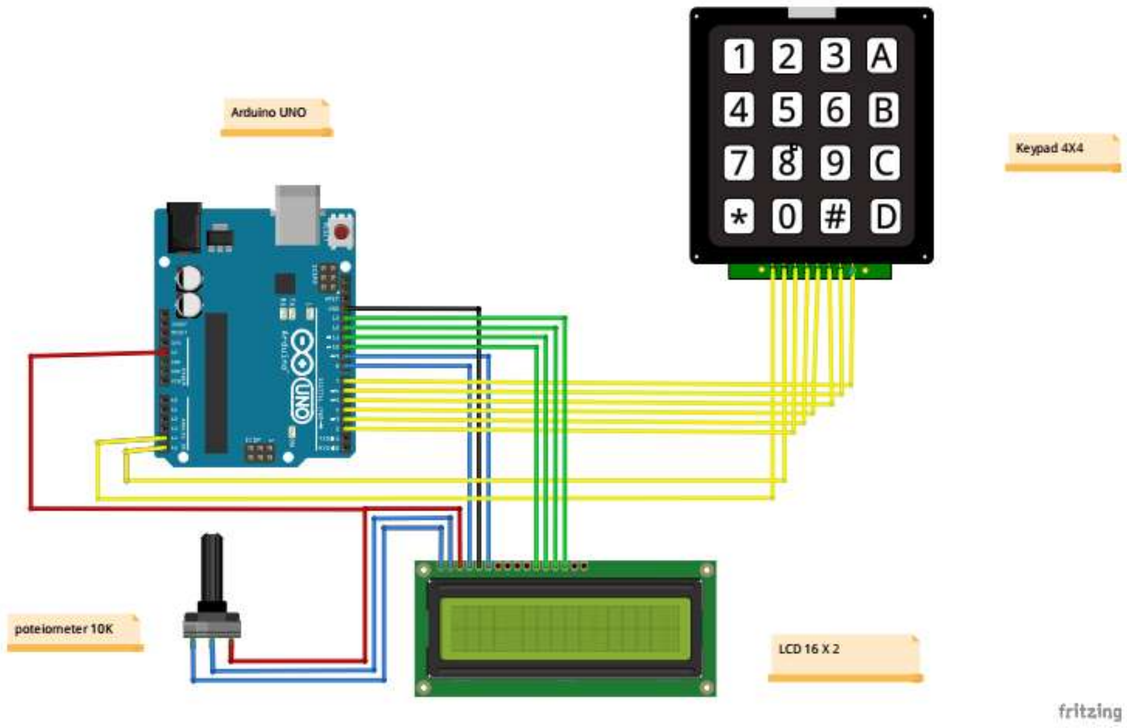


Figure 3.2 connection Keypad with Arduino

3.4 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and
Find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments),
Animation and so on a 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD [16]Show figure 2.14below.

3.5 Sliding Window Algorithm

To predict the temperature of the next day of the current year we applied the sliding window algorithm by taking readings of temperature for the last previous seven days from the current of the day of the same year and taking readings for temperature for the 14 last previous days from the current of the day of the previous year and taking.

3.6 Complete Design Circuit

The Arduino Capture the Temperature Degree of the current day by get the value of DHT-11 sensor and displayed at LCD, to predict the temperature of the next day is by applying Sliding Window Algorithm and that by taking readings of temperature for the last previous seven days from the current of the day of the same year and taking readings for temperature for the 14 last previous days from the current of the day of the previous year and taking, the value of last previous seven days (current year), 14 last previous days (previous year) is pickup by Keypad, Then the prediction temperature for next day is calculated and displayed at LCD. Figure below show the full design circuit 3.3.

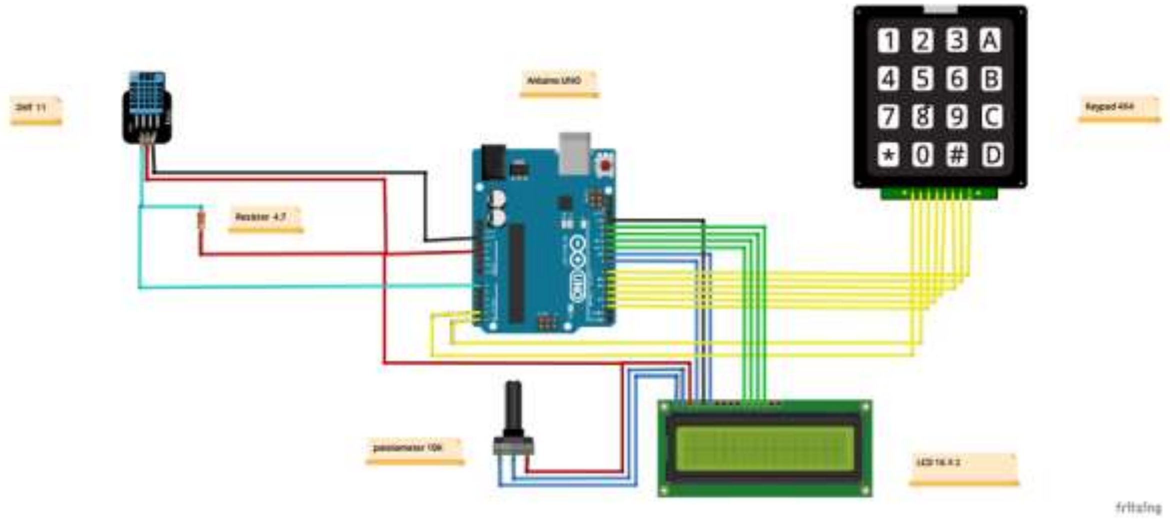


Figure 3.3: full design circuit.

3.7 Flowchart

Figure 3.4: below describing the design of temperature weather prediction.

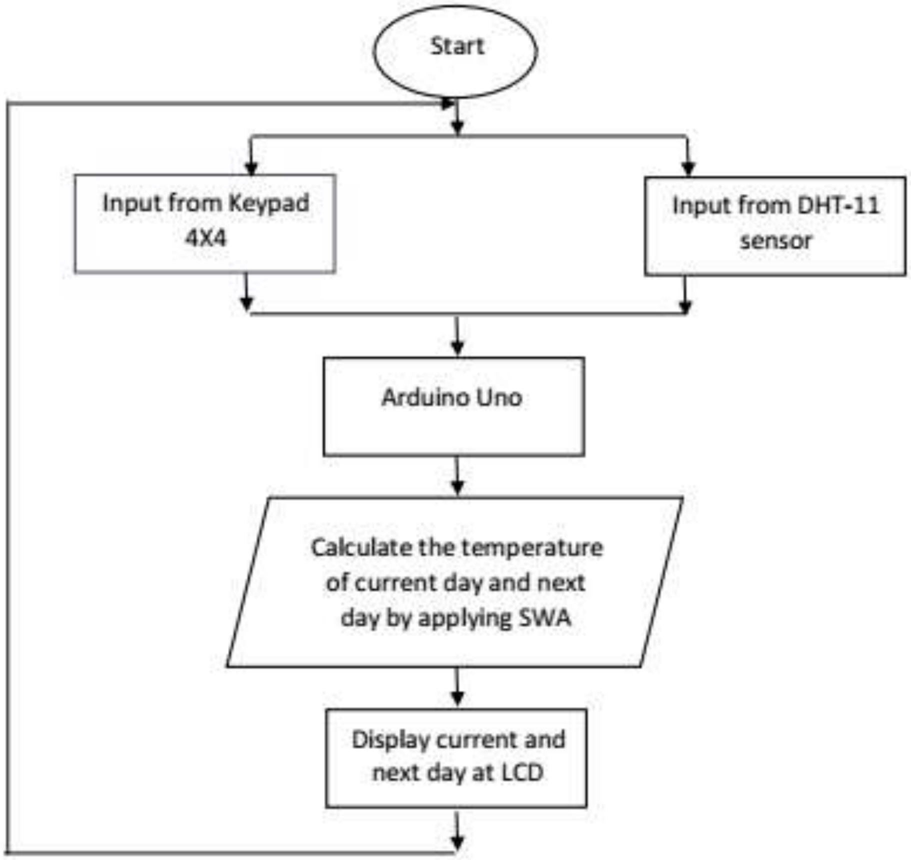

Start
Input from Keypad 4X4
Input from DHT-11 sensor
Arduino Uno
Calculate the temperature of current day and next day by applying SWA
Display current and next day at LCD

Figure3.4: Flowchart.

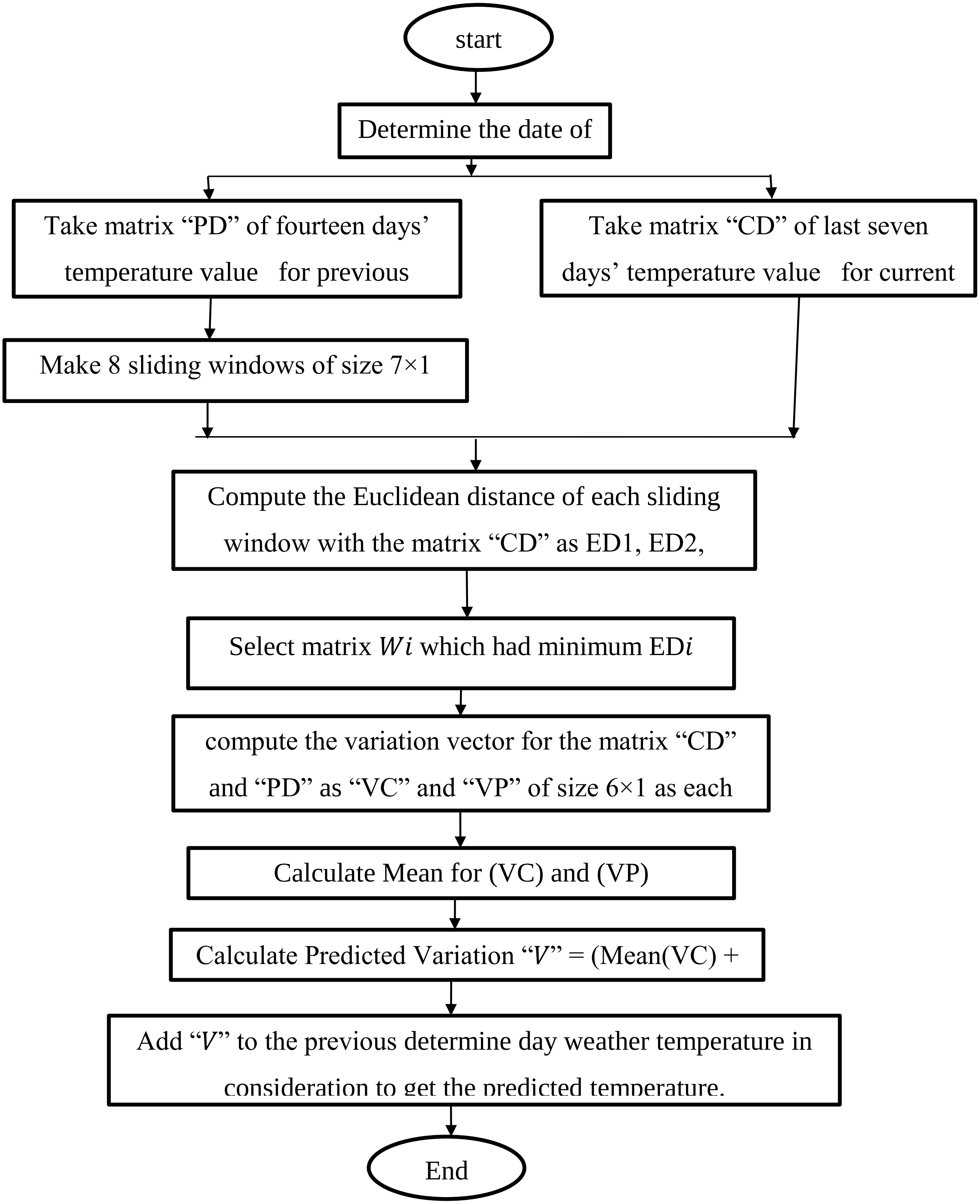

start
Determine the date of
Take matrix "PD" of fourteen days' temperature value for previous
Take matrix "CD" of last seven days' temperature value for current
Make 8 sliding windows of size 7×1
Compute the Euclidean distance of each sliding window with the matrix "CD" as ED1, ED2,
Select matrix Wi which had minimum EDi
compute the variation vector for the matrix "CD" and "PD" as "VC" and "VP" of size 6×1 as each
Calculate Mean for (VC) and (VP)
Calculate Predicted Variation "V" = (Mean(VC) +
Add "V" to the previous determine day weather temperature in consideration to get the predicted temperature.
End

Figure3.5: Sliding Window Algorithm flowchart.

CHAPTER FOUR

SYSTEM SIMULATION AND RESULT

4.1 System simulation

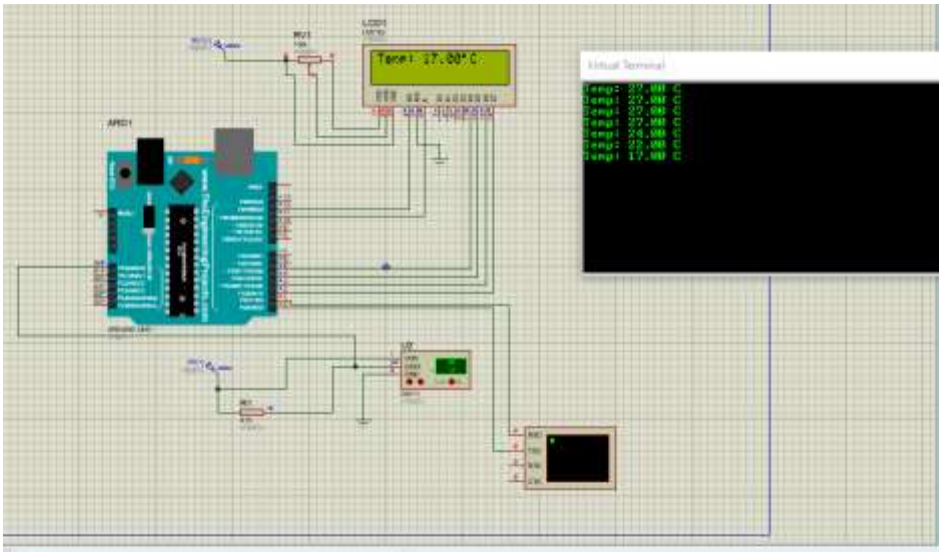
DHT-11 and Keypad 4X4 is simulated with applying Sliding Window Algorithm to calculate temperature degree for current day and predicted next day.

4.1.1 DHT-11 Circuit Simulation

The DHT-11 is a digital-output relative humidity and temperature sensor.

It uses thermistor to measure the surrounding temperature air, DHT-11 has three pins Vcc (+5v), GND (ground) and Data.

DHT11 module works on serial communication i.e. single wire communication. This module sends data in form of pulse train of specific time period by pin Vcc end of DHT-11 to Arduino pin A0, a pull up resistor 4.7K Ohms is connected (required to keep the data line high and in order to enable the communication) between the Data pin of sensor and the Arduino Board pin A0; While the other end is connected to GND, show figure 4.1 and then the temperature degree is displaying in LCD.



```
Temp: 17.00°C
```

```
Temp: 27.00 C
Temp: 27.00 C
Temp: 27.00 C
Temp: 27.00 C
Temp: 24.00 C
Temp: 22.00 C
Temp: 17.00 C
```

Figure 4.1 DHT-11 simulation

4.1.2 Keypad Circuit Simulation

This 4x4 matrix keypad Arduino to be scanned to Determined which button pressed at moment, the lines are connected as input to Arduino to pins (A4, A5, 2, 3) for rows, for (4, 5, 6, 7) columns, the key pressed is displayed at LCD. Show figure 4.2

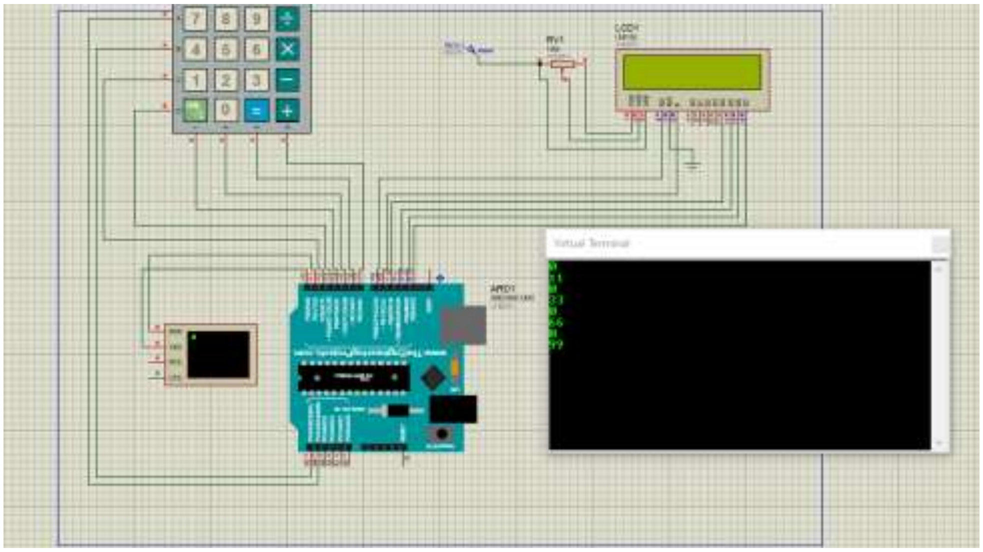


Figure 4.2: keypad circuit simulation

4.1.3 Weather Temperature Prediction System

The circuit here is including DHT-11, Keypad 4X4 and LCD 16X2, DHT-11 sensor to measure temperature and fed value to Arduino, Keypad 4X4 to enter value of temperature to be using to predicted temperature to next day which is calculated by Sliding Window Algorithm which is applied by Arduino and then the value of temperature for current and next day is displayed at LCD. Show figure 4.3.

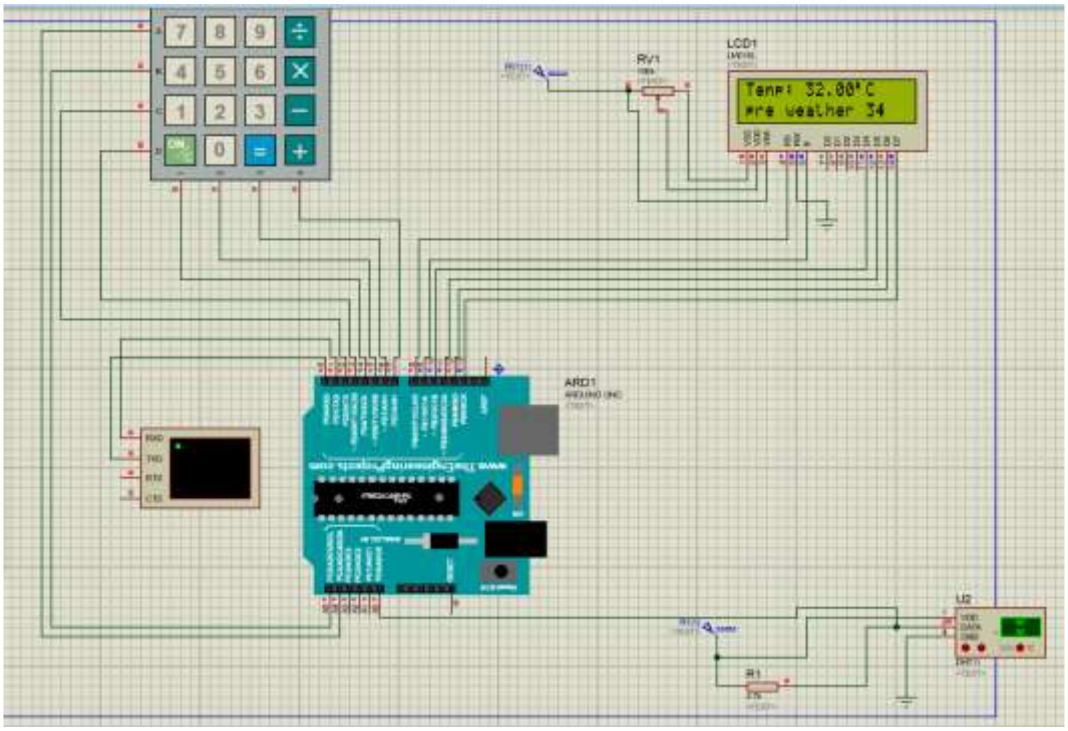


Figure 4.3: Temperature Prediction System.

4.2 Hardware Implementation

Below using several months as cases applying Sliding Window Algorithm for forecasting temperature in determine day.

4.2.1 Case 1

The system picks up the value of temperature by DHT-11 sensor fed it to

Arduino, the Sliding Window Algorithm predicted temperature for next day, Using keypad to enter temperature value needing by algorithm to predicted temperature, as experiment the algorithm predicted the temperature of 15/12/2018,the values of temperature that needed to predicted this day is last 14 days from predicted day which is from 8-21/12/2017 and last 7 days from 8-14/12/2018 the actual temperature for the day predicted which is 15/12/2018 is 33 C° the predicted temperature calculated by algorithm is 31C°.

Show figure 4.4, 4.5.

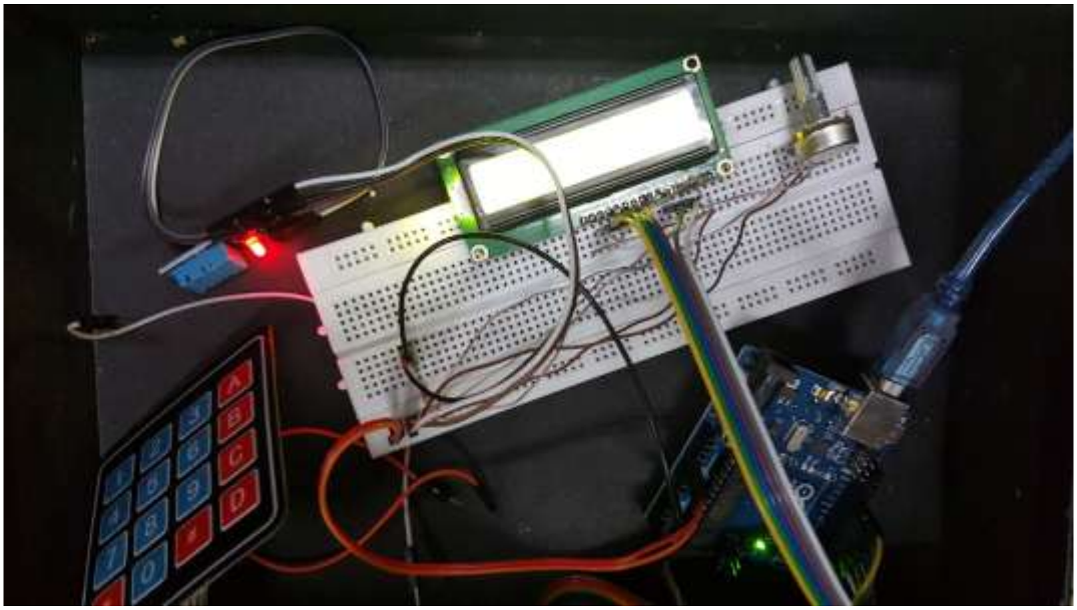


Figure 4.4: Hardware Implantations

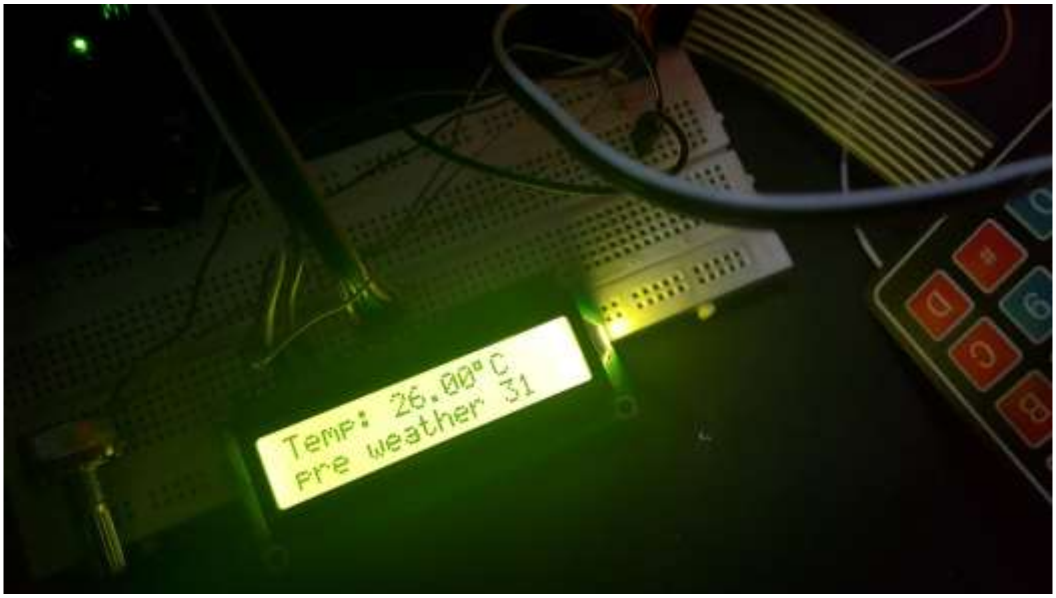


Figure 4.5: Hardware Implantations

4.2.1 Case 2

The system picks up the value of temperature by DHT-11 sensor fed it to
Arduino, the Sliding Window Algorithm predicted temperature for next day, Using keypad to enter temperature value needing by algorithm to predicted temperature, as experiment the algorithm predicted the temperature of 15/3/2018, the values of temperature that needed to predicted this day is last 14 days from predicted day which is from 8-21/3/2017 and last 7 days from 8-14/12/2018 the actual temperature for the day predicted which is 15/3/2018 is 36 C° the predicted temperature calculated by algorithm is 34C°.
Show figure 4.6.

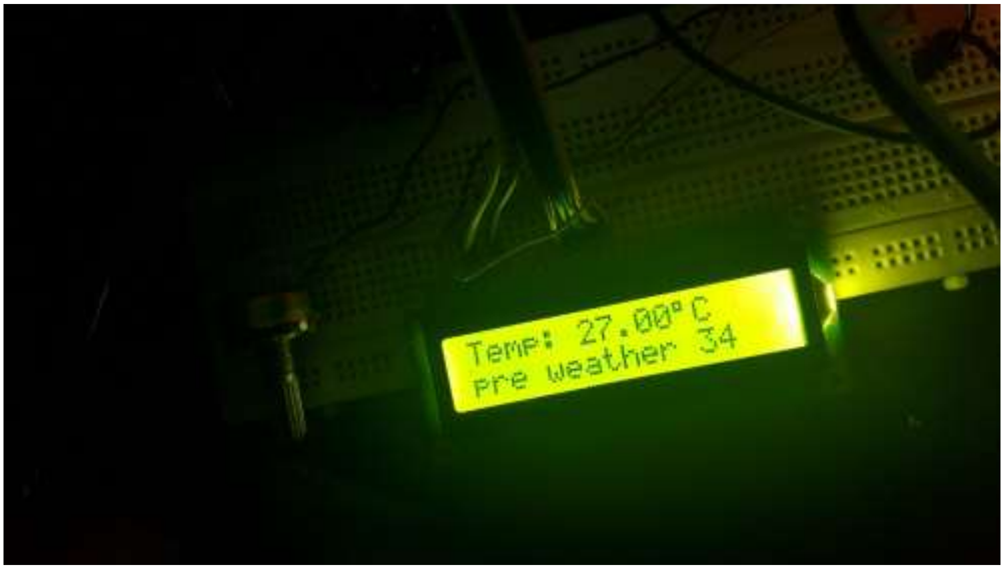


Figure 4.6: Hardware Implantations Case2

4.2.2 Case 3

The system picks up the value of temperature by DHT-11 sensor fed it to Arduino, the Sliding Window Algorithm predicted temperature for next day,Using keypad to enter temperature value needing by algorithm to predicted temperature, as experiment the algorithm predicted the temperature of 7/7/2018, the values of temperature that needed to predicted this day is last 14 days from predicted day which is from 30/6-13/7/2017 and last 7 days from 30/6-6/7/2018 the actual temperature for the day predicted which is 7/7/2018 is 39 C° the predicted temperature calculated by algorithm is 41C°.

Show figure 4.7.

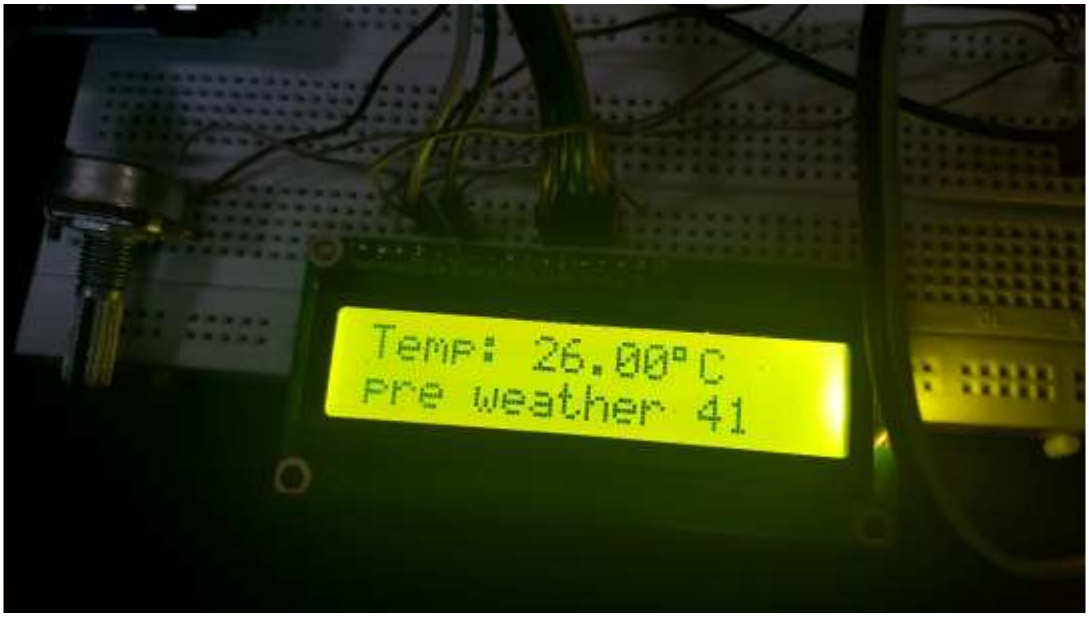


Figure 4.7: Hardware Implantations Case3

4.2.3 Case 4

The system picks up the value of temperature by DHT-11 sensor fed it to Arduino, the Sliding Window Algorithm predicted temperature for next day,Using keypad to enter temperature value needing by algorithm to predicted temperature, as experiment the algorithm predicted the temperature of 15/10/2018, the values of temperature that needed to predicted this day is last 14 days from predicted day which is from 8-21/10/2017 and last 7 days from 8-14/10/2018 the actual temperature for the day predicted which is 15/10/2018 is 40 C° the predicted temperature calculated by algorithm is $38C^{\circ}$.

Show figure 4.8.

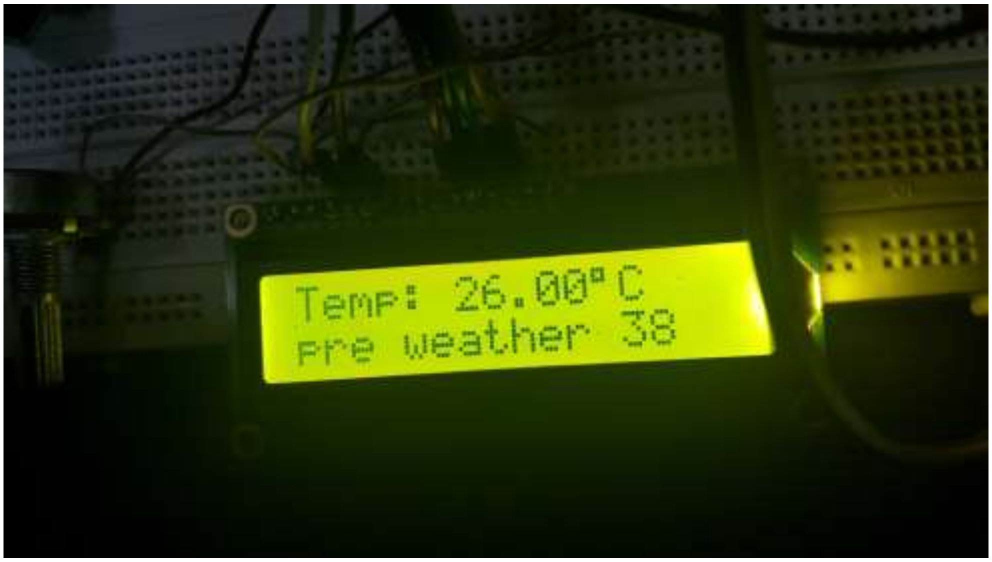


Figure 4.8: Hardware Implantations Case4

4.3 Result

DHT-11 sensor measure temperature and fed value to Arduino using Keypad 4X4 to enter value of temperature which is used to predicted temperature to next day which calculated by Sliding Window Algorithm which is applied by Arduino and then the value of temperature for current and next day is displayed at LCD.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

There are a variety of end uses to weather forecasts. Weather forecasting is important because they are used to protect life and property. Forecasts based on temperature and precipitation are important to agriculture by helps farmers and gardeners plan for crop irrigation and protection (irrigation scheduling, freeze protection), Helps people to plan outdoor activities, helps people know outside weather dangers, helps businesses plan for transportation hazards that can result from the weather. On an everyday basis, people use weather forecasts to determine what to wear on a given day, the system is measures the temperature of the day and forecasts of the temperature of the next day.

5.2 Recommendations

To improve system performance in future development, some suggestion
Below.

- Use rain and wind and humidity sensors.
- Use week and month prediction weather.
- Use Website and Application to display weather prediction.
- Make forecasting wireless weather remote station.

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Appendix A

```
#include <LiquidCrystal.h> //Header file for LCD from
https://www.arduino.cc/en/Reference/LiquidCrystal
#include <dht.h>
#include <Keypad.h> //Header file for Keypad from https://github.com/Chris-
-A/Keypad
byte c[7]={37,38,39,39,36,36,35};
byte p[14]={37,36,38,31,23,32,34,37,39,27,33,36,29,36};
int w1[7];int w2[7];int w3[7];int w4[7];int w5[7];int w6[7];int w7[7];int
w8[7];
float m[8];int h[8];int vp[6];int vc[6];
int x2=0;
int b=0;int  index;int n;int o; int r; int pre=0;
float min;
dht DHT;
#define DHT11_PIN A0
float z1;float z2;float z3;float z4;float z5;float z6;float z7;float z8;
const byte ROWS = 4; // Four rows
const byte COLS = 4; // Three columns
// Define the Keymap
char keys[ROWS][COLS] = {
  {'7','8','9','D'},
  {'4','5','6','C'},
  {'1','2','3','B'},
  {'*','0','#','+'}
```

```
};
int j1=0;
byte rowPins[ROWS] = { A4, A5, 2, 3 };// Connect keypad ROW0, ROW1, ROW2 and ROW3 to these Arduino pins.
byte colPins[COLS] = { 4, 5, 6, 7 }; // Connect keypad COL0, COL1 and COL2 to these Arduino pins.
Keypad kpd = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS ); //  Create the Keypad
const int rs = 8, en = 9, d4 = 10, d5 = 11, d6 = 12, d7 = 13; //Pins to which LCD is connected
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
int j2=0;int f=0;
void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
float x1=0;float x2=0;float x3;float x4;float x5;float x6;float x7;float x8;
lcd.begin(16, 2);
lcd.clear();
 Serial.println("for enter array press #");
}
void loop() {
if(f==0){
  //this is algorithm
for (int i=0; i<=6; ++i){
  w1[i]=p[i];
  //Serial.print(w1[i]);
}
//Serial.println(" ");
for (int i=1; i<=7; ++i){
  w2[i-1]=p[i];
 // Serial.print(w2[i-1]);
}
//Serial.println(" ");
for (int i=2; i<=8; ++i){
  w3[i-2]=p[i];
 // Serial.print(w3[i-2]);
 }
//Serial.println(" ");
for (int i=3; i<=9; ++i){
  w4[i-3]=p[i];
  //Serial.print(w4[i-3]);
  }
//Serial.println(" ");
for (int i=4; i<=10; ++i){
  w5[i-4]=p[i];
 //Serial.print(w5[i-4]);
   }
//Serial.println(" ");
for (int i=5; i<=11; ++i){
  w6[i-5]=p[i];
  //Serial.print(w6[i-5]);
}
```

```
//Serial.println(" ");
for (int i=6; i<=12; ++i){
  w7[i-6]=p[i];
 // Serial.print(w7[i-6]);
 }
//Serial.println(" ");
for (int i=7; i<=13; ++i){
  w8[i-7]=p[i];
 // Serial.print(w8[i-7]);
  }
for (int i=0; i<=6 ;++i)
 {float y1=0;float x1=0;
   y1= sq(c[i]-w1[i]);
   x1=x1+y1;
  z1=sqrt(x1);
  if (i==6){
  //  Serial.print("\n");
 //Serial.println(z1);
 }
}
 for (int i=0; i<=6 ;++i)
 {float y2=0;float x2=0;
   y2= sq(c[i]-w2[i]);
   x2=x2+y2;
   z2=sqrt(x2);
  if (i==6){
  //  Serial.print("\n");
 //Serial.println(z2);
 }
 }
for (int i=0; i<=6 ;++i)
 {float y3=0;float x3=0;
   y3= sq(c[i]-w3[i]);
   x3=x3+y3;
   z3=sqrt(x3);
  if (i==6){
 //   Serial.print("\n");
// Serial.println(z3);
}
 }
 for (int j=0; j<=6 ;++j)
 {float y4=0;float x4=0;
   y4= sq(c[j]-w4[j]);
   x4=x4+y4;
   z4=sqrt(x4);
  if (j==6){
 //   Serial.print("\n");
// Serial.println(z4);
}
 }
for (int i=0; i<=6 ;++i)
 {float y5=0;float x5=0;
   y5= sq(c[i]-w5[i]);
   x5=x5+y5;
   z5=sqrt(x5);
  if (i==6){
  //  Serial.print("\n");
 //Serial.println(z5);
 }
 }
for (int i=0; i<=6 ;++i)
 {float y6=0;float x6=0;
   y6= sq(c[i]-w6[i]);
   x6=x6+y6;
   z6=sqrt(x6);
  if (i==6){
  //  Serial.print("\n");
 //Serial.println(z6);
 }
 }
for (int i=0; i<=6 ;++i)
 {float y7=0;float x7=0;
   y7= sq(c[i]-w7[i]);
   x7=x7+y7;
   z7=sqrt(x7);
  if (i==6){
  //  Serial.print("\n");
// Serial.println(z7);
}
 }
for (int i=0; i<=6 ;++i)
```

```
 {float y8=0;float x8=0;
   y8= sq(c[i]-w8[i]);
  x8=x8+y8;
   z8=sqrt(x8);
  if (i==6){
 //   Serial.print("\n");
// Serial.println(z8);
}
}
 m[0]=z1;
 m[1]=z2;
 m[2]=z3;
 m[3]=z4;
 m[4]=z5;
 m[5]=z6;
 m[6]=z7;
 m[7]=z8;
 /* Serial.println(m[0]);
 Serial.println(m[1]);
 Serial.println(m[2]);
 Serial.println(m[3]);
 Serial.println(m[4]);
 Serial.println(m[5]);
 Serial.println(m[6]);
 Serial.println(m[7]);*/

 min=m[0];
```

```
for(int i=1;i<=7;++i)
{
  if(min>m[i]){
       min=m[i];
     index=i+1;
    //Serial.println(index);
//Serial.print("\n");
//Serial.println(min);
     //if (min != m[i]){
      //idex=idex+1;
     //Serial.print(idex);}
    }
    }
    //Serial.print("\n");
    if (index==1)
{for(int i=0;i<=6;++i){
  h[i]=w1[i];
//Serial.print(h[i]);
}
}
 if (index==2)
{for(int i=0;i<=6;++i){
  h[i]=w2[i];
//Serial.println(h[i]);
}}

 if (index==3)
```

```
{for(int i=0;i<=6;++i){
  h[i]=w3[i];
//Serial.println(h[i]);
}}
if (index==4)
{for(int i=0;i<=6;++i){
  h[i]=w4[i];
//Serial.println(h[i]);
}}
 if (index==5)
{for(int i=0;i<=6;++i){
  h[i]=w5[i];
//Serial.println(h[i]);
}}
    if (index==6)
{for(int i=0;i<=6;++i){
  h[i]=w6[i];
//Serial.println(h[i]);
}}
 if (index==7)
{for(int i=0;i<=6;++i){
  h[i]=w7[i];
//Serial.println(h[i]);
}}
 if (index==8)
{for(int i=0;i<=6;++i){
  h[i]=w8[i];
//Serial.println(h[i]);
}
 }
for (int i=0;i<=5;++i){
  vp[i]=h[i+1]-h[i];
  }
for (int i=0;i<=5;++i){
  vc[i]=c[i+1]-c[i];
  }
for (int i =0;i<=5;++i){
  n+=vp[i];
  o+=vc[i];
  //Serial.print("\n");
//Serial.print(n);
//Serial.print(o);
  }
//Serial.print("\n");
//Serial.println(n);
//Serial.println(o);
//r=n/6;
//s=o/6;
//Serial.print("\n");
//Serial.print(r);
//Serial.print(s);
pre=(n+o)/2;
Serial.println("pre=");
int aa=c[6];
```

```
r=pre+aa;
//Serial.print(r);
//Serial.print(c[6]);
  //if(pre!=0&& j1!=0&&j2!=0 &&f==0){
   int chk = DHT.read11(DHT11_PIN);
  lcd.setCursor(0,0);
  lcd.print("Temp: ");
  lcd.print(DHT.temperature);
  lcd.print((char)223);
  lcd.print("C");
  lcd.setCursor(0,1);
  lcd.print("pre weather ");
  lcd.print(r);
  Serial.print("Temp: ");
   Serial.print(DHT.temperature);
   Serial.print((char)223);
   Serial.print("C");
  //lcd.setCursor(0,1);
   Serial.println("pred weather ");
   Serial.print(r);
   // }
   while(pre!=0){
   char k = kpd.getKey();
int z=0;int y;
if(k=='D'&& j1==7){
    GetNumber1(&c[0]);
      j1=0;
      Serial.println("for enter array press #");
   }
while(j1<=6){
   Serial.println(p[j1]);
  j1++;
   }
   if(k=='C'&& j2==14){
    GetNumber2(&p[0]);
      j2=0;
    pre=0;
           Serial.println("for enter array press #");
   }
   while(j1<=6){
   Serial.println(p[j1]);
  j1++;
    }
while(j2<=13){
   Serial.println(p[j2]);
  j2++;
   }
   }
 }}
//function
void GetNumber1(byte *cd2)
{int i=0;
   int num = 0;
   char key = kpd.getKey();
  while(key != '#'||i<=6)
  {
    switch (key)
    {
      case NO_KEY:
        break;
      case '0': case '1': case '2': case '3': case '4':
      case '5': case '6': case '7': case '8': case '9':
        lcd.print(key);
         Serial.println (num);
        num = num * 10 + (key - '0');
        Serial.print (num);
        break;
      case '+':
       Serial.println (num);
      cd2[i]=num;
        num = 0;
        lcd.clear();
        i++;
        break;
    }
    key = kpd.getKey();
  }
 return;
}
void GetNumber2(byte *cd3)
{int i=0;
```

```
  int num = 0;
  char key = kpd.getKey();
  while(key != '#'||i<=13)
  {
    switch (key)
    {
      case NO_KEY:
        break;
      case '0': case '1': case '2': case '3': case '4':
      case '5': case '6': case '7': case '8': case '9':
        lcd.print(key);
         Serial.println (num);
        num = num * 10 + (key - '0');
        Serial.print (num);
        break;
      case '+':
       Serial.println (num);
      cd3[i]=num;
        num = 0;
        lcd.clear();
        i++;
        break;
    }
    key = kpd.getKey();
  }
 return;
}
```