

QIBLA AND PRAYER TIME FINDER UTILIZING GLOBAL POSITIONING SYSTEM (GPS) AND DIGITAL COMPASS

By

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CERTIFICATION OF APPROVAL

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Electrical & Electronics Engineering Programme
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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Sholleh Cahyoadi Bin Suparno

ABSTRACT

The purpose of this project is to fulfil the requirement in Universiti Teknologi PETRONAS (UTP) curriculum structure for student to take Final Year Project paper. As the world introduced to the advance and sophisticated technology, this project will utilize Global Positioning System (GPS) and digital compass to provide new portable qibla and prayer time finder device. The existing qibla and prayer time finder devices have some weakness as the user need to enter the location manually. This will brings some difficulties if the user did not know his current location. Problem also can occur if the location of the user is not in the location database of the qibla and prayer time finder tools. This report is the final report written to discuss further information about the project, Qibla and Prayer Time Finder Utilizing Global Positioning System (GPS) and Digital Compass. This report will discuss the project implementation and prototype development to provide better qibla and prayer time finder that will be equipped with GPS and digital compass. GPS and digital compass will provides more accuracy to the finder tools and will ease the user.

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CHAPTER 1

INTRODUCTION

This chapter of the report will brief about the background of the project and define the problem. Objectives and the scope of study of the project will also be discussed.

1.1 Background of Study

Prayer is one of the elements in The Five Pillars of Worship. Every Muslims that fulfil the requirement to perform prayer must perform prayer five times a day according to the prayer time. In order to perform prayer, a Muslim need to pray facing the Kaabah located in Mecca. The direction facing the Kaabah is known as qibla.

In present day, there are many qibla and prayer time finder tools that can helps Muslims all over the world to find qibla direction and to determine prayer time. This tool is very useful especially for travellers.

1.2 Problem Statement

Current technology enables the Muslims around the world to accurately determine qibla direction and prayer times. Research and findings in astronomical helps in determining qibla direction and computing prayer time. Based from this research and findings, people develop qibla direction and prayer time finder tools

where this application can easily be found in the internet and there also some portable device to determine qibla direction and prayer time.

Present qibla and prayer time finder tools requires user to enter a location to the finder tools. This can be a big problem if the user does not know the exact location where he or she is at the moment. The problem can also occur because current qibla and prayer time finder tools have limited location in their location database.

Calculations of the qibla direction and prayer times are related to the longitude and latitude of the location. GPS and digital compass can give an exact location of the user. Output from GPS and digital compass gives the exact longitude and latitude of any places the person is currently at.

Objective of this project is to utilized GPS and digital compass to develop a portable qibla and prayer time finder tools. This project will integrate the available technology and built a portable system

1.3 Objectives

- 1.2.1 To study the algorithm to find qibla direction
- 1.2.2 To study the algorithm to determine prayer time
- 1.2.3 To study the working principle of GPS and digital compass
- 1.2.4 To utilizes GPS and digital compass in qibla and prayer time finder tools
- 1.2.5 To develop a portable system of qibla and prayer time finder that equipped with GPS and digital compass.

1.4 Scope of Study

Study in this project will include the qibla and prayer time algorithm to find qibla direction and to determine prayer times for any given location. This project will also study on working principle of GPS and digital compass and how it can be utilized to be used with qibla and prayer time finder tools. Beside that, this project will study on existing qibla and prayer time finder tools as an example and reference to build a new qibla and prayer time finder that equipped with GPS and digital compass.

CHAPTER 2

LITERATURE REVIEW

In this chapter, we will discuss about qibla, prayer times, GPS, and also other components used in this project.

2.1 Qibla

Qibla is the direction that should be faced when a Muslim prays. The Qibla, for any point of reference on the Earth, is the direction of the Kaabah. The Kaabah is a focal point for prayer.

2.1.1 Qibla determination

There are several methods used to determine qibla direction. The qibla direction is determined during two moments in each year when the sun is directly overhead the Kaabah, the direction of shadows in any sunlit place will point directly away from the Qibla. This happens on May 27 or May 28 at 9:18 GMT and on July 15 or July 16 at 9:27 GMT. Likewise there are two moments in each year when the Sun is directly over the antipodes of the Kaabah. This happens on January 12 or January 13 at 21:29 GMT and on November 28 at 21:09 GMT [1] .

There is also an algorithm used to determine the qibla direction. The algorithm show as follow:

$$q = \tan^{-1} \frac{\sin(\lambda_K - \lambda)}{\cos \phi \tan \phi_K - \sin \phi \cos(\lambda_K - \lambda)}$$

Where:

q = qibla

ϕ_K = Mecca latitude

λ_K = Mecca longitude

ϕ = any latitude of a place

λ = any longitude of a place

The result gives the direction based on True North while the compass gives direction of Magnetic North. In order to calculate the qibla direction from the compass, the result must be subtracted with Magnetic Declination value [3].

2.2 Prayer Time

There are five prayer times; Fajr, Zuhr, Asr, Maghrib, and Isha. In the early days, prayer times are determined by referring to the sun. Nowadays there is an algorithm to determine prayer time for any given location.

In order to calculate the prayer times for a given location, we need to know the latitude and the longitude of the location as well as the local time zone of the place. Beside that, we also need to obtain the Equation of Time and Declination of The Sun for a given date to accurately calculate the prayer times.

2.2.1 Prayer time algorithm

Nowadays prayer times can be computed by using prayer time algorithm. There are two astronomical measures that are essential for computing prayer times. These two measures are the *Equation of Time* and the *Declination of The Sun*.

The equation of time is the difference between time as read from a sundial and a clock. It results from an apparent irregular movement of the Sun caused by a combination of the obliquity of the Earth's rotation axis and the eccentricity of its orbit [5].

The Declination of the Sun is the angle between the rays of the sun and the plane of the earth equator. The declination of the Sun changes continuously throughout the year. The algorithm to calculate Declination of the Sun, D and Equation of Time, T shown in Table 1 [2].

Table 1: Calculation of D and T

Declination of The Sun, D	Equation of Time, T
$\frac{180}{\pi} * \{ 0.006918$ $- [0.399912 * \text{Cos}[\beta]] + [0.070257 * \text{Sin}[\beta]]$ $- [0.006758 * \text{Cos}[2 * \beta]] +$ $[0.000907 * \text{Sin}[2 * \beta]]$ $- [0.002697 * \text{Cos}[3 * \beta]] +$ $[0.001480 * \text{Sin}[3 * \beta]] \}$ <p style="text-align: right;">(2.2)</p>	$229.18 * \{ 0.000075$ $+ [0.001868 * \text{Cos}[\beta]] -$ $[0.032077 * \text{Sin}[\beta]]$ $- [0.014615 * \text{Cos}[2 * \beta]] -$ $[0.040849 * \text{Sin}[2 * \beta]] \}$ <p style="text-align: right;">(2.3)</p>

Where:

$$\pi = 3.1415926536$$

$$\text{Year Angle, } \beta = \frac{2\pi(J)}{365}$$

J is the Day of Year from 0 to 364 and from 0 to 365 for leap year.

Example:

$$1^{\text{st}} \text{ January} = 0$$

$$2^{\text{nd}} \text{ February} = 32$$

$$1^{\text{st}} \text{ March} = 59$$

$$31^{\text{st}} \text{ December} = 364$$

The value of Declination of the Sun, D and Equation of Time, T then can be used to determine the prayers time. The equation to determine prayer times shown in Table 2 [2].

Table 2: Equation for Prayer Times

الفجر	Fajr	=	Z-Vd
الشروق	Sunrise	=	Z-U
الظهر	Zuhr	=	Z
العصر	Asr	=	Z+W
المغرب	Maghrib	=	Z+U
العشاء	Isha	=	Z+Vn

Where:

$$Z = 12 + \frac{R-L}{15} - \frac{T}{60}$$

$$U = \frac{180}{15 * \pi} * ArcCos \left[\frac{\sin \left[(-0.8333 - 0.0347 * Sign(H) * Abs(H)^{0.5}) * \frac{\pi}{180} \right] - \sin \left[D * \frac{\pi}{180} \right] * \sin \left[B * \frac{\pi}{180} \right]}{\cos \left[D * \frac{\pi}{180} \right] * \cos \left[B * \frac{\pi}{180} \right]} \right]$$

Abs (H): is the absolute value of H while Sign (H): is the sign of H or H/Abs (H)

$$Vd = \frac{180}{15 * \pi} * ArcCos \left[\frac{-\sin \left[Gd * \frac{\pi}{180} \right] - \sin \left[D * \frac{\pi}{180} \right] * \sin \left[B * \frac{\pi}{180} \right]}{\cos \left[D * \frac{\pi}{180} \right] * \cos \left[B * \frac{\pi}{180} \right]} \right]$$

$$Vn = \frac{180}{15 * \pi} * ArcCos \left[\frac{-\sin \left[Gn * \frac{\pi}{180} \right] - \sin \left[D * \frac{\pi}{180} \right] * \sin \left[B * \frac{\pi}{180} \right]}{\cos \left[D * \frac{\pi}{180} \right] * \cos \left[B * \frac{\pi}{180} \right]} \right]$$

$$W = \frac{180}{15 * \pi} * ArcCos \left[\frac{\sin \left[ArcCot \left[Sh + Tan \left[Abs(B - D) * \frac{\pi}{180} \right] \right] \right] - \sin \left[D * \frac{\pi}{180} \right] * \sin \left[B * \frac{\pi}{180} \right]}{\cos \left[D * \frac{\pi}{180} \right] * \cos \left[B * \frac{\pi}{180} \right]} \right]$$

For calculation of Fajr and Isha prayer, the Fajr angle, G_{dt} and Isha angle, G_n is different based on the convention used by the countries. The convention used and the respective Fajr and Isha Angle shown in Table 3 [5].

Table 3: Convention for Fajr Angle, G_d and Isha Angle, G_n

Convention	Fajr Angle	Isha Angle
Shia Ithna Ashari (Jafari)	16	14
University of Islamic Sciences, Karachi	18	18
Islamic Society of North America (ISNA)	15	15
Muslim World League (MWL)	18	17
Umm al-Qura, Makkah	19	90 mins after Maghrib
Egyptian General Authority of Survey	19.5	17.5

2.2.2 Prayer Times Time Table from JAKIM

Jabatan Kemajuan Islam Malaysia (JAKIM) is a main government agency that responsible on Islamic matter in federal level in Malaysia. Prayer time timetable provided by JAKIM will be used as the reference and to compare the results from the device. Prayer time timetable provided by JAKIM is more accurate and reliable compared to available prayer time's software. Prayer time timetable are available on website provided by JAKIM for prayer time <www.e-solat.gov.my> [16].

2.3 Global Positioning System (GPS)

Global Positioning System is a Global Navigation Satellite System (GNSS) developed by the United States Department of Defense. It uses constellation of between 24 to 32 Medium Earth Orbit satellites that transmit precise microwave signals which enable GPS to receive and determine their current location, the time, and their velocity [6].

GPS use at least three satellites above it to determine the location. The determination of the location is known as trilateration. The GPS device will measure the distance to the satellites above it. The distance then can be used to determine the location.

In the real world application, GPS is used to determine basic location, navigation to move from one location to other location, mapping to create the map of the world, tracking to monitor movement of people and things, and timing to bring precise timing to the world.

Better systems have been developed to make GPS give precise result in shorter time. Differential GPS and Assisted GPS can give better result compared to the stand alone conventional GPS.

2.3.1 Differential GPS

Differential GPS or "DGPS" can yield measurements good to a couple of meters in moving applications and even better in stationary situations. Differential GPS involves the cooperation of two receivers, one that's stationary and another that's roving around making position measurements. One receiver measures the timing errors and then provides correction information to the other receivers that are roving

around. That way virtually all errors can be eliminated from the system, even the pesky Selective Availability error that the DoD puts in on purpose [7].

This reference station receives the same GPS signals as the roving receiver but instead of working like a normal GPS receiver it attacks the equations backwards. Instead of using timing signals to calculate its position, it uses its known position to calculate timing. It figures out what the travel time of the GPS signals should be, and compares it with what they actually are. The difference is an "error correction" factor. The receiver then transmits this error information to the roving receiver so it can use it to correct its measurements [7].

2.3.2 Assisted GPS

Assisted GPS is a system where outside sources, such as an assistance server and reference network, help a GPS receiver perform the tasks required to make range measurements and position solutions. The assistance server has the ability to access information from the reference network and also has computing power far beyond that of the GPS receiver. The assistance server communicates with the GPS receiver via a wireless link. With assistance from the network, the receiver can operate more quickly and efficiently than it would unassisted, because a set of tasks that it would normally handle is shared with the assistance server.

The resulting AGPS system consisting of the integrated GPS receiver and network components, increase the performance beyond that of the same receiver in a stand-alone mode [8].

There are three basic types of data that the assistance server provides to the GPS receiver: precise GPS satellite orbit and clock information; initial position and time estimate; and for AGPS-only receivers, satellite selection, range, and range-rate

information. The assistance server is also able to compute position solutions, leaving the GPS receiver with the sole job of collecting range measurements [8].

AGPS architectures increase the capability of a stand-alone receiver to conserve battery power, acquire and track more satellites, thereby improving observation geometry, and increase sensitivity over a conventional GPS architecture. These enhanced capabilities come from knowledge of the satellite position and velocity, the initial receiver position, and time supplied by the assistance server [8].

2.3.3 GPS-41ML GPS Receiver

GPS Module GPS-41ML from RF solution as shown in the figure below will be used in the project. It has 12 parallel channels and 4100 search bins that provides fast satellite signal acquisition and short startup time. The serial interface protocol is based on the National Marine Electronics Association’s NMEA 0183 ASCII Interface specification. This module offers good navigation performance even with limited sky view [9].

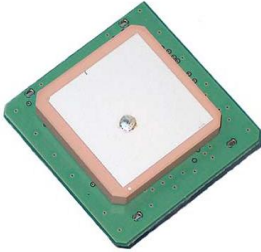


Figure 1: GPS-41ML GPS Receiver

2.3.4 NMEA 0183 ASCII Interface

The NMEA 0183 is a standard defines and electrical interface and data protocol for communication between marine instrumentation. NMEA stand for the National Marine Electronics Association, a non-profit association of manufacturer, distributors, dealers, educational institutions, and others interested in peripheral marine electronics occupation. The NMEA 0183 data stream consists of a series of "sentences" delimited by a newline character. Each sentence begins with a six character identifier, the first character of which is always "\$". The NMEA 0183 standard defines dozens of sentences, but only a fraction applies directly to GPS devices [13].

In GPS application, there are several sentence type uses in NMEA 0183. The formats of the sentence in NMEA 0183 are as follows [14]:

- \$GPAAM - Waypoint Arrival Alarm
- \$GPALM - GPS Almanac Data (Can also be received by GPS unit)
- \$GPAPB - Autopilot format "B"
- \$GPBOD - Bearing, origin to destination
- \$GPBWC - Bearing and distance to waypoint, great circle
- \$GPGGA - Global Positioning System Fix Data
- \$GPGLL - Geographic position, latitude / longitude
- \$GPGRS - GPS Range Residuals
- \$GPGSA - GPS DOP and active satellites
- \$GPGST - GPS Pseudo range Noise Statistics
- \$GPGSV - GPS Satellites in view
- \$GPHDT - Heading, True
- \$GPMSK - Control for a Beacon Receiver
- \$GPMSS - Beacon Receiver Status
- \$GPR00 - List of waypoints in currently active route

\$GPRMA - Recommended minimum specific Loran-C data
\$GPRMB - Recommended minimum navigation info
\$GPRMC - Recommended minimum specific GPS/TRANSIT data
\$GPRTE - Routes
\$GPTRF - TRANSIT Fix Data
\$GPSTN - Multiple Data ID
\$GPVBW - Dual Ground / Water Speed
\$GPVTG - Track made good and ground speed
\$GPWPL - Waypoint location
\$GPXTE - Cross-track error, Measured
\$GPZDA - UTC Date / Time and Local Time Zone Offset

In this project, it will be focus more on \$GPGLL sentence format to obtain geographic position that is the latitude and longitude of the location. The example of the \$GPGLL sentence format shown as follows:

\$GPGLL, 4916.45, N, 12311.12, W, 225444, A

The sentence interpreted as follows:

4916.46, N	Latitude 49 deg. 16.45 min. North
12311.12, W	Longitude 123 deg. 11.12 min. West
225444	Fix taken at 22:54:44 UTC
A	Data valid

Other sentence format may also be used to get more information from the GPS receiver.

2.4 Digital Compass

A compass is a navigational device for determining direction relative to the earth magnetic poles. The compass is specifically designed as an aid to navigation system. The compass greatly improved the safety and efficiency of travel, especially ocean travel. A compass can be used to calculate heading,



Figure 2: Honeywell HMC6352

The Honeywell HMC6352 is a fully integrated compass module that combines 2-axis magneto-resistive sensors with the required analog and digital support circuits, and algorithms for heading computation. By combining the sensor elements, processing electronics, and firmware into a 6.5mm by 6.5mm by 1.5mm LCC package, Honeywell offers a complete, ready to use electronic compass. This provides design engineers with the simplest solution to integrate high volume, cost effective compasses into wireless phones, consumer electronics, vehicle compassing, and antenna positioning. This compass use I2C 2-wire Serial Interface which is very easy to use with microcontroller [23].

2.5 Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Microcontrollers are designed for embedded applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

There are many companies producing microcontroller. Each microcontroller has certain features and some features that unique from other microcontroller. Selecting a suitable microcontroller depends on the application used. The selection criteria may look into the word size of the microcontroller, memory size, price, numbers of available I/O (input and output) pin, and also memory requirement. Physical size of the microcontroller also can be an issue if the size of the designed device taken into consideration.

PIC who initially known as “Programmable Interface Controller” has now renamed as “Programmable Intelligent Computer”. It is a family of Harvard architecture microcontrollers made by Microchip Technologies. In this project, PIC 18F2520 will be used as it has big memory and relatively small size with only 28 pins. It has high computational performance at an economical price with the addition of high- endurance. It used flash memory type with memory size of 64kB.



Figure 3: PIC 18F2520

2.6 Liquid Crystal Display (LCD)

LCD is an electro-optical amplitude modulator realized as a thin, flat display device that made up from any number of color or monochrome pixels arrayed in front of a light source or reflector. LCD is usually used in battery-powered electronics device because it only use very small amount of electric power.

2x16 Character LCD is the most common message display device to display any alphabet and numerical characters. By using the SK40C, user is able to complete the circuit for this project easily. Since this LCD display is very commonly used, it is easier to get support and information to use this LCD display for the project.



Figure 4: 2X16 Character LCD Display

CHAPTER 3

METHODOLOGY

This chapter will discuss the methodology taken in doing this project.

3.1 Procedure Identification

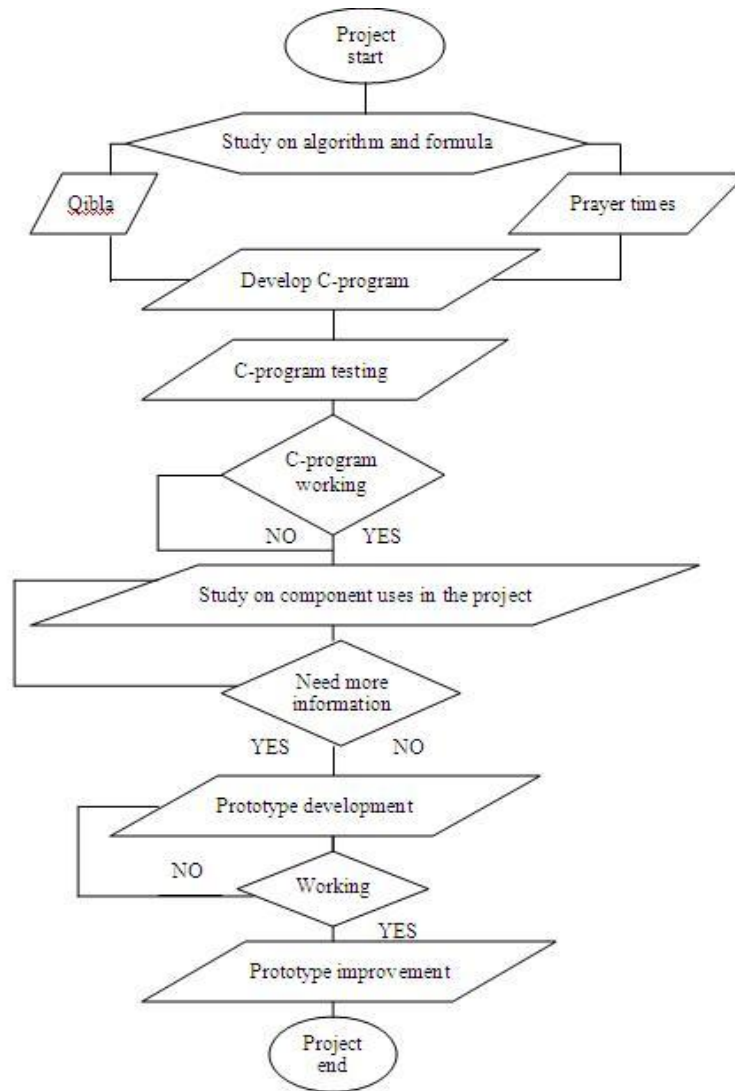


Figure 5: Flow of Procedure

3.2 Qibla Direction Determinations

A C-program has been developed for the qibla direction determination. Based on the qibla algorithm, a C-program has been written in Bloodshed Dev-C++ compiler. User need to enter longitude and latitude of the location. The program then will give the result on the direction of the qibla in degree, clockwise from the north.

The C-program written to verified the qibla algorithm and make sure that the algorithm gives accurate qibla direction as qibla is a very crucial for Muslim to perform prayer.

The C-programme written during the first phase of the project gives reliable result. No correction or modification done to the programme.

3.3 Prayers Time Calculation

Based on the prayer times algorithm discussed earlier in this report, a C-program source code has been written. The C-program has been written using Bloodshed Dev-C++ compiler. In this program, users need to select the calculation method (convention used by country), enter the date (day, month, and year), longitude and latitude of the place, and time zone. Users also need to choose the Mazhab (school of scholars) as an input to the program.

The C-programme written during the first phase of the project did not give accurate prayers time. There are many prayers time algorithm available and comparison done between the algorithms to find better algorithm that will give accurate results for prayers time.

Results from the C-programme then will be compared to the prayer time’s time table provided by JAKIM. The result then also compared with the value from other prayers time finder that is Athan Basic 3.0.

Both qibla and prayer time C program written are modified to be implemented on the PIC.

3.4 Tools and Equipment Used

3.3.1 Hardware Components

3.3.1.1 GPS-41ML GPS Receiver

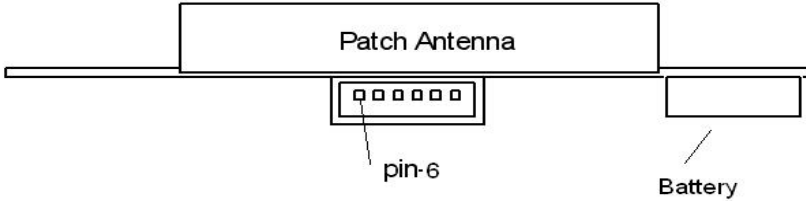


Figure 6: Lateral View

Table 4: Pin out Description

Pin Number	Signal Name	Description
1	Serial Data Out 1	Asynchronous serial output at LVTTTL level, to output NMEA message
2	Serial Data In 1	Asynchronous serial input at LVTTTL level, to input configuration commands
3	Serial Data Out 2	Asynchronous serial output at RS-232 level, to output NMEA message
4	Serial Data In 2	Asynchronous serial input at RS-232 level, to input configuration commands
5	Power	3.8V ~ 8.0V DC input
6	Ground	Power and signal ground

GPS-41ML module connection support both the LVTTTL-level and RS232-level serial interface are provided on the interface connector. It also support supply voltage of 3.8V~8.0V.

3.3.1.2 Honeywell HMC6352.

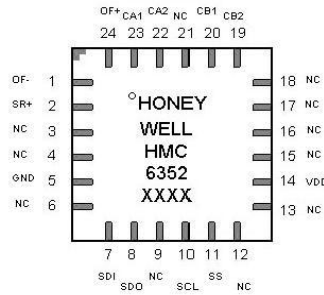


Figure 7: Honeywell HMC6352 pin configuration

Table 5: Honeywell HMC6352 pin description

HMC6352		
Pin	Name	Description
1	OF-	No User Connection (Offset Strap Negative)
2	SR+	No User Connection (Set/Reset Strap Positive)
3	NC	No User Connection
4	NC	No User Connection
5	GND	Supply/System Ground
6	NC	No User Connection
7	SDI	I2C Data Output (SPI Data In)
8	SDO	No User Connection (SPI Data Out)
9	PGM	No User Connection (Program Enable)
10	SCL	I2C Clock (SPI Clock)
11	SS	No User Connection (Slave Select)
12	NC	No User Connection
13	NC	No User Connection
14	VDD	Supply Voltage Positive Input (+2.7VDC to +5.0VDC)
15	NC	No User Connection
16	NC	No User Connection
17	NC	No User Connection
18	NC	No User Connection
19	CB2	Amplifier B Filter Capacitor Connection
20	CB1	Amplifier B Filter Capacitor Connection
21	NC	No User Connection
22	CA2	Amplifier A Filter Capacitor Connection
23	CA1	Amplifier A Filter Capacitor Connection
24	OF+	No User Connection (Offset Strap Positive)

3.3.1.3 LCD Display

2x16 Character LCD is the most common message display device to display any alphabet and numerical characters. Qibla direction and prayer time will be displayed on the LCD.

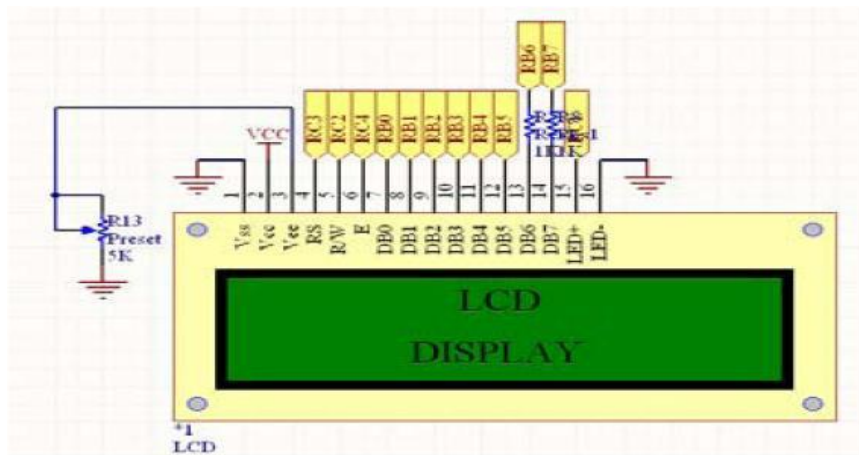


Figure 8: LCD Display

Table 6: LCD connection pin and function

Pin	Name	Pin Function	Connection
1	VSS	Ground	GND
2	VCC	Positive supply for LCD	5V
3	VEE	Brightness adjust	Connected to a preset to adjust brightness
4	RS	Select register, select instruction or data register.	RB1
5	R/W	Select read or write	RB2
6	E	Start data read or write	RB0
7	DB0	Data bus pin	—
8	DB1	Data bus pin	—
9	DB2	Data bus pin	—
10	DB3	Data bus pin	—
11	DB4	Data bus pin	RB4
12	DB5	Data bus pin	RB5
13	DB6	Data bus pin	RB6
14	DB7	Data bus pin	RB7
15	LED+	Backlight positive input	5V
16	LED-	Backlight negative input	GND

LCD can be controlled using either with 8 pins (8-bit interface) or 4 pins (4-bit interface), depending on the I/O pins users have. The pin 15 and 16 is for LCD backlight which is optional whether we want the backlight to be switched on. Switching on the backlight of LCD will cause the battery to dry up rapidly. The 3rd pin (VEE) needs to be connected to a variable resistor to control the LCD contrast, while the R/W (read or write) pin is connected to pin B2. R/S and E are connected to pin B1 and pin B0 to PIC respectively. For data communication pins, D4-D7 (4-bit) from the LCD is connected directly to pin B4-B7 of the PIC.

3.3.1.4 Microcontroller

: PIC 18F2520 has features that can significantly reduce power consumption during operation. It also has a small size with only 28-pins which is very important for portable device where physical size is a crucial factor.

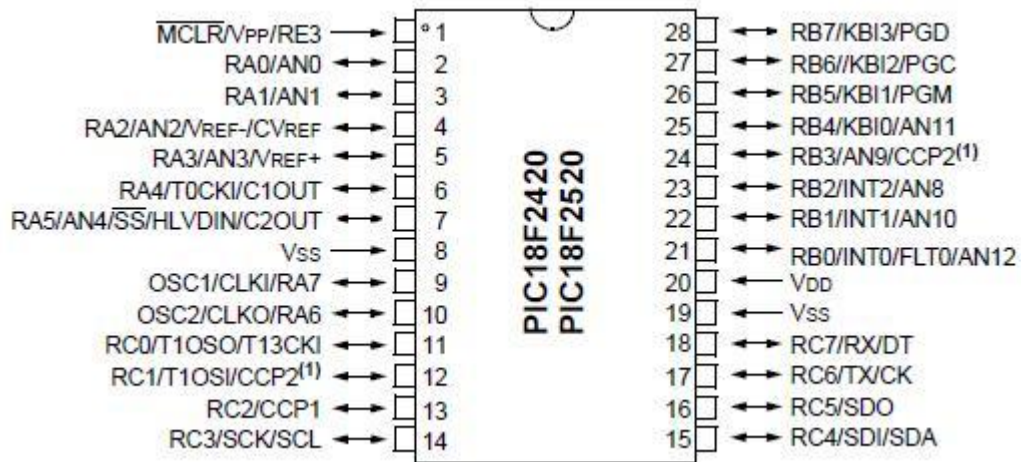


Figure 9: PIC 2520 pin diagram

3.3.2 Software

3.3.2.1 Bloodshed Dev-C++, C Language Compiler

C language is the simplest programming language. Bloodshed Dev-C++ is a full-featured Integrated Development Environment (IDE) for the C/C++ programming language. It uses Mingw port of GCC (GNU Compiler Collection) as its compiler. Dev-C++ can also be used in combination with Cygwin or any other GCC based compiler [11].

The software is used to write a C program from qibla and prayer time algorithm. Program written is only for verification of the algorithm. Written program also can be modified and implemented on the PIC.

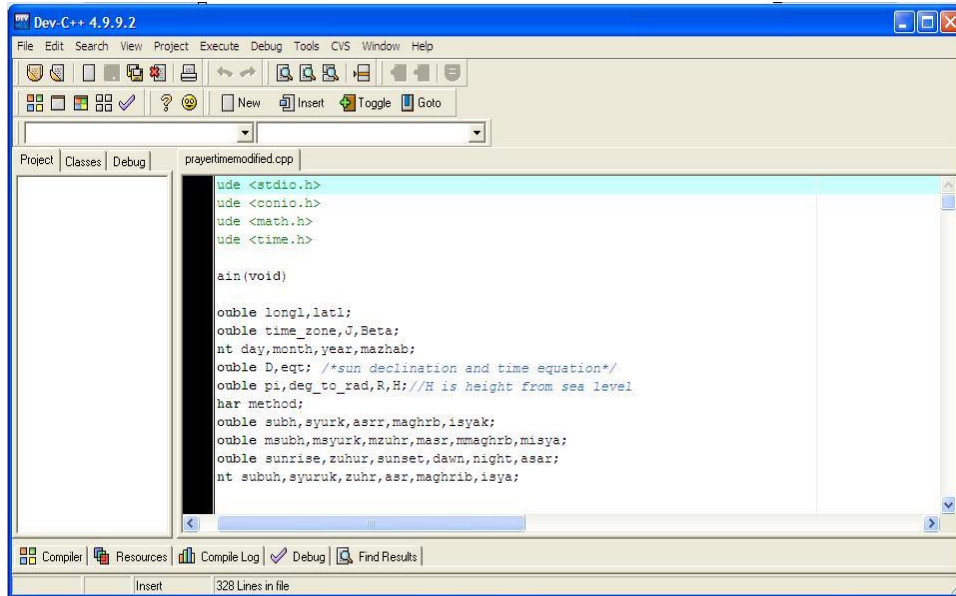


Figure 10: Bloodshed Dev-C++

3.3.2.2 CCS C Compiler IDE

PIC microcontroller is a special purpose integrated circuit designed to perform one or few dedicated function depending on code integrated inside it. It is usually embedded as a part of a complete device including hardware and mechanical parts. The code is written using programming language such as c or basic that provides a structured mechanism for defining pieces of data, and the operation or transformation that to be carried by microcontroller.

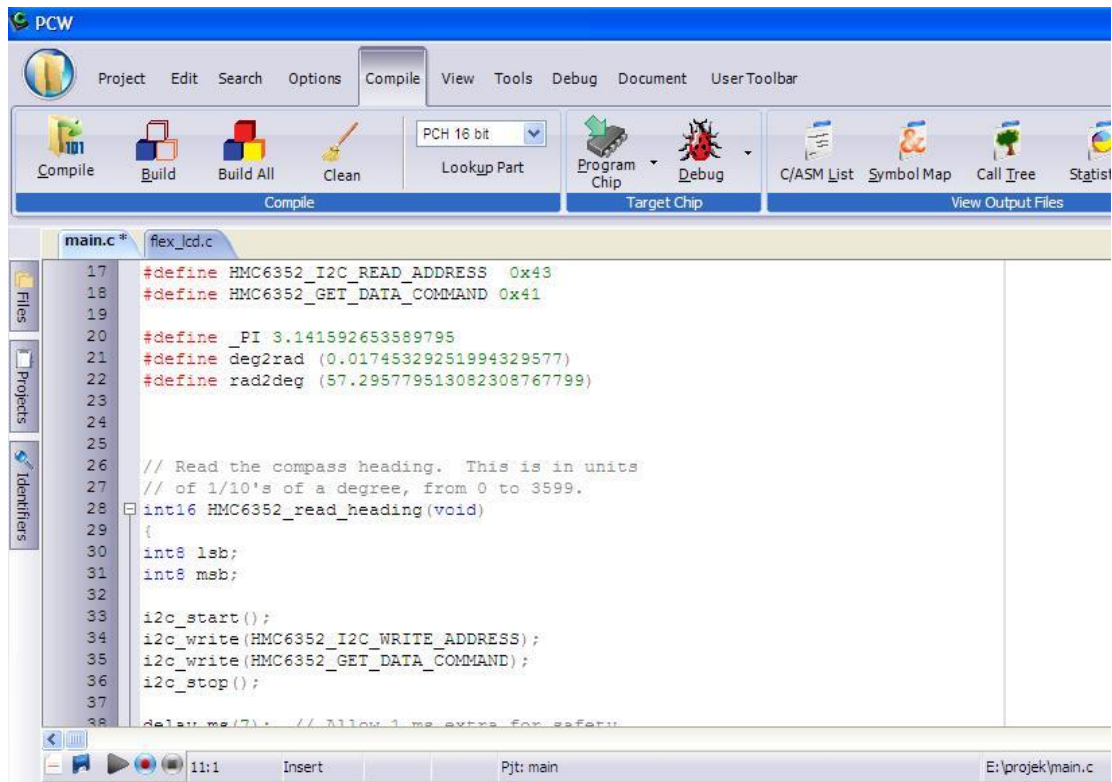


Figure 11: CCS C Compiler IDE

CCS C Compiler which has been developed exclusively for the PIC microcontroller has a generous library of built-in function, preprocessor commands, and ready-to-run example programs to quickly jump-start any project. It has Microsoft Window based Integrated Development Environment (IDE) compiler that capable to aid in program design and editing. Features of the IDE include a colour syntax editor, a powerful C Aware Real-time Debugger, RTOS, linker, and a New Project Wizard for peripherals and drivers.

3.3.2.3 PICKit 2 Programmer

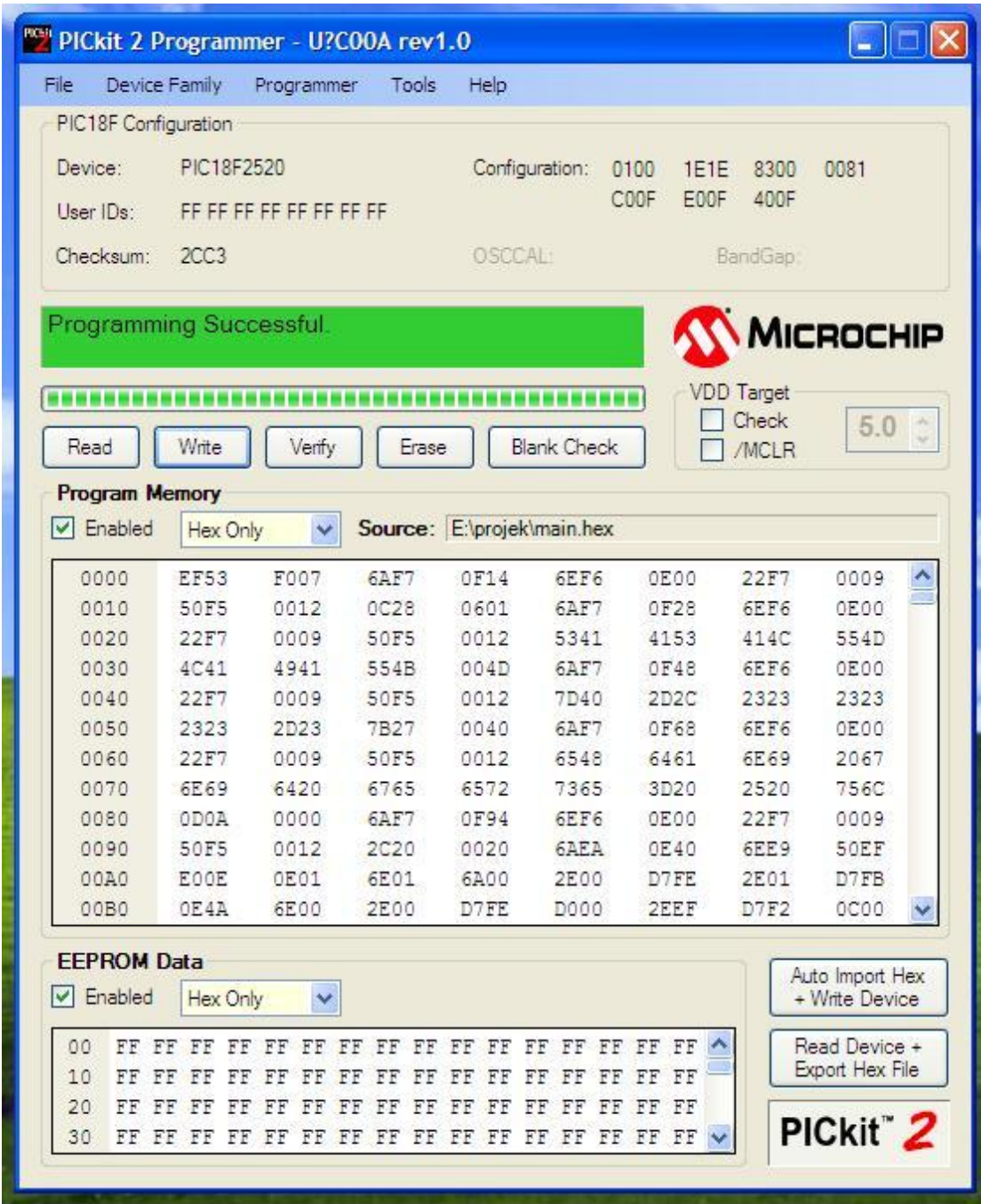


Figure 12: PICKit 2 Programmer Software

The PICKit 2 Programmer is a Windows PC application that provides a simplified, feature rich interface for PICKit 2 device. It will transfer the code to PIC microcontroller through PICKit 2 device.

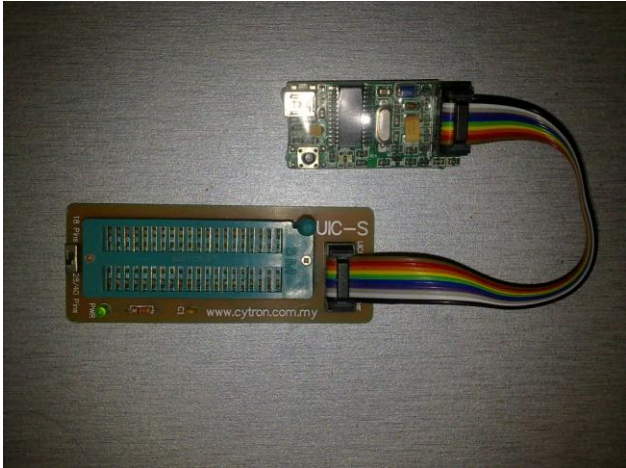


Figure 13: PIC burner

3.3.3 Hardware Architecture

Qibla and Prayer Time Finder designed by modules. Using this approach, parts are easier to implement and troubleshooting can be done easily. It consists of hardware and software parts. Figure X shows the architecture of the Qibla and Prayer Time Finder.

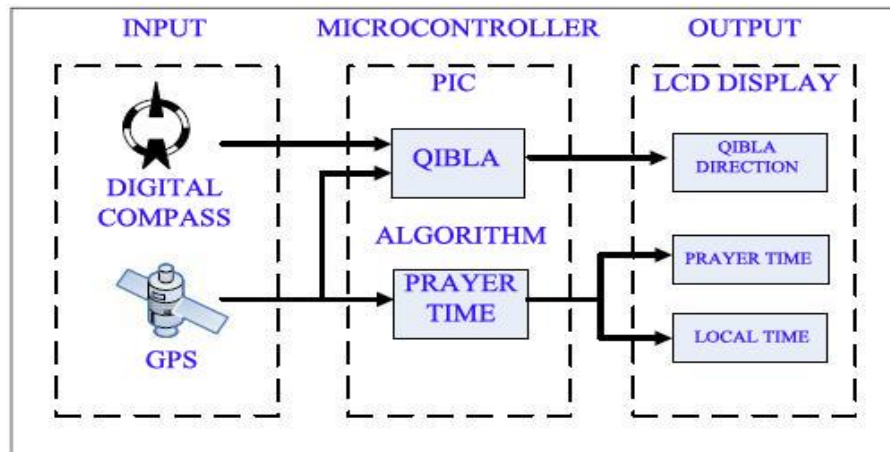


Figure 14: Device architecture

The architecture can be divided into three parts which are input, microcontroller, and output. The input part consists of digital compass and GPS receiver. Digital compass give the direction of magnetic north while GPS receiver gives latitude, longitude, altitude, date, and time.

This input then fed into microcontroller where information from the input will be utilize by the algorithm to give qibla direction and prayer time.

Microcontroller part consist the software that programmed into PIC Microcontroller.

The output part consists of LCD display which will display the information such as qibla direction, prayer time, and GPS data.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter will show the result obtained from the project work done so far. The results also discussed in this chapter.

4.1 Qibla Direction Determinations

The C-program written earlier compiled and executed. The program shows the results as shown in the table below:

Table 7: Result for Qibla Direction Determination

Location	Latitude (degree)	Longitude (degree)	Results from C-program (degree)	Value from Athan Basic (degree)	% difference
Tronoh	4.4167	100.9833	292.0077	292.1683	0.05
New York	40.75	-73.9967	58.4881	58.5356	0.08
Tokyo	35.6833	139.7667	293.0654	293.1738	0.04

The Results from C-program gives the direction of the qibla from the true north. There is slight difference between the results from the C-program compared to the value from Athan Basic.

As stated earlier, the results from the C-program gives the direction of the qibla from the true north. Values from Athan Basic already consider magnetic declination of a compass. This may be the cause of the difference in value from the

results from the C-program with the value from Athan Basics. However, the qibla direction is still reliable as the percentage difference is very small.

4.2 Prayer Time Calculation

Tronoh is selected as a location to determine the prayer times. The results are shown as below:

Date: 16 August 2010

Location: Tronoh

Time zone: 8

Latitude: 4.4167 degree

Calculation method: Muslim World League

Longitude: 100.9833 degree

Mazhab : Syafi'i

Altitude: 63 meters

Table 8: Result for Prayer Time

Prayer	Results from C-program	Time from Athan Basic 3.0	Time provided by JAKIM
Subuh	6:01	6:02	5:55
Syuruk	7:08	7:12	7:12
Zuhur	13:20	13:20	13:24
Asr	16:50	16:35	16:40
Maghrib	19:33	19:28	19:30
Isyak	20:35	20:34	20:42

From the above table, we can compare the prayers time from the C-programme, Athan Basic software, and JAKIM prayers timetable. We can clearly see that even the well published software like Athan Basics 3.0 give different prayers time compared to the time provided by JAKIM.

The results from C-program are very near to the value from the reference software. The small difference happens because of the difference of number of decimal places taken into the calculation. However, compared to the prayers time provided by JAKIM, the time difference is considered as big as the smallest

difference is about four minutes and the largest difference is ten minutes during Asr prayer.

Correction is done to the C-programme where altitude also taken into account in order to determine the prayers time. The altitude will effect Syuruk and Maghrib time.

4.3 Prototype

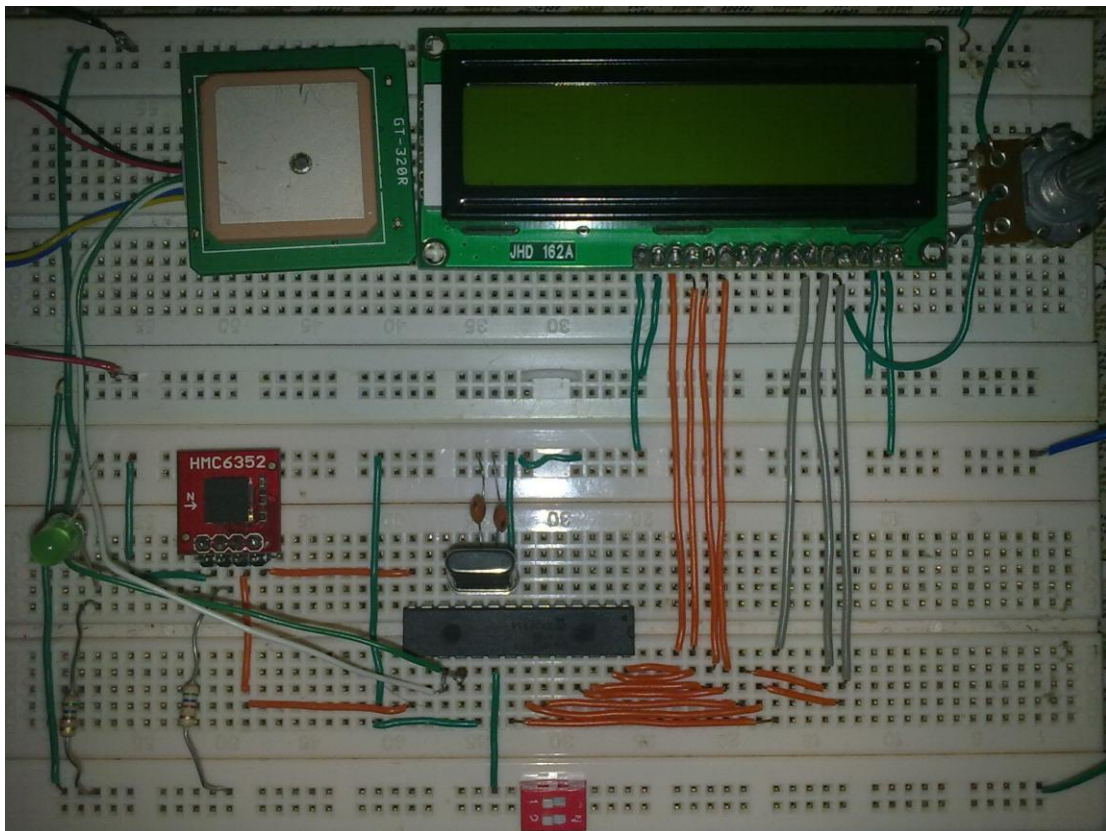


Figure 15: Completed device

GPS, digital compass, LCD Display, and PIC integrated together as a complete device. The device use 5volt supply from an AC/DC adapter.

Prayer time and local time will be displayed on the LCD after the device turned on and after the device get clear signal and reading from the GPS. Prayer time calculation is based on the algorithm discussed earlier in this report

Qibla direction determined using earth coordinate and North direction. User need to rotate the device until the heading value shown on the LCD is the same as qibla value. As shown on the figure, initial heading is given as “0”, while qibla is “292”. User need to rotate the device until the heading value is the same as qibla value.



Figure 16: Qibla result



Figure 17: Qibla direction

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter will conclude the project work that has been done and will give some recommendation on improving the project and discuss future work that need to be done.

5.1 Conclusion

GPS and digital compass can be utilized to determine qibla direction and prayer time. GPS provides location information such as latitude and longitude that can be used to determine qibla and prayer time. Digital compass provides heading that can be used to show the qibla direction.

This project fulfills the objective which is to develop a portable device for qibla and prayer time finder that utilize GPS and digital compass. GPS receiver provides information of the latitude, longitude, and the altitude also date and time and this information will be synchronized with digital compass in order for the whole system to operate correctly.

This device integrates several features and functions that make it prominent from others. In most products, determination of prayer time and qibla direction is based on the location of the nearest city or district inside the database. Using GPS receiver, user location can always be updated automatically.

This system is reliable, user friendly and could be used in everywhere to determine qibla direction and prayer time for any location.

5.2 Recommendation

Improvement can be done for the device and same added features also can be added. The device design can be made more compact to reduce space and more portable. Modification can be done for the display panel where bigger display panel can be used. Added software also can be added such as portable Al-Quran, Hadith reader, and other Islamic application.

Despite developing a whole new qibla and prayer time finder tools, improvement and innovation can be done to the existing qibla and prayer time finder tools. As an example, GPS and digital compass can be integrated to the existing electronics prayer time timetable which can be found in the mosque.

As qibla and prayer time is related to Islamic teaching, it is better to get an approval from Jabatan Kemajuan Islam Malaysia (JAKIM), a government body that responsible for Islamic matter in Malaysia. JAKIM can provide an approval that this device is reliable to determine qibla direction and prayer time.

As in 2009, the Muslim population is about 1.57 billion adherents, making up 23% of the world population Therefore, it is highly believed that this device has good opportunities to commercialize not only in Malaysia whose majority of its citizen is a Muslim, but also can be commercialize to the world as Muslims are the second largest religion in the world [30].

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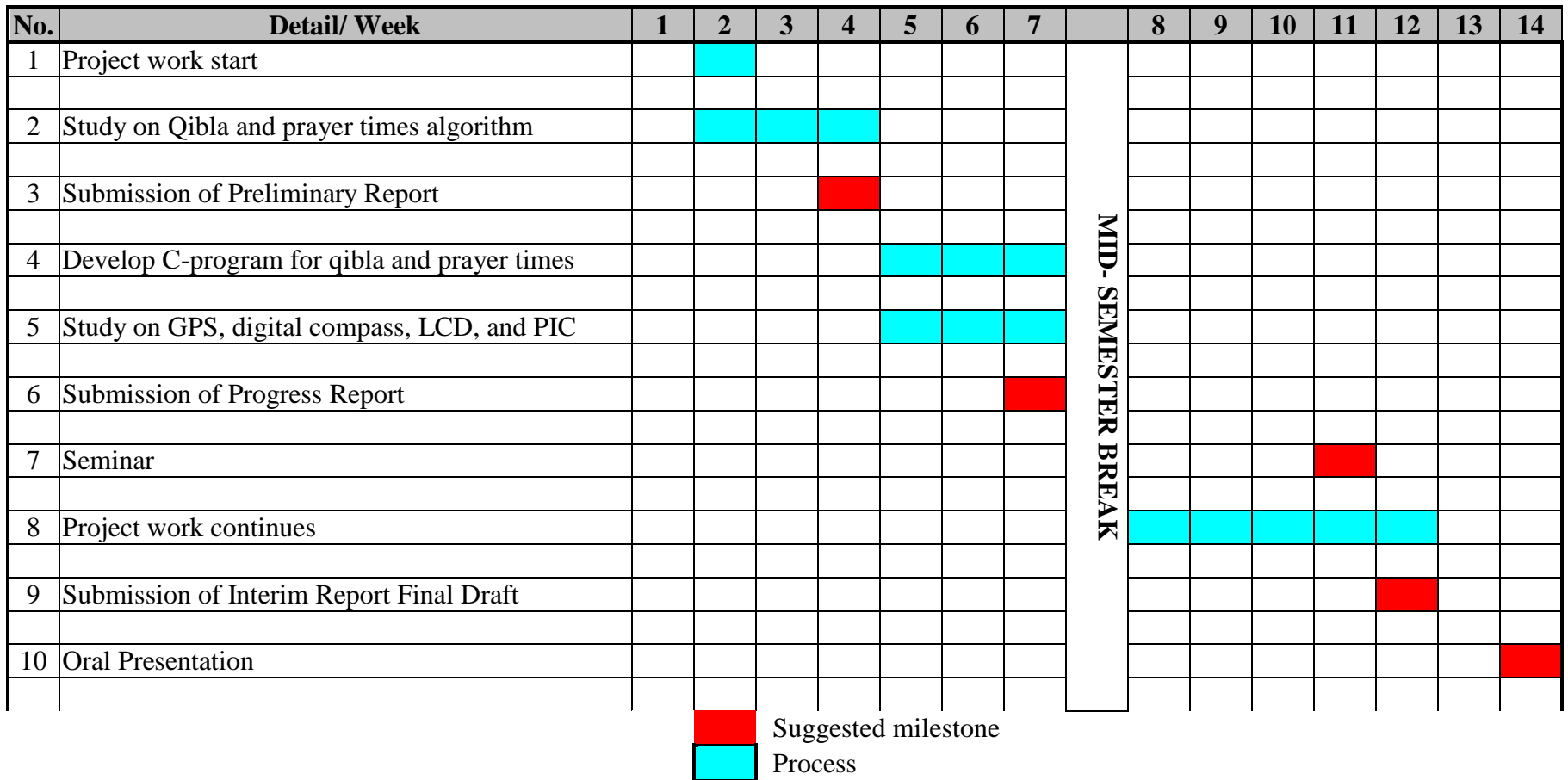
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APPENDICES

APPENDIX A GANTT CHART



No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14	
1	Prototype development: Capturing data from GPS and digital compass								MID-SEMESTER BREAK								
2	Submission of Progress Report 1																
3	Project Work Continue: Built the complete prototype																
4	Submission of Progress Report 2																
5	Seminar																
5	Prototype testing and improvement																
6	Poster Exhibition																
7	Submission of Dissertation (soft bound)																
8	Oral Presentation																
9	Submission of Project Dissertation (Hard Bound)																

 Suggested milestone
 Process

APPENDIX B

SOURCE CODE

1. C-Program for Qibla Determination and Prayer Time calculation using Blodsheed C++

```
#include <stdio.h>
#include <conio.h>
#include <math.h>
#include <time.h>

int main(void)
{
    double longl,latl;
    double longm,latm,qibla;
    double time_zone,J,Beta;
    int day,month,year,mazhab;
    double D,eqt; /*sun declination and time equation*/
    double pi,deg_to_rad,R,H;//H is height from sea level
    char method;
    double subh,syurk,asrr,maghrb,isyak;
    double msubh,msyurk,mzuhr,masr,mmaghrb,misya;
    double sunrise,zuhur,sunset,dawn,night,asar;
    int subuh,syuruk,zuhr,asr,maghrib,isyah;

    pi=3.1415926536;
    deg_to_rad=pi/180.0;
    longm=39.8230; //Mecca longitude
    latm=21.4233; //Mecca latitude

    time_t now;
    time(&now);
    printf("\n\nToday is %s\n\n", ctime(&now));

    printf ("[a]Shia Ithna Ashari (Jafari)\n");
    printf ("[b]University of Islamic Sciences, Karachi\n");
    printf ("[c]Islamic Society of North America (ISNA)\n");
    printf ("[d]Muslim World League (MWL)\n");
    printf ("[e]Umm al-Qura, Makkah\n");
    printf ("[f]Egyptian General Authority of Survey\n");

    printf ("\n\nPlease select the calculation method from above:");
    scanf ("%s",&method);
```

```

printf ("\nEnter day: ");
scanf ("%d", &day);

printf ("Enter month: ");
scanf ("%d", &month);

printf ("Enter year: ");
scanf ("%d", &year);

printf ("\nEnter longitude of the location: ");
scanf ("%lf", &longl);

printf ("Enter latitude of the location: ");
scanf ("%lf", &latl);

printf ("Enter altitude of the location(in meter): ");
scanf ("%lf", &H);

printf ("\nEnter the time zone: ");
scanf ("%lf", &time_zone);

printf ("\n\n[1]Maliki,Syafi'i,Hanbali\n");
printf ("\n[2]Hanafi\n");

printf ("\nPlease select your mazhab:");
scanf ("%d",&mazhab);

//leap year

if (year%4==0)
{
if (month==1==2)
{
J=(30*(month-1))+day-1;
}
else if (month==3==4==5)
{
J=(30*(month-1)+day-2);
}
}
else if (month==6)
{
J=151+day;
}
else if (month==7)
{
J=181+day;
}
else if (month==8)
{
J=212+day;
}
else if(month==9)
{

```

```

        J=243+day;
    }
    else if (month==10)
    {
        J=273+day;
    }
    else if (month==11)
    {
        J=303+day;
    }
    else if (month==12)
    {
        J=334+day;
    }
    else
    {
        printf ("Invalid Code");
    }
}

//non-leap year

if (year%4!=0)
{
    if (month==1==2)
    {
        J=(30*(month-1))+day-1;

    }
    else if (month==3==4==5)
    {
        J=(30*(month-1)+day-2);
    }
    else if (month==6)
    {
        J=150+day;
    }
    else if (month==7)
    {
        J=180+day;
    }
    else if (month==8)
    {
        J=211+day;
    }
    else if(month==9)
    {
        J=242+day;
    }
    else if (month==10)
    {
        J=272+day;
    }
    else if (month==11)

```

```

{
    J=303+day;
}
else if (month==12)
{
    J=333+day;
}
else
{
    printf ("Invalid Code");
}
}

//year angle

Beta=(2*pi*J)/365;
R=15*time_zone;

//Calculation of Declination of Sun and Equation of Time

D = (180/pi)*(0.006918-(0.399912*cos(Beta))+(0.070257*sin(Beta))-
(0.006758*cos(2*Beta))+(0.000907*sin(2*Beta))-(0.002697*cos(3*Beta))+(0.001480*sin(3*Beta)));

eqt = 229.18*(0.000075+(0.001868*cos(Beta))-(0.032077*sin(Beta))-(0.014615*cos(2*Beta))-
(0.040849*sin(2*Beta)));

//prayer time calculation

zuhur = 12 +((R-longl)/15) - (eqt/60);

//subuh prayer and isyak prayer
switch(method)
{
case 'a':

    dawn= (180/(15*pi))*acos(-sin(16*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad)/(cos(D*deg_to_rad)*cos(latl*deg_to_rad)));

    night= (180/(15*pi))*acos(-sin(14*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad)/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    break;

case 'b':

    dawn= (180/(15*pi))*acos(-sin(18*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad)/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    night= (180/(15*pi))*acos(-sin(18*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad)/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    bre

```

```

case 'c':

    dawn= (180/(15*pi))*acos((-sin(15*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    night= (180/(15*pi))*acos((-sin(15*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    break;

case 'd':

    dawn= (180/(15*pi))*acos((-sin(18*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad)));

    night= (180/(15*pi))*acos((-sin(17*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad)));

    break;

case 'e':

    dawn=(180/(15*pi))*acos((-sin(19*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    night=(180/(15*pi))*acos((-sin(1.5*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    break;

case 'f':

    dawn= (180/(15*pi))*acos((-sin(19.5*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    night= (180/(15*pi))*acos((-sin(17.5*deg_to_rad)-
sin(D*deg_to_rad)*sin(latl*deg_to_rad))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad)));

    break;

default:

    printf("Invalid Code\n");

}

subh = zuhur - dawn;

isyak = zuhur + night;

//asar prayer

if (mazhab==1)

```



```

{
    if (latl-D<0)
    {
        asar=(180/(15*pi))*acos(((sin(atan(1/(1+(tan((-latl-
D)*deg_to_rad))))))-sin(D*deg_to_rad)*sin
(latl*deg_to_rad)))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad));
    }

    else

    {
        asar=(180/(15*pi))*acos(((sin(atan(1/(1+(tan((latl-
D)*deg_to_rad))))))-sin(D*deg_to_rad)*sin
(latl*deg_to_rad)))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad));
    }
    }
    else if (mazhab==2)
    {

        if (latl-D<0)
        {
            asar=(180/(15*pi))*acos(((sin(atan(1/(2+(tan((-latl-
D)*deg_to_rad))))))-sin(D*deg_to_rad)*sin
(latl*deg_to_rad)))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad));
        }

        else
        {
            asar=(180/(15*pi))*acos(((sin(atan(1/(2+(tan((latl-
D)*deg_to_rad))))))-sin(D*deg_to_rad)*sin
(latl*deg_to_rad)))/(cos(D*deg_to_rad)*cos(latl*deg_to_rad));
        }
    }

    else
    {
        printf ("Invalid Code");
    }

    asrr = zuhur + asar;

    // syuruk and maghrib

    sunset = (180/(15*pi))*((acos(sin((-0.8333-0.0347*(pow(H,0.5))))*deg_to_rad))-
(sin(latl*deg_to_rad)*sin(D*deg_to_rad)))/(cos(latl*deg_to_rad)*cos(D*deg_to_rad));

    syurk = zuhur - sunset;
    maghrb = zuhur + sunset;

```

```

    qibla=atan((sin(longm*deg_to_rad-
longl*deg_to_rad))/(cos(latl*deg_to_rad)*tan(latm*deg_to_rad)-
sin(latl*deg_to_rad)*cos(longm*deg_to_rad-longl*deg_to_rad)));

printf ("\n\nQIBLA DIRECTION");
if (qibla/deg_to_rad<0)
{
    printf ("\n\nThe qibla direction from the true North is %.4lf\n", 360+qibla/deg_to_rad);
}
else
{
    printf ("\n\nThe qibla direction from the true North is %.4lf\n", qibla/deg_to_rad);
}

//prayer times in minutes

msubh=subh*60;
msyurk=syurk*60;
mzuhr=zuhur*60;
masr=asr*60;
mmaghrb=maghrb*60;
misya=isyak*60;

subuh= msubh;
syuruk=msyurk;
zuhr=mzuhr;
asr=masr;
maghrib=mmaghrb;
isya=misya;

//show result
printf ("\n\n PRAYER TIME");
printf ("\n\nsubuh    %d:%.2d\n", (subuh/60),(subuh%60));
printf ("syuruk    %d:%.2d\n", (syuruk/60),(syuruk%60));
printf ("zuhur     %d:%.2d\n", (zuhr/60),(zuhr%60));
printf ("asr       %d:%.2d\n", (asr/60),(asr%60));
printf ("maghrib   %d:%.2d\n", (maghrib/60),(maghrib%60));
printf ("isyak    %d:%.2d\n", (isya/60),(isya%60));

getch ();
return 0;
}

```

2. CCS C Compiler IDE Source Code

```
#include <18F2520.H>
#fuses HS, NOWDT, NOPROTECT, BROWNOUT, PUT, NOLVP

#use delay(clock=4000000)
#use i2c(Master, sda=PIN_C4, scl=PIN_C3, FORCE_HW)

#include <Flex_LCD.c>

#define HMC6352_I2C_WRITE_ADDRESS 0x42
#define HMC6352_I2C_READ_ADDRESS 0x43
#define HMC6352_GET_DATA_COMMAND 0x41

int16 heading;
void setup()
{
    // setup_timer_0(RTCC_INTERNAL | RTCC_DIV_32);
    // enable_interrupts(INT_TIMER0);
    // enable_interrupts(global);
    // set_rtcc (100);
    lcd_init();
}

int16 HMC6352_read_heading(void);
void clearLCD();
//=====
void main()
{
    setup();
    clearLCD();
    while(1)
    {

        heading = HMC6352_read_heading();
        heading=heading/100;
        lcd_gotoxy(1,1);
        printf(lcd_putc, "heading=%lu", heading);
        lcd_gotoxy(1,2);
        printf(lcd_putc, "Qibla=292");
        delay_ms(1000); }

}
//=====
int16 HMC6352_read_heading(void)
{
    int8 lsb;
    int8 msb;

    i2c_start();
```

```

i2c_write(HMC6352_I2C_WRITE_ADDRESS);
i2c_write(HMC6352_GET_DATA_COMMAND);
i2c_stop();

delay_ms(7);

i2c_start();
i2c_write(HMC6352_I2C_READ_ADDRESS);
msb = i2c_read();
lsb = i2c_read(0);
i2c_stop();

return((int16)msb | ((int16)lsb << 8));
}

//=====
void clearLCD()
{
    printf(lcd_putc, "\f");
    delay_ms(100);
}
//Get GPS Data

char term[2] , *ptr ;
char string[31];
float lon ;
float lat ;
int x ;

lon = 0 ;
lat = 0 ;

        strcpy(term , " " ) ;

while(TRUE) {

    for (x = 0 ; x <= 30 ; x++)
    {
        string[x] = getc() ;

    }

    ptr = strtok(string ,term) ;
    ptr = strtok(0 , term);
    lat = atof(ptr);

        lcd_putc("%C %S %7.2f %C " );
while(1);
    }

} }

```

APPENDIX C

PRAYER TIME TIMETABLE

JAKIM eSolat
 إِنَّ الصَّلَاةَ كَانَتْ عَلَى الْمُؤْمِنِينَ كِتَابًا مَّوْقُوتًا
 Sesungguhnya sembahyang itu adalah satu ketetapan yang diwajibkan atas orang-orang yang beriman, yang tertentu waktunya (An-Nisaa' 103)

Date	Day	Imsak	Subuh	Syuruk	Zohor	Asar	Maghrib	Isyak
01-08-2010	Sunday	5:44	5:54	7:12	13:26	16:47	19:34	20:47
02-08-2010	Monday	5:44	5:54	7:12	13:26	16:46	19:34	20:46
03-08-2010	Tuesday	5:44	5:54	7:12	13:26	16:46	19:33	20:46
04-08-2010	Wednesday	5:45	5:55	7:12	13:26	16:46	19:33	20:46
05-08-2010	Thursday	5:45	5:55	7:12	13:25	16:45	19:33	20:46
06-08-2010	Friday	5:45	5:55	7:12	13:25	16:45	19:33	20:45
07-08-2010	Saturday	5:45	5:55	7:12	13:25	16:44	19:33	20:45
08-08-2010	Sunday	5:45	5:55	7:12	13:25	16:44	19:32	20:45
09-08-2010	Monday	5:45	5:55	7:12	13:25	16:44	19:32	20:44
10-08-2010	Tuesday	5:45	5:55	7:12	13:25	16:43	19:32	20:44
11-08-2010	Wednesday	5:45	5:55	7:12	13:25	16:42	19:32	20:43
12-08-2010	Thursday	5:45	5:55	7:12	13:24	16:42	19:31	20:43
13-08-2010	Friday	5:45	5:55	7:12	13:24	16:41	19:31	20:43
14-08-2010	Saturday	5:45	5:55	7:12	13:24	16:41	19:31	20:42
15-08-2010	Sunday	5:45	5:55	7:12	13:24	16:40	19:31	20:42
16-08-2010	Monday	5:45	5:55	7:12	13:24	16:40	19:30	20:42
17-08-2010	Tuesday	5:45	5:55	7:12	13:24	16:39	19:30	20:41
18-08-2010	Wednesday	5:45	5:55	7:11	13:23	16:38	19:30	20:41
19-08-2010	Thursday	5:45	5:55	7:11	13:23	16:38	19:29	20:40
20-08-2010	Friday	5:45	5:55	7:11	13:23	16:37	19:29	20:40
21-08-2010	Saturday	5:45	5:55	7:11	13:23	16:36	19:29	20:39

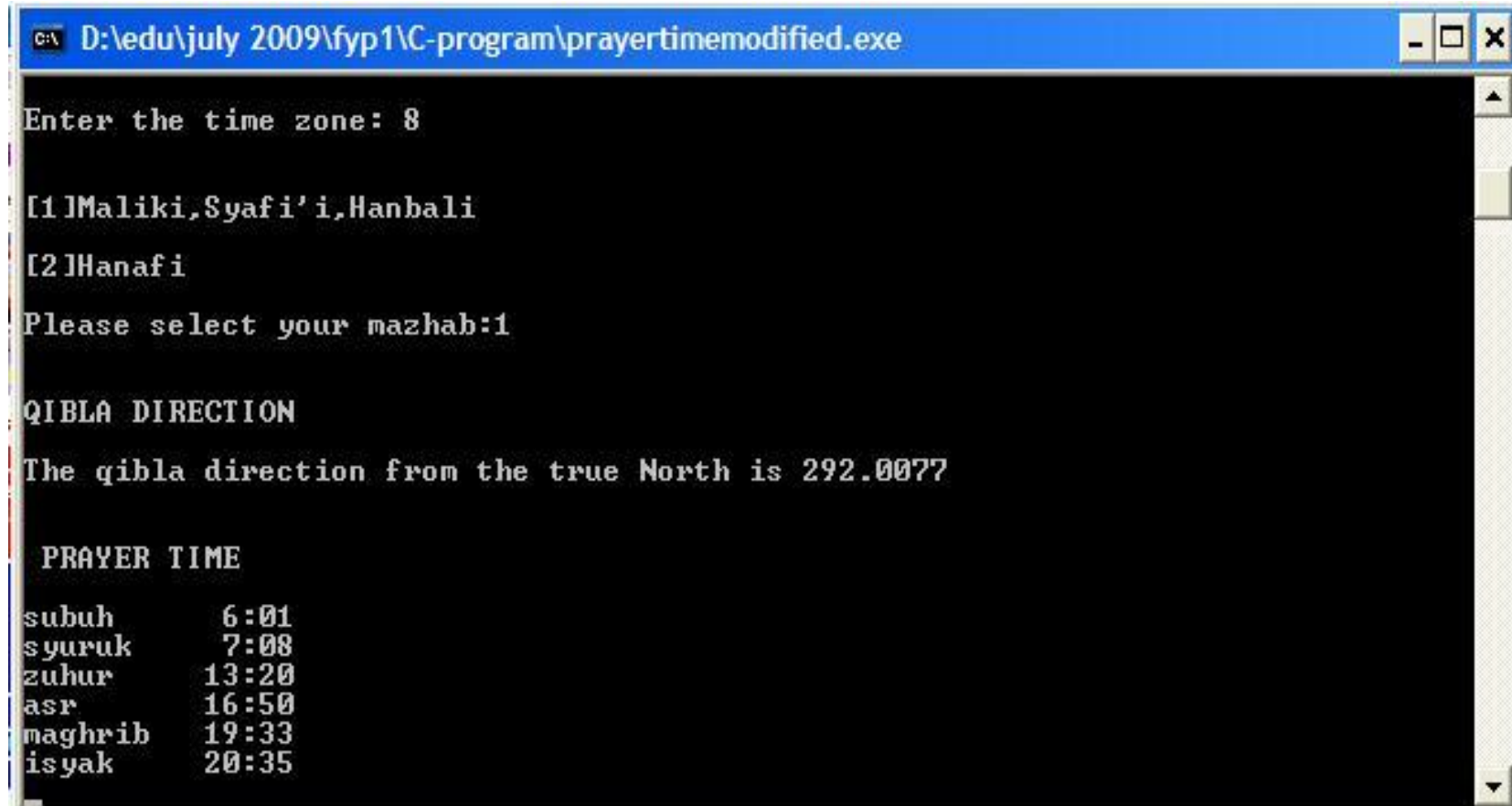
Waktu Solat

Imsak	5:45
Subuh	5:55
Syuruk	7:11
Zohor	13:23
Asar	16:38
Maghrib	19:29
Isyak	20:40

GMT: 8
 Arah Kiblat: [Clock icon]
 Laman Utama
 Soalan Lazim
 Meja Bantuan
 English Version

APPENDIX D

QIBLA DIRECTION AND PRAYER TIME RESULT USING DEV C++



```
C:\> D:\edu\july 2009\fyp1\C-program\prayertimemodified.exe

Enter the time zone: 8

[1]Maliki,Syafi'i,Hanbali
[2]Hanafi
Please select your mazhab:1

QIBLA DIRECTION
The qibla direction from the true North is 292.0077

PRAYER TIME
subuh      6:01
syuruk     7:08
zuhur      13:20
asr         16:50
maghrib    19:33
isyak      20:35
```

