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PRAYER TIME BY USING ALTERA DE2 BOARD

NORAZMAN BIN HUSSIN

Submitted to the Faculty of Electrical Engineering
in partial fulfilment of the requirement for the degree of
Bachelor Degree of Engineering (Computer)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

APRIL 2010

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Specially dedicated to

my beloved mother, father, brothers and sister who have

encouraged, guided and inspired me throughout my journey of education.

ACKNOWLEDGEMENT

I would like to take this opportunity to express my deepest gratitude to my supervisor, Dr. Muhammad Nadzir Bin Marsono who has persistently assisted me in completing this project. He has given me support and insight in doing this project and has patiently listed and guided.

I would also like to express my special thanks to Dr. Shaikh Nasir Bin Shaikh Husin who was supervised me for Final Year Project 1 to overcome problems during the course of the project. A Special appreciation I gave to my beloved family especially my parents for their concerns and prayer in accomplishing this project.

I am grateful that I have received help and support from friends. My special thanks to Mr. Jeffri Bin Ismail and Mr. Khomarudden Bin Mohd Khair Juhari who are technicians for given me using any equipment inside ECAD laboratory for this project. It is my greatest thanks and joy that I have met with these people. Thank you.

ABSTRACT

It is an obligation on Muslims to perform the obligatory prayers whenever they are at specific times of the day. The prerequisite of prayers knows the time for that prayer times. Traditionally this has been based on position of the sun and stars at night. However the science and mathematics of astronomy have advanced, in part due to above requirements. Precise algorithms based on geographical position (latitude and longitude) are established to determined the exact prayer times. This project utilities these algorithms and implement it on a Field Programmable Gates Array (FPGA) based system. The FPGA is using C programming code to determine the prayer time. This is an alternative to keying in geographical position to determine the prayers times.

ABSTRAK

Tanggungjawab seorang Muslim adalah untuk mengerjakan Ibadah Solat di mana sahaja mereka berada dan pada masa yang telah ditetapkan. Untuk melakukan Ibadah Solat, seorang itu perlu mengetahui waktu sembahyang tersebut. Sebelum ini, penetapan waktu sembahyang telah dibuat berdasarkan kedudukan matahari dan bintang pada malam hari. Bagaimanapun, peningkatan dalam ilmu sains dan matematik telah membantu dalam menentukan kedua-dua prasyarat tersebut. Algoritma yang tepat berdasarkan kedudukan geografi (latitud dan longitud) telah dihasilkan untuk menentukan waktu solat. Projek ini dilaksanakan menggunakan algoritma tersebut dan diimplimenkan menggunakan sistem Lapangan Aturcara Get Logik (FPGA). Lapangan Aturcara ini diintegrasikan menggunakan pengaturcaraan C untuk menentukan waktu solat. Ini merupakan satu cara alternatif untuk menggunakan kedudukan geografi dalam menentukan waktu solat.

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
DC	-	Direct Current
DIP	-	Dual Inline Package
FSR	-	File Select Register
GND	-	Ground
GPR	-	General Purpose Register
LCD	-	Liquid Crystal Display
WDT	-	Watch Dog Timer
EEPROM	-	Electronically Erasable Read-only Memory
PWM	-	Pulse Width Modulation
RISC	-	Reduce Instruction Set Computer
CPU	-	Central Processing Unit
SSP	-	Synchronous Serial Port
ICSP	-	In-Circuit Serial Port
IO	-	Input Output
PC	-	Personal Computer
DIY	-	Do It Yourself

CHAPTER 1

INTRODUCTION

1.1 Times of Solat

Solat times are set in such a way that there is continuous communication with the creator. There are times in which Solat cannot be offered. Prayer is not allowed at sunrise and sunset to avoid confusion with worshippers of the sun. The obligatory prayers need to be performed during their times. Currently, specific astronomical theories based Quran and Hadith are being used on deciding each time prayer. It is said in Quran (which means):

"When ye have performed the act of worship, remember Allah, standing, sitting and reclining. And when ye are in safety, observe proper worship. Worship at fixed times hath been enjoined on the believers."

(Surah al-Nisaa': 103)

1.2 Problem Statements

It is hard to know the prayer of each prayer times. In the old days, people use stick and sees is shadow to know the prayer times. Nowadays, astronomical researches and findings are used in computing the prayer time.

There are several applications on the Internet that calculate prayer times. They have to insert information on current location and prayer information will be given. As the technologies grow, various mobile companies' gives prayer time services. The problem is that the applications itself are not portable, self generated but rely on the service itself. Services from websites need the user to have internet connections making it not practical for daily use.

People exchange the daily change from a place to another one and they needs to know the time of the prayer in the present place that they goes. By the way, people somehow need to ask which lives in that place. The problem is when somebody moves to a place that it has rarely Muslim. It can be that it does them that they confused and that they vacillated to request in there.

1.3 Objectives

This project is prepared to reach some objectives that are to identify the given entrance and later to exhibit the exit depending of entrance. It will recognize four push buttons like Mode, Select, Back and Next. Secondly, to discover an advisable algorithm that use to write the C or C++ code programming in Quartus II and Nios II to obtain the real hardware made by using DE2 board. This method will need software to turn it. Finally, to learn more on Quartus II and Nios II that program more popular is used to solve a problem in directing the field for FPGA.

1.4 Work Scope

The scopes and guidelines in this project are listed to ensure the project is conducted within its intended boundary. This is ensuring the project is leading in the right direction to achieve the objectives of this project.

The first scope of this project is to implement a device that can find time prayer based on date, time and location.

Secondly, using an end product device such as DE2 board, and programmed it to make it works like as planning.

The development of the application is made using C programming code where it builds at Nios2 to program into FPGA inside the DE2 board. By the way, Quartus is used to declare the hardware at DE2 board.

CHAPTER 2

BASIC CONCEPT AND THEORY

2.1 Introduction

The five Islamic prayers name Subuh, Zuhur, Asar, Maghrib and Isyak. The synchronization of these five prayers varies from a site to another one and day per day. It is obligatory so that the Muslims make these prayers at the correct time.

The prayer times for any location given in the Earth can mathematically be determined if the latitude and the longitude of the location are known. Nevertheless, the theoretical determination of the prayer times is a very long process. Of this tediousness it can much be alleviated using computer programs.

2.2 Definition of prayer times

There are the quotations of Quran that define the importance of making prayer in the specific moment and to be obligatory to follow the time of the prayer (which means):

"When ye have performed the act of worship, remember Allah, standing, sitting and reclining. And when ye are in safety, observe proper worship. Worship at fixed times hath been enjoined on the believers."

(Surah al-Nisaa': 103)

"Therefore be patient with what they say, and celebrate (constantly) the praises of thy Lord, before the rising of the sun, and before its setting; yea, celebrate them for part of the hours of the night, and at the sides of the day: that thou mayest have (spiritual)."

(Surah Toha: 130)

Hadith related that verify the prayer time which means: Ibn 'Abbas said, The Messenger of Allah, peace and blessings of Allah be on him, said:

"Gabriel acted as imam for me twice in the (Sacred) House; so he said the Zuhur prayer with me when the sun had declined from the meridian and (the shadow) was the measure of a thong, and he said the Asar prayer with me when the shadow of everything was the like of it, and he said the Maghrib prayer with me when one who fasts breaks at fast, and he said the Isyak prayer with me when redness in the horizon had disappeared, and he said the Subuh prayer with me when food and drink are prohibited to one who fasts. When it was the next day, he said with me the Zuhur prayer when the shadow (of a thing) was the like of it, and he said with me the Asar prayer when the shadow (of a thing) was its double, and he said with me the Maghrib prayer when one who fasts breaks the fast, and he said with me the Isyak prayer when one-third of the night had passed, and he said with me the Subuh prayer when

the dawn was bright. Then he turned to me and said, O Muhammad! This is the time of the prophets before thee, and the time is between these two times."

(Ad. Tr-Msh. 4:1)

Each prayer must be made in its specified time. The definition of hourly of the prayer based on al-Quran and Hadith is follows:

- SUBUH starts with the dawn or morning twilight. Subuh ends just before sunrise.

- ZUHUR begins after midday when the trailing limb of the sun has passed the meridian. For convenience, many published prayer timetables add five minutes to mid-day (zawal) to obtain the start of Zuhur. Zuhur ends at the start of Asar time.

- The timing of ASAR depends on the length of the shadow cast by an object. According to the Shafi School of jurisprudence, Asar begins when the length of the shadow of an object exceeds the length of the object. According to the Hanafi School of jurisprudence, Asar begins when the length of the shadow exceeds TWICE the length of the object. In both cases, the minimum length of shadow (which occurs when the sun passed the meridian) is subtracted from the length of the shadow before comparing it with the length of the object.

- MAGHRIB begins at sunset and ends at the start of Isyak.

- ISYAK starts after dusk when the evening twilight disappears.

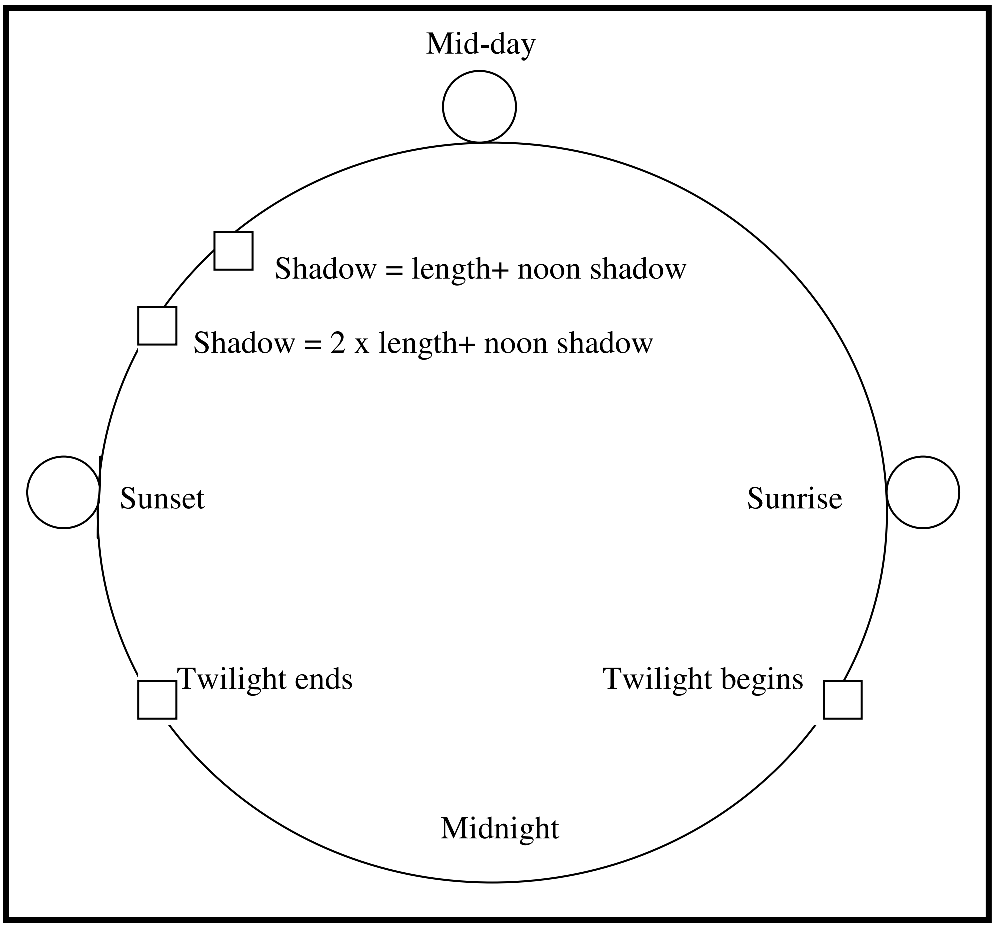


Figure 2.1 : Position of prayer times

2.3 Calculation of Solat Times

To calculate the prayer times for a certain place we need to know the latitude (B) and longitude (L) of the location and its reference longitude (R). B and L may be obtained from an atlas and R may be calculated by multiplying 15 by the reference between local time and GMT.

One also need to know two astronomical measures called the declination angle of the sun (D) and the real time-mean time difference, also known as the equation of time (T). Declination is the angular distance between a celestial object and the celestial equator. The Declination and the Right Ascension are used together to give the position of a star with reference to the celestial equator and the vernal equinox respectively.

The equation of the time is a correction to be added to apparent solar time, as read on a sundial, to obtain means solar time, as commonly used. This difference is a consequence of the elasticity and tilt of the Earth's orbit, causing the irregular apparent movement of the Sun across the sky. D and T vary according to the time of year and can be obtained accurately from The Star Almanec or approximate.

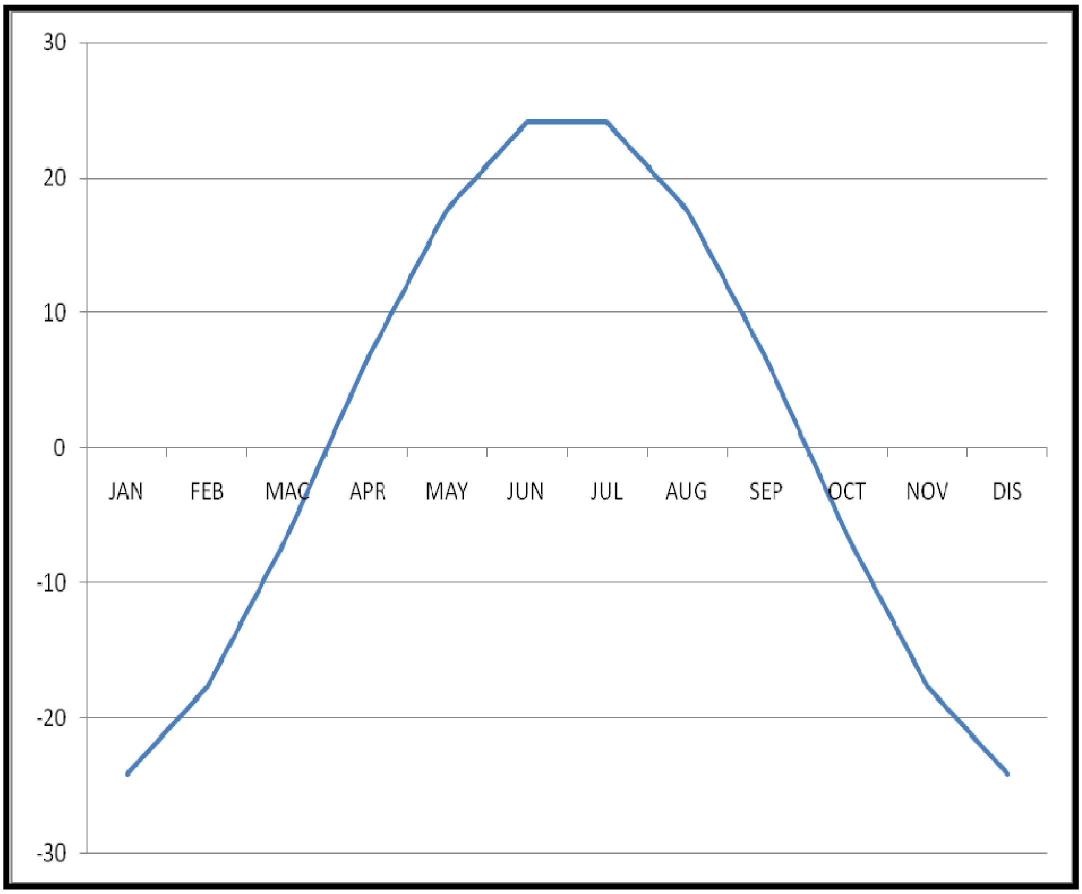


Figure 2.2 : Graph of Declination angle (D) versus Month

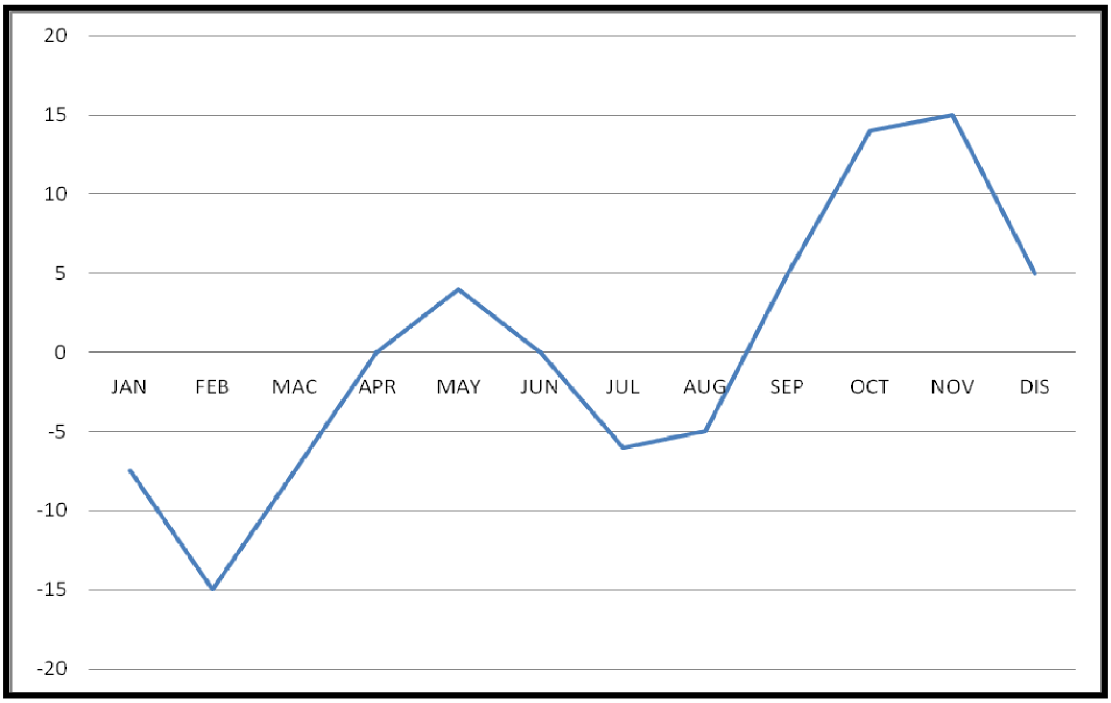


Figure 2.3 : Graph of Equation of Time (T) versus Month

The following equation may be used to calculate the prayer times:

$$Z = 12 + \frac{(R-L)}{15} + \frac{T}{60} \qquad .....1$$

$$U = \frac{1}{15} \arccos \frac{\{\sin(-0.8333-0.0347\,(H)\,\hat{}\,0.5)\} - \sin D.\sin B}{\cos D.\cos B} \qquad .....2$$

$$V = \frac{1}{15} \arccos \frac{-\sin G - \sin D.\sin B}{\cos D.\cos B} \qquad .....3$$

$$W = \frac{1}{15} \arccos \frac{\sin\{\text{arccot}\,(1 + \tan(B + D))\} - \sin D.\sin B}{\cos D.\cos B} \qquad .....4$$

$$X = \frac{1}{15} \arccos \frac{\sin\{\text{arccot}\,(2 + \tan(B + D))\} - \sin D.\sin B}{\cos D.\cos B} \qquad .....5$$

Where:

B = latitude of place

D = longitude of place

R = reference longitude (i.e. TIME BAND x 15)

H = height above sea level (in metres)

D = declination angle of sun from celestial equator (negative in southern hemisphere)

T = equation of time

G = twilight angle

- Subuh = Z - V
- Sunrise = Z – U
- Zuhur = Z
- Asar1 (Shafi) = Z + W
- Asar2 (Hanafi) = Z + X
- Maghrib/Sunset = Z + U
- Isyak = Z + V

The algorithm to calculate T and D are not shown here. Zuhur time is calculated using Equation 1. The time for sunrise and sunset/Maghrib may be calculated by subtracting or adding 'U' (obtained from Equation 2) to the Zuhur time respectively.

Subuh and Isyak times may be calculated by subtraction or adding 'V' (obtained from Equation 3) to the Zuhur time respectively. The term G (twilight angle) in Equation 3 is usually set to 18 degrees. For a location with extreme latitude, days in summer may be so long that twilight persists between sunset and the next sunrise. Under these circumstances, 'V' is undefined and Subuh and Isyak have to be determined using agreed principles of Fiqh.

The start of Asar time (Shafi) may be obtained by adding ‘W’ (obtained from Equation 4) to Zuhur; Asar time (Hanafi) is calculated by adding ‘X’ (obtained from Equation 5) to Zuhur.

Zuhur, Asar (Shafi and Hanafi) and Maghrib times may be calculated unambiguously. But Subuh and Isyak times depend on twilight and required the adoption of a suitable *twilight angle.* Generally, a twilight angle of 18 degrees may represent a safe upper limit although opinions and practices vary. In locations at higher latitude, twilight may persist throughout the night during some months of the year.

Table 2.1 : Twilight angle of different Organization

Organization	**Subuh Twilight angle**	**Isyak Twilight angle**	**Region**
University of Islamic Sciences, Karachi	18	18	Pakistan, Bangladesh, India, Afghanistan, parts of Europe
Islamic Society of North America (ISNA)	15	15	Parts of USA & Canada, parts of UK
World Islamic League	18	17	Europe, Far East, parts of USA
Um Ul-Qura, Makkah	19	90 mins after Maghrib, 120 mins during Ramadhan	Arabian Peninsula
Egyptian General Organisation of Surveying	19.5	17.5	Africa, Syria, Iraq, Lebanon, Malaysia, parts of USA

2.4 Related work

Malaysia, in the south east part of Asia, has a geographic coordinate that reads 2° 30' North latitude and 112° 30' East longitude. Kuala Lumpur which is the capital of Malaysia is located in between 3° 10' North latitude and 101° 42' East longitude. As a result of its latitude and longitude, Malaysia stays ahead by eight hours from the Greenwich Mean Time. Malaysia has several types of landscapes for its certain latitude and longitude measurements.

Malaysia has tropical weather, influenced by monsoonal climate because of its latitude and longitude. Tropical climate here gives hot summer that is accompanied with high humidity level. But the weather in general in Malaysia is without extremities. Monsoon comes twice a year. During the summer season and the other during winter. Summer monsoon brings lots of downpour in Malaysia. Winter monsoon does not cause that much rain and is generally dry.

Locations	Latitude	Longitude
Air Hitam	01°55'N	103°11'E
Alor Setar	06°07'N	100°22'E
Ampang	03°08'N	101°45'E
Aur, Pulau	02°35'N	104°10'E
Babi Besar, Pulau	02°25'N	103°59'E
Bacuk	06°04'N	102°25'E
Bagan Datoh	03°59'N	100°47'E
Bagan Serai	05°01'N	100°32'E
Baling	05°41'N	100°55'E
Bandar Maharani/Muar	02°03'N	102°34'E
Bandar Penggaram/Batu Pahat	01°50'N	102°56'E
Bandar Sri Aman	01°15'N	111°32'E
Banggi	07°17'N	117°12'E
Batu Caves	03°15'N	101°40'E
Batu Gajah	04°28'N	101°03'E
Batu Pahat	01°50'N	102°56'E
Bau	01°25'N	110°09'E
Beaufort	05°30'N	115°40'E
Bekok	02°20'N	103°07'E
Beluran	49°50'N	86°50'E
Bentung	03°31'N	101°55'E
Betung	01°24'N	111°31'E
Bidor	04°06'N	101°15'E
Binatang/Bintangor	02°10'N	111°40'E
Bintangoe	02°10'N	111°40'E
Bintulu	03°10'N	113°00'E

Figure 2.4 : Malaysia latitude and longitude

CHAPTER 3

DESIGN AND DEVELOPMENT

3.1 Introduction

This chapter discusses the main process, hardware development and software development. In main process, it contains how to choose device can be used in this project, implement the hardware, testing and verification.

The second process is hardware development that will be discussed about the specification of device that was choosing in main process. Finally, software development process will discuss the conceptual and planning phase, development process, troubleshooting, testing and verification.

3.2 Main Process

Figure 3.1 below shows the main process of the Prayer Time Device. Literature review were done to study all devices related followed by selecting device needed. The device that was selected based on the software that must used to develop this project.

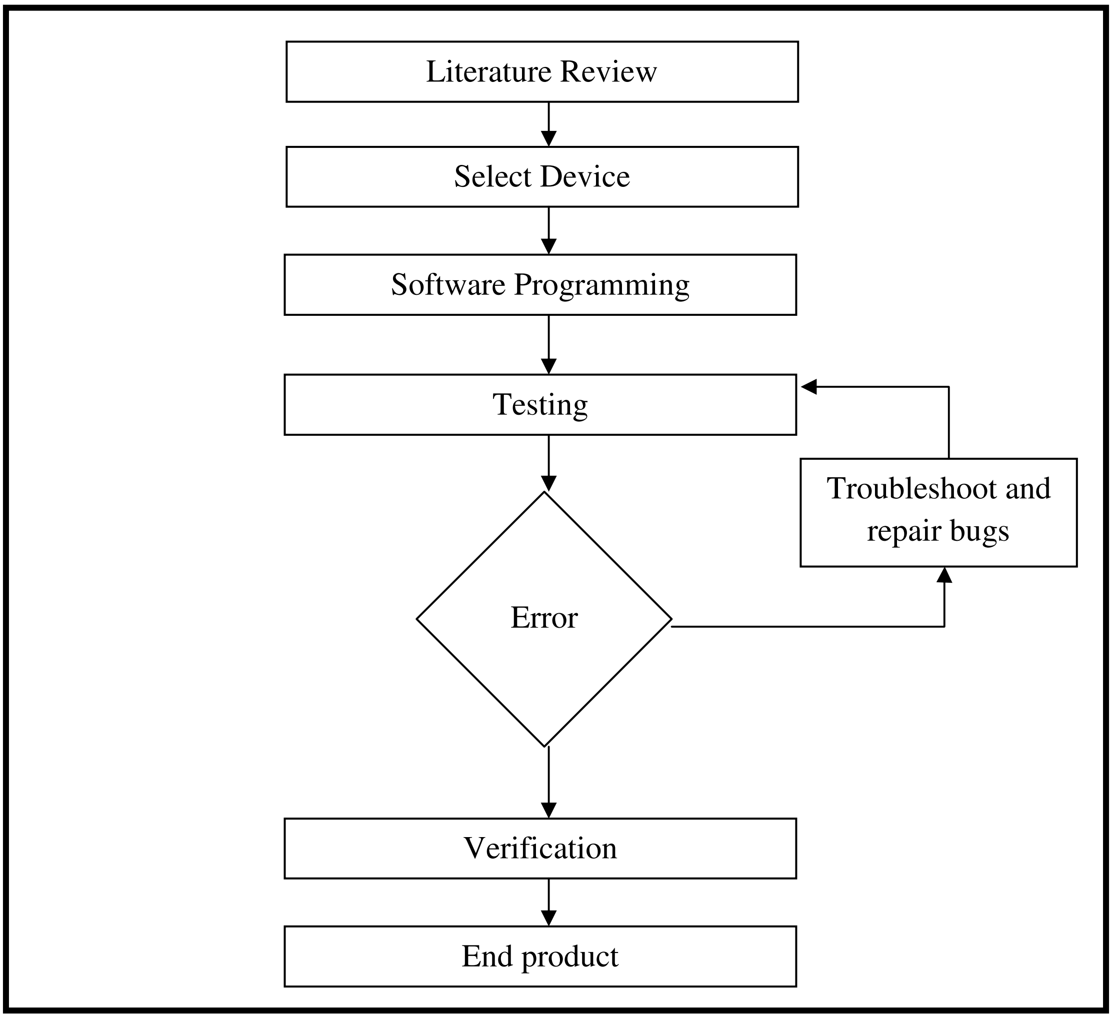


Figure 3.1 : Flow chart of Main Process

DE2 board was used in designing and implement the hardware before programming the codes in software. Testing and verifications need to be carried out to ensure the results are reliable and achieves the objectives of the project.

3.3 Hardware Development process

The device choosen is Altera DE2 board. The purpose of this board is to provide the ideal vehicle for learning about digital logic, computer organization, and FPGAs. It uses the state-of-the-art technology in both hardware and CAD tools to expose to a wide range of topics. The board offers a rich set of features that make it suitable for and a variety of design projects, as well as for the development of sophisticated digital systems.

The DE2 board features a state-of-the-art Cyclone II 2C35 FPGA in a 672-pin package. All important components on the board are connected to pins of this chip, following the user to control all aspects of the board's operation. The DE2 board includes a sufficient number of robust switches (of both toggle and push-button type), LEDs, and 7-segment displays. For more advanced experiments, there are SRAM, SDRAM, and Flash memory chips, as well as a 16 x 2 character display.

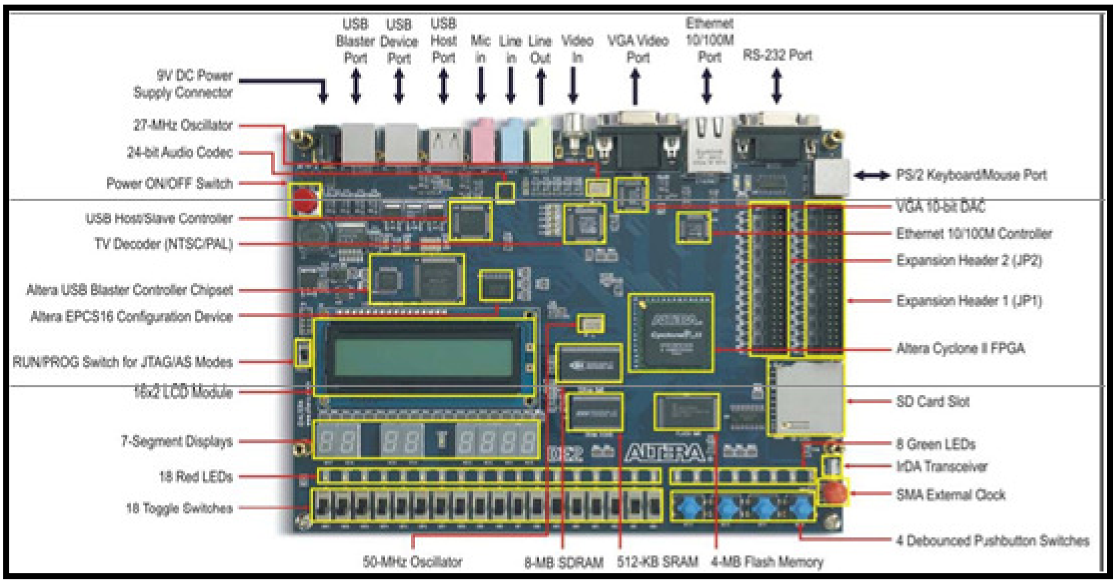


Figure 3.2 : The DE2 board

Software provided with the DE2 board features the Quartus II Web Edition CAD system, and the Nios II Embedded Processor. Also included are several aids to help userd with features of the board, such as tutorials and example applications.

Traditionally, manufacturers of educational FPGA boards have provided a variety of hardware features and software CAD tools needed to implement designs on these boards, but very little material has been offered that could be used directly for teaching purposes.

The DE2 Board has eight 7-segment displays. These displays are arranged into two pairs and a group of four, with the intent of displaying numbers of various sizes. As indicated in the schematic in Figure 3.3, the seven segments are connected to pins on the Cyclone II FPGA. Applying a low logic level to a segment causes it to light up, and applying a high logic level turns it off. Each segment in a display is identified by an index from 0 to 6, with the positions given in Figure 3.4. Note that the dot in each display is unconnected and cannot be used.

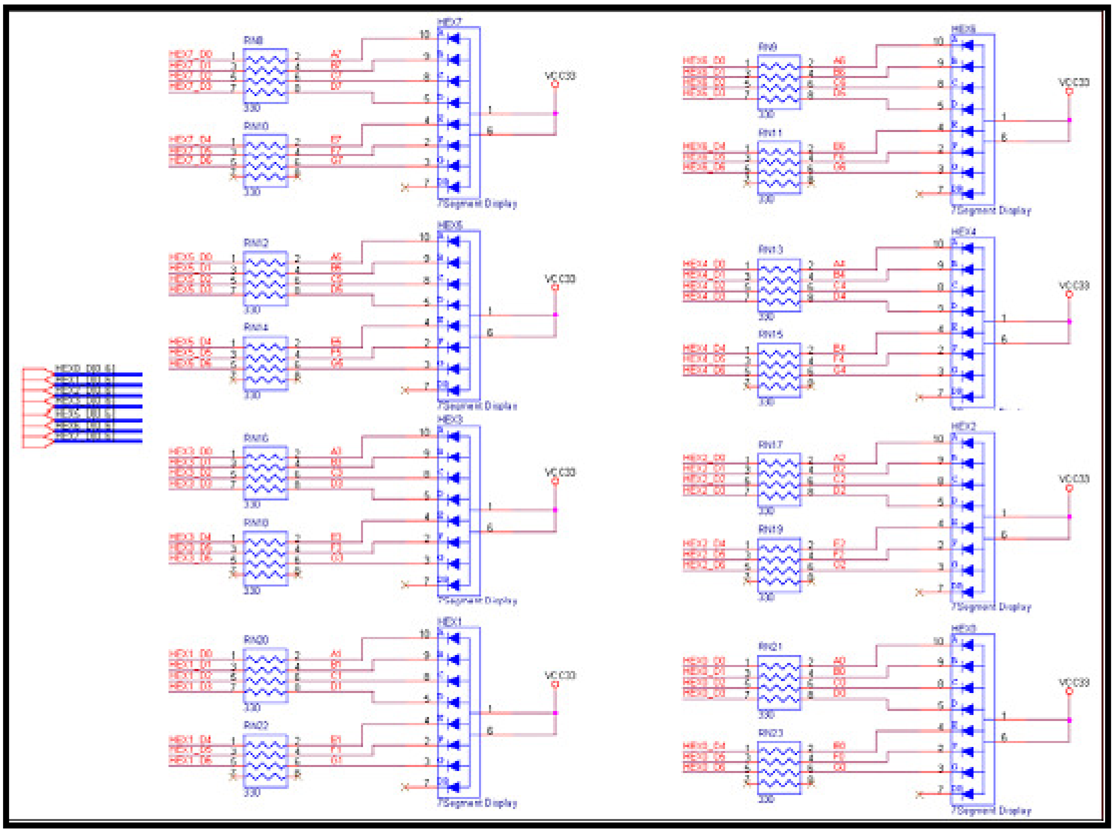


Figure 3.3 : Schematic diagram of the 7-segment displays.

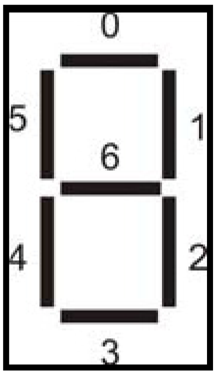


Figure 3.4 : Position and index of each segment in a 7-segment display.

The LCD module has built-in fonts and can be used to display text by sending appropriate commands to the display controller, which is called HD44780. Detailed information for using the display is available in its datasheet, which can be found on the manufacturer's web site, and from the Datasheet folder on the DE2 System CD-ROM. A schematic diagram of the LCD module showing connections to the Cyclone II FPGA is given in Figure 3.5. The associated pin assignments appear in Table 3.1.

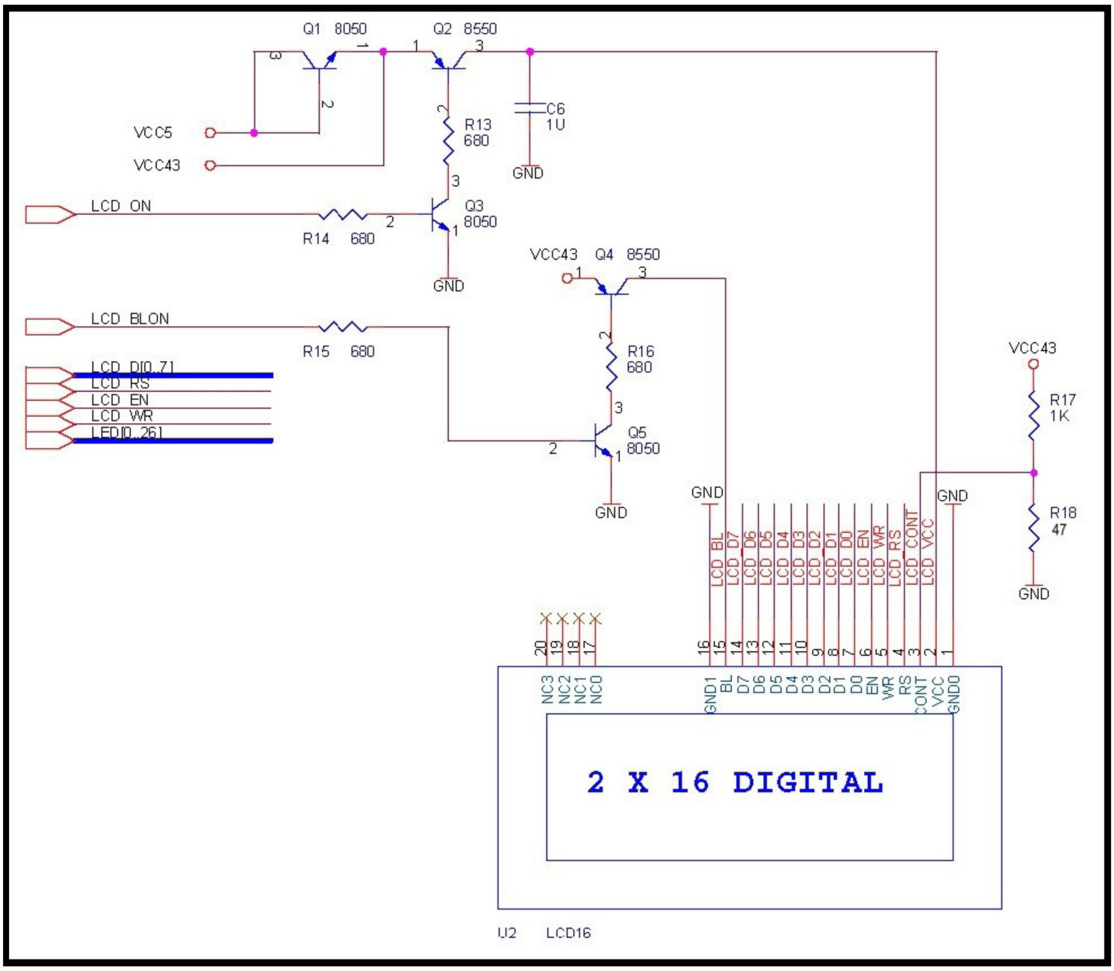


Figure 3.5 : Schematic diagram of the LCD module.

Table 3.1 : Pin assignments for the LCD module.

Signal Name	FPGA Pin No.	Description
LCD_DATA[0]	PIN_J1	LCD Data[0]
LCD_DATA[1]	PIN_J2	LCD Data[1]
LCD_DATA[2]	PIN_H1	LCD Data[2]
LCD_DATA[3]	PIN_H2	LCD Data[3]
LCD_DATA[4]	PIN_J4	LCD Data[4]
LCD_DATA[5]	PIN_J3	LCD Data[5]
LCD_DATA[6]	PIN_H4	LCD Data[6]
LCD_DATA[7]	PIN_H3	LCD Data[7]
LCD_RW	PIN_K4	LCD Read/Write Select, 0 = Write, 1 = read
LCD_EN	PIN_K3	LCD Enable
LCD_RS	PIN_K1	LCD Command/Data Select, 0 = Command, 1 = Data
LCD_ON	PIN_L4	LCD Power ON/OFF
LCD_BLON	PIN_K2	LCD Back Light ON/OFF

3.4 Software Development process

The development process of the software was done using The Spiral Model. The model originally proposed by Boehm [BOE88] is an evolutionary software process model that couples the iterative nature of prototyping with the controlled and systematic aspects of the linear sequential model. A Spiral Model is divided into a number of framework activities also called as task regions. The Development phases are as following:

- **Phase 1 : Conceptualization and Planning Phase**

  This phase is where the planning of the project is done. The specifications that are being taken are the main objective, the project scope, time frame of the development process and sources needed in accomplishing the projects.

- **Phase 2 : Development process**

  After deciding the concepts and the prerequisites of the projects, this implementation phase is done. The software design was carried out by coding the program and this phase is very time consuming.

- **Phase 3 : Troubleshooting**

  The software and the hardware are implemented together. Debugging is carried out to overcome any logical flaws in algorithm implementation.

- **Phase 4 : Testing and Verification**

  Testing and verification have to be made to ensure the softwares are reliable. Data comparisons with the standard output from other sources are applied.

CHAPTER 4

SOFTWARE DESIGN AND DEVELOPMENT

4.1 Introduction

This chapter discusses the embedded C coding, the assembly language, software development environment and detail design. A part of the declaration of the hardware is the same reason of the assembly language of the use.

For the software development environment, Quartus and Nios was chooses. It is because for the Altera hardware need to use Altera software tool to make it will program successfully. For the software development environment, Quartus and Nios were chooses. It is because so that the necessity of the Altera hardware it uses the tool of the Altera software to do will program successfully it. In detail design, it will demonstrate that the design has become and to elaborate the function for that product.

4.2 Embedded C programming

The software part presented is written in C high-level language. C that it programs provides really more convenience for the new users reducing to the minimum the necessity to understand the architecture of the microcontroller itself of the detail and to stress more in the programming algorithms. This means that the C programming can help the user to focus of how making a routine functional to smoothly work the code rather that spends the time that thinks about where to put the data and the code.

With C high-level programming, the users they will only need to know how to write the code rather than to knowing how the microcontroller executes codes to the wished result. Inevitable which it continues being a necessity to understand the architectonic structures of registries and the file of data of the microcontroller, the users can make use the structure of C programming language save more hour studying the codes for LCD, seven segments, microcontroller and the ways to integrate them together.

4.3 Assembly language

Apart from the complexity of assemble code, assembly language is important in the microcontroller where it allows users to supervise each aspect of the program. Another advantage of the assembly language is the resources available in the Internet where one can just download most of the demo and example code in this language format. The disadvantage of the C code language is that the compiled size is generally more length than assembly language. In this project, verilog was used like assembly language.

4.4 Software Development environment

For this project, there is development with two aspects that are development of hardware and software. For the hardware development, Quartus of Altera's software is used with verilog language to declare the hardware. By the way, software development cannot the same software because it does not have equal like the hardware. Nios also as Altera's software used for develops the software development that is using programming C code programming language.

4.4.1 Altera Quartus II environment

For Quartus environment, Computer Aided Design (CAD) software makes it easy to implement a desired logic circuit by using a programmable logic device, such as a field-programmable gate array (FPGA) chip. A typical FPGA CAD flow is illustrated in Figure 4.1.

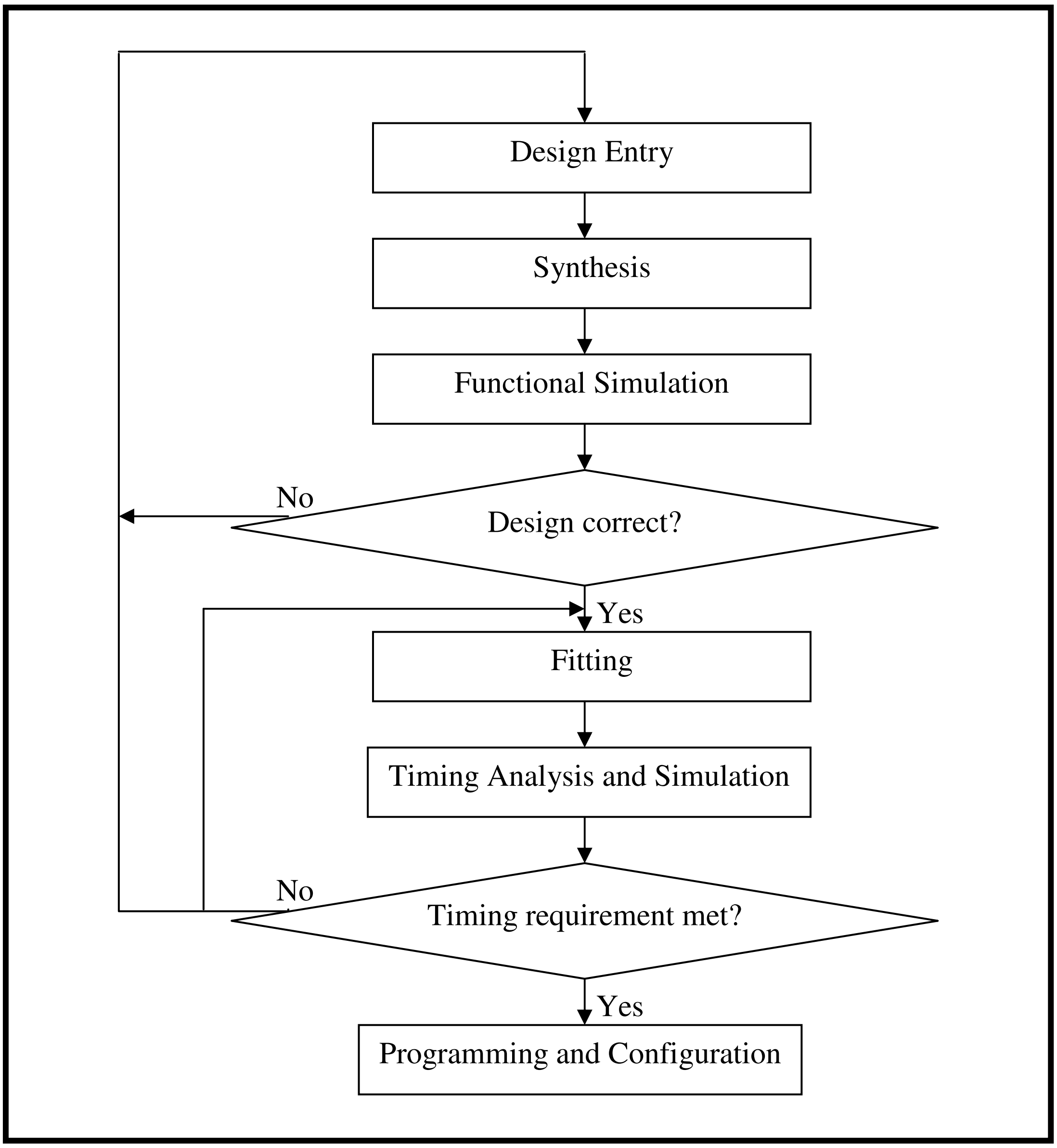


Figure 4.1 : Typical CAD flow chart

It involves the following basic steps:

- **Design Entry**

  The desired circuit is specified either by using a hardware description language, such as Verilog or VHDL, or by means of a schematic diagram.

- **Synthesis**

  The CAD Synthesis tool synthesizes the circuit into a netlist that gives the logic elements (LEs) needed to realize the circuit and the connections between the LEs.

- **Functional Simulation**

  The synthesized circuit is tested to verify its functional correctness; the simulation does not take into account any timing issues.

- **Fitting**

  The CAD Fitter tool determines the placement of the LEs defined in the netlist into the LEs in an actual FPGA chip; it also chooses routing wires in the chip to make the required connections between specific LEs.

- **Timing Analysis**

  Propagation delays along the various paths in the fitted circuit are analyzed to provide an indication of the expected performance of the circuit.

- **Timing Simulation**

  The fitted circuit is tested to verify both its functional correctness and timing.

- **Programming and Configuration**

  The designed circuit is implemented in a physical FPGA chip by programming the configuration switches that configure the LEs and establish the required wiring connections.

4.4.2 Altera Nios II environment

For Nios environment, have the System Navigator product which is supports JTAG-based debugging of the Altera Nios II processor core. By referring to the Figure 4.2 below, the product consists of hardware and software. The software consists of a host Application Binary Interface (ABI), Command-Line Interface (CLI), optional source-level debugger and the FS2 windows for supporting the product hardware features. The hardware includes Nios II OCI (On-Chip Instrumentation) and the FS2 System Navigator Family of probes.

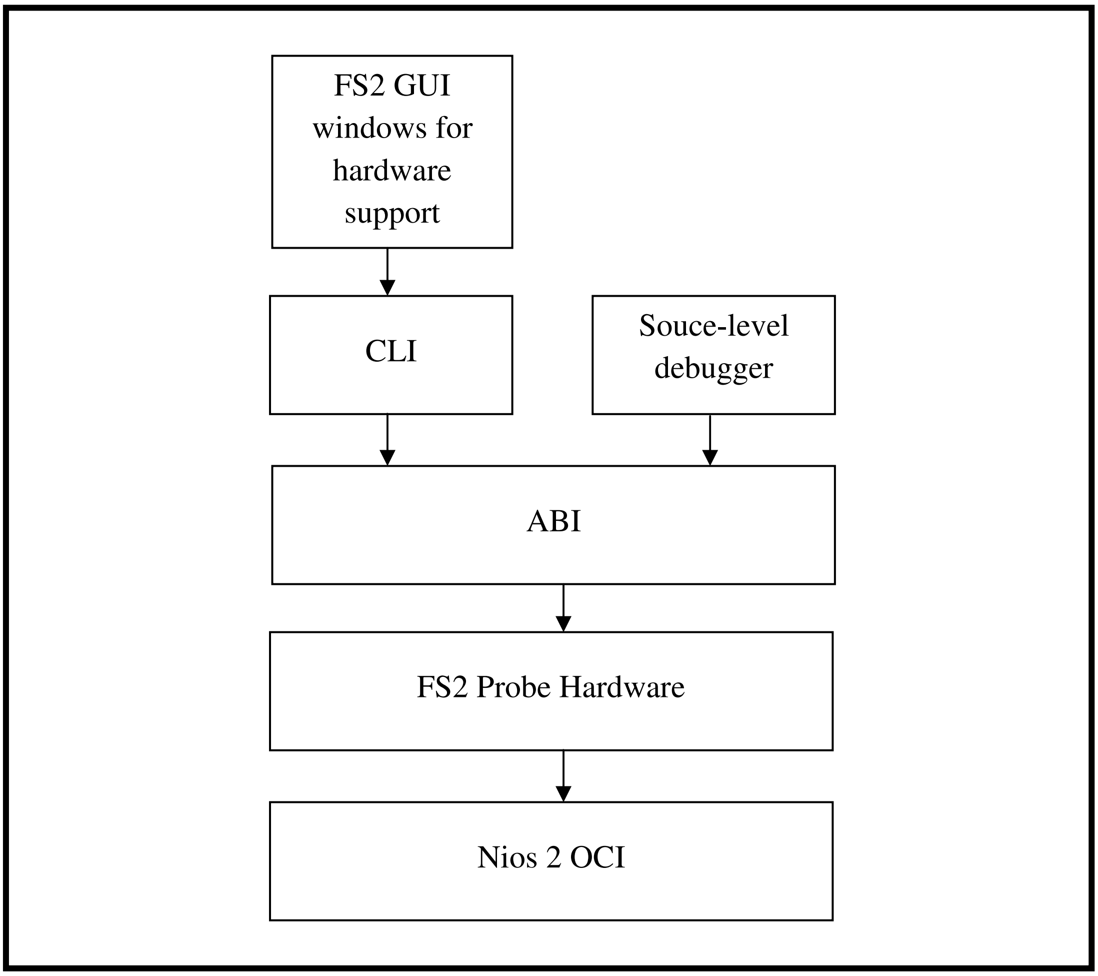
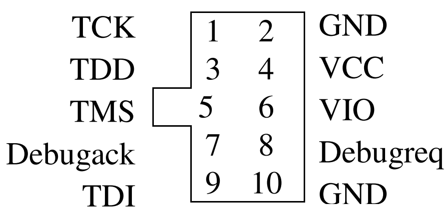


Figure 4.2 : Nios Hardware and Software interface

The CLI can be used as both a user interface and as a means of automating sequences of tasks. It is based on TCL/TK, a widely used command language and GUI builder. A number of command primitives and Tcl procedures have been added to customize Tcl for this application. Commands are included for system configuration, emulation control, memory access including an assembler and disassembler, register access, trace and trigger access, file download, and status indication.

The probe uses a 10-position flat ribbon cable with standard 0.100” square post headers. A connector with an orientation key such as 3M 2510-6002UB is recommended. The pinout of the target connector is described in the Table 4.1 below.

Table 4.1 : Pinout of the target connector



Pin	Signal	I/O	Active	Comments
2, 10	GND	--	--	Signal reference
4	VCC	I	--	Power source for debugger (Not used by System Navigator)
6	VIO	I	--	Used by debugger to determine target power-on state.
1	TCK	O	H	JTAG test clock
3	TDO	I	H	JTAG test data output
5	TMS	O	H	JTAG test mode select
9	TDI	O	H	JTAG test data input
7	Debugack	I	H	Optional signal indicating CPU is in debug mode
8	Debugreq	O	H	Debug interrupt request (optional)

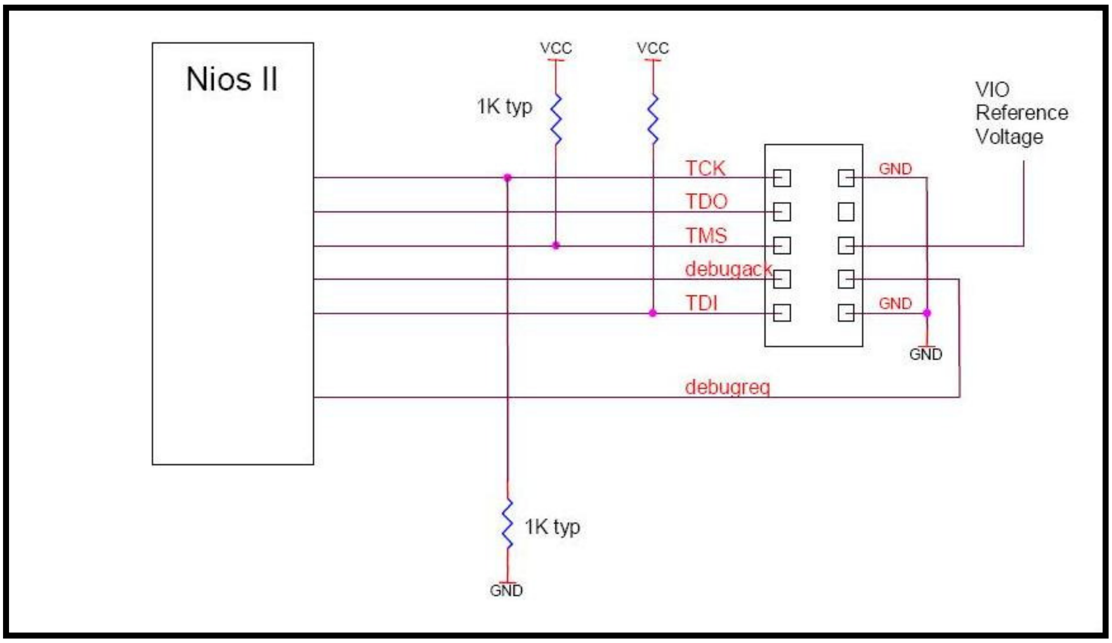


Figure 4.3 : JTAG connector

If the Nios II processor is part of a chain of JTAG devices, whether all on the same physical chip or on separate chips, the devices should be connected in a daisy-chain with TCK and TMS common to all devices and TDO from one device leading to TDI of the next.

For targets that include the off-chip Trace Port, FS2 provides the System Navigator Original Edition (OE/T) probe with a high-speed ribbonized coax connection to the target. Trace data is compressed then multiplexed onto this cable. The probe demultiplexes the trace data and stores it in high-speed SRAM. Off-chip trace is typically much deeper than on-chip trace but requires use of several chip I/O pads.

4.5 Detail Design

Before the Prayer Time constructed, some of the requirements need to know first. This is because to do that successfully it works without any error. The requirements need to know are year, month, day, time, minute and location. The Prayer Time developed is based on flow chart in Figure 4.4 to works correctly whereas we wanted that it did.

Based on the flow chart below, year, month, day, hour, minute and location need to insert manually. Once you push the Mode button, it will loop until the location inserted. After all requirements inserted, the time and the prayer time will exhibit in seven segments in DE2 board. One of 16 LEDs will blink as second indicator. If the time and the prayer time are equal, 16 LEDs blinking in 60 seconds together. After that, the next prayer time will exhibit like Subuh, Zohor, Asar, Maghrib and Isyak respectively. Continuously direct operation until it is the energy unplugs.

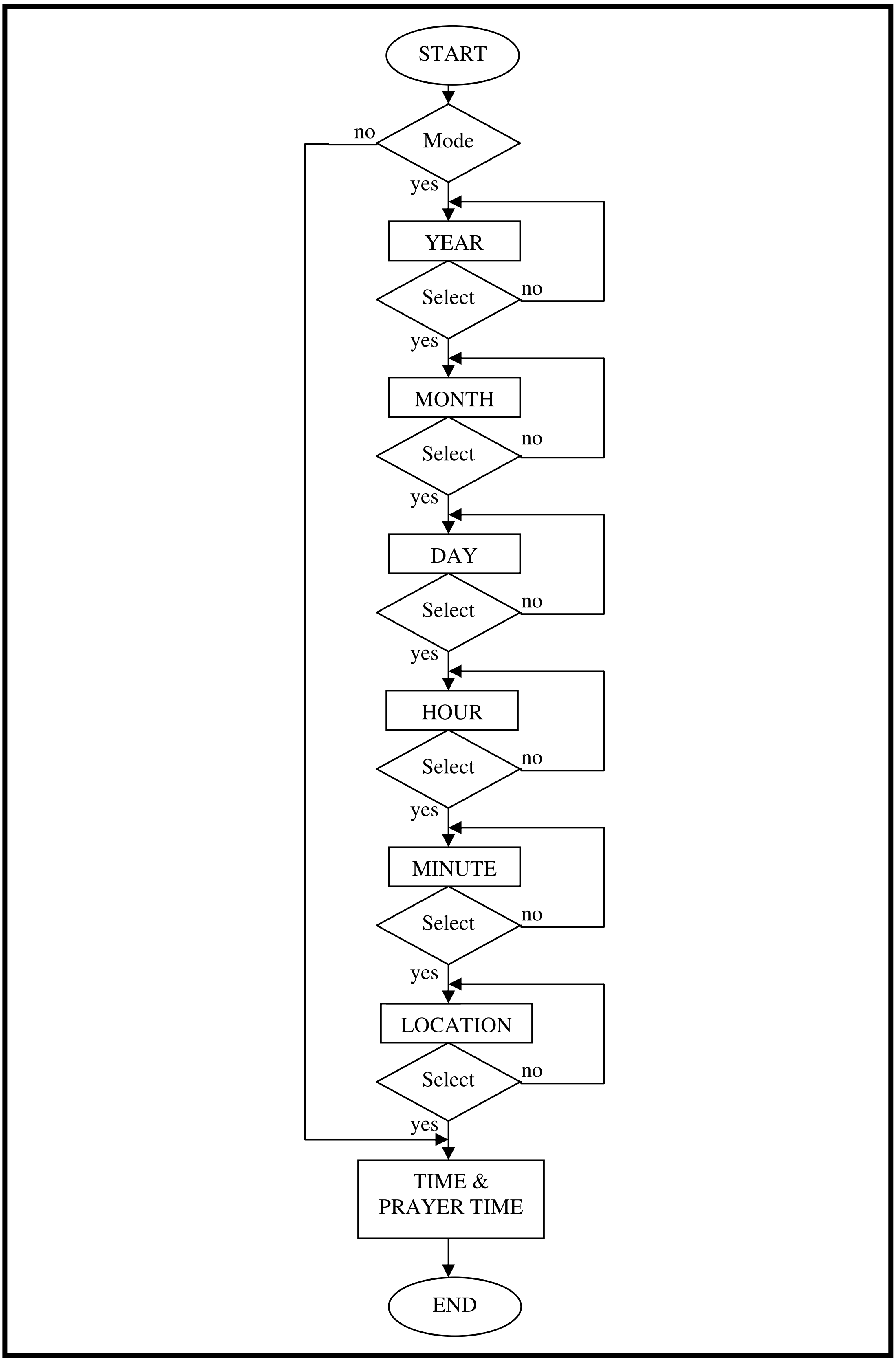


Figure 4.4 : Prayer Time flow chart

CHAPTER 5

RESULT AND DISCUSSION

5.1 Introduction

This chapter discusses on the device, working the device, seeing the prayer times, fits the date, location and time. For the device it mainly discussed the component in DE2 board are used. In the operation of the device it discusses how to know that the device begins.

In seeing the prayer time, it will discuss how the time of the prayer can be recognized. According to adjustment the date, time and location it is demonstrations like user manual.

5.2 The Device

The device in Figure 5.1 shows the DE2 board where use LCD, red LEDs, seven segments and push button are. The LCD will display the prayer time which are

Subuh, Zohor, Asar, Maghrib and Isyak. The seven segments will display number for year, month, day, hour, minute, time and prayer time. Furthermore, all sixteen red LEDs are used to indicate the time for pray. Besides that, all four push buttons are used as input which are Mode, Select, Back and Next. The figure below shows the specification was discussed above.

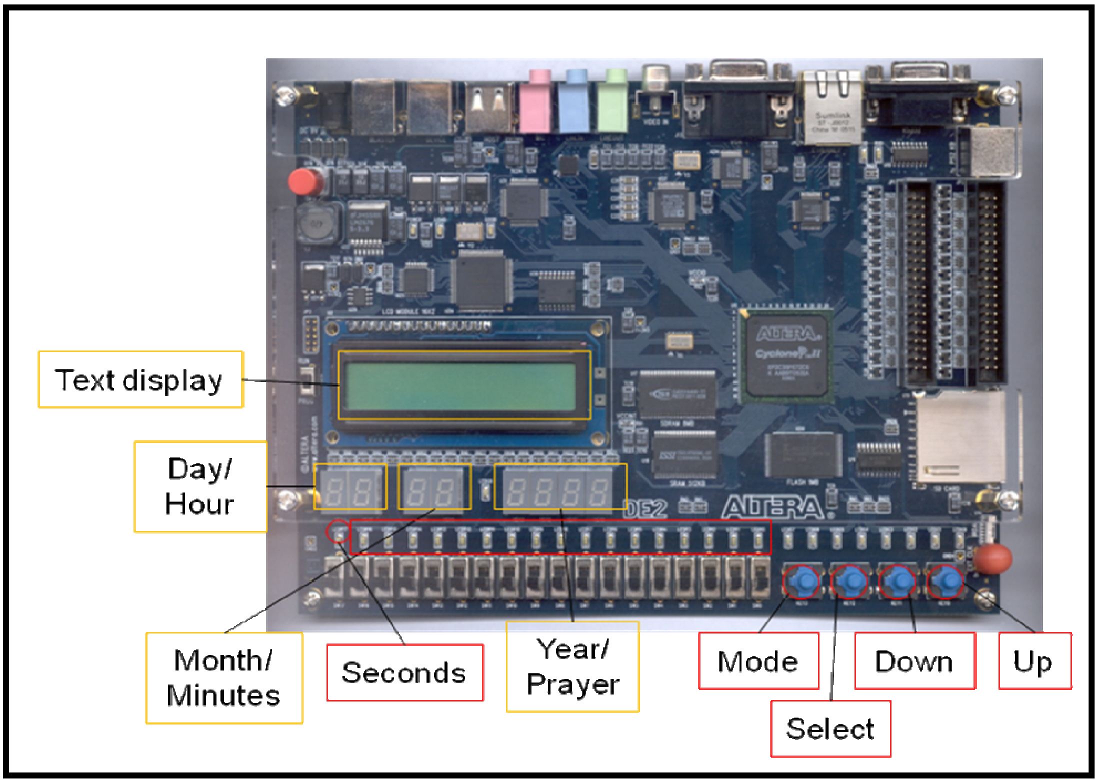


Figure 5.1 : I/O configuration on DE2 board

5.3 Working The Device

The device has been develop need to know either it will operation successful or not. For this Prayer Time, it will display “PRAYER TIME” at the first row and the second row will display “By : AZMAN” which is mean the device is begin the operation. After that, it will display seven segments as time and prayer time and also one of sixteen LEDs where it is at left hand side from user.

Figure 5.2 : Begin operation

5.4 Seeing the Prayer Times

After all of the requirements are inserted, this device will display prayer times which are Subuh, Syuruk, Zohor, Asar, Maghrib and Isyak respectively. It will display one prayer time in one time only. For this case, if the time is same with prayer time all red LEDs will blink in one minute. If the prayer time was past, it will display the next prayer time.

Figure 5.3 : Prayer Time displayed

5.5 Fits the Date

This device is depending on date where it will calculate automatically if date was inserted. The calculation will match with equation of time and declination angle where it is also depending on earth moving. For adjusting the date, the figure below will display as user manual for that.

Figure 5.4 : Setting year

Figure 5.5 : Setting month

Figure 5.6 : Setting day

After Figure 5.4 displayed, user need to press Back or Next at push buttons. If users press Back, the seven segments will count down until the user stop to press it. For press Next, the seven segments will count up until the user stop to press it too.

After the year was set, user needs to press Select at push button to display at Figure 5.5 for set the month. The procedures are same like before where user need to press Back or Next at push buttons. If users press Back, the seven segments will count down until the user stop to press it. For press Next, the seven segments will count up until the user stop to press it too.

After the month was set, user needs to press Select at push button again to display at Figure 5.6 for set the day. The procedures are same like before where user need to press Back or Next at push buttons. If users press Back, the seven segments will count down until the user stop to press it. For press Next, the seven segments will count up until the user stop to press it too.

5.6 Fits the Time

Time is very important to in all devices are depending on clock. In this case, clock is needs to determine that time for prayer was past or not. Without time, this Prayer Time will not running properly as programmed. For adjusting the time, the figure below will display as user manual for that.

Figure 5.7 : Setting hour

Figure 5.8 : Setting minute

After Figure 5.7 displayed, this mean it is time to set the time for hour. The procedures are same like before where user need to press Back or Next at push buttons. If users press Back, the seven segments will count down until the user stop to press it. For press Next, the seven segments will count up until the user stop to press it too.

After the hour was set, user needs to press Select at push button again to display at Figure 5.8 for set the day. The procedures are same like before where user need to press Back or Next at push buttons. If users press Back, the seven segments will count down until the user stop to press it. For press Next, the seven segments will count up until the user stop to press it too.

5.7 Fits the Location

In this prayer time, locations are important too like time. This is because, without location, prayer time is nothing use because it is also depending on location too. For this project there are seven locations are programmed to DE2 board which are Batu Pahat, Johore Bahru, Kota Tinggi, Mersing, Muar, Pontian and Segamat.

For the default location is Batu Pahat. If users press Back, the location displayed will reverse alphabet respectively until the user stop to press it. For press Next, the location displayed will forward alphabet respectively until the user stop to press it too. The Figure was discussed above will displayed below as reference.

Figure 5.9 : Location displayed

5.8 Discussion

In Malaysia, most of the Malaysians are Muslim. That why some of the organization exists to guide and protecting human right from some human want to diversion and will blind the human right or illegal. A familiar of the organization in Malaysia is Jabatan Kemajuan Islam Malaysia (JAKIM). Any things who want to build dependent on religion, Islam mostly need to use their procedure.

Return back to the Prayer Time device, it is need to use JAKIM guide if it want to market widely. It is because, to valid that time for prayer especially during Ramadhan also known as fasting month for sure to eat after fasting a whole day. For this situation, we used JAKIM as our reference prayer time. Unfortunately this end product is not accurately like JAKIM's prayer time. It is rounded about more or less 2 minutes for Subuh, Maghrib and Isyak although used twilight angle are 20° and 18° for Subuh and Isyak respectively.

CHAPTER 6

CONCLUSION AND FURTHER WORK

6.1 Conclusion

This project offers simple and efficient way to find the Prayer Time based on knowing the location of that area. The portable and automated design make it as a device that be used in any places, bulky and some needs Internet connection to get this service.

The user friendly interface and simple instruction will help people in getting fast result in any places at any time without having using other resources. It is also using the same calculation method with Jabatan Kemajuan Islam Malaysia (JAKIM) where as 20° and 18° twilight angle for Subuh and Isyak respectively.

Unfortunately, this Prayer Time Device uses only 9V DC Wall-mount power supply makes it hard to use at any places without socket plug. In another weakness of this device is date, time andcurrent location have to be inserted manually by user every time to operate the system. The recommendation part will discuss on how to improve the weakness and ways to make the device better.

6.2 Further Work

The project develop is functioning well with no error. However, the development of Prayer Time device can be improved to a more advanced and better application in further. For further improvement, several suggestions are proposed:

- Automatic Input

By using the Global Positioning System (GPS), date, time and location can be set automatically by connecting GPS with the DB-9 serial connector and interface with RS-232 to the DE2 board.

- Better Hardware used

The device can be use smaller than DE2 board or build on their own but it is still using this concept. In another way, this project will build in with battery for easy used. It will smaller (pocket size) and easier to bring the device anywhere.

- Add function

This device can be multipurpose device, not only determining the Prayer Time but also can show Hijrah Calendar. It can also be a table watch with alarm function and so forth.

- Use memory to store data

This device will need to insert date, time and location for the first time used where all the first data will stored in temporary Read-Only Memory (ROM) although the device doesn’t have power to make it easy to use again.

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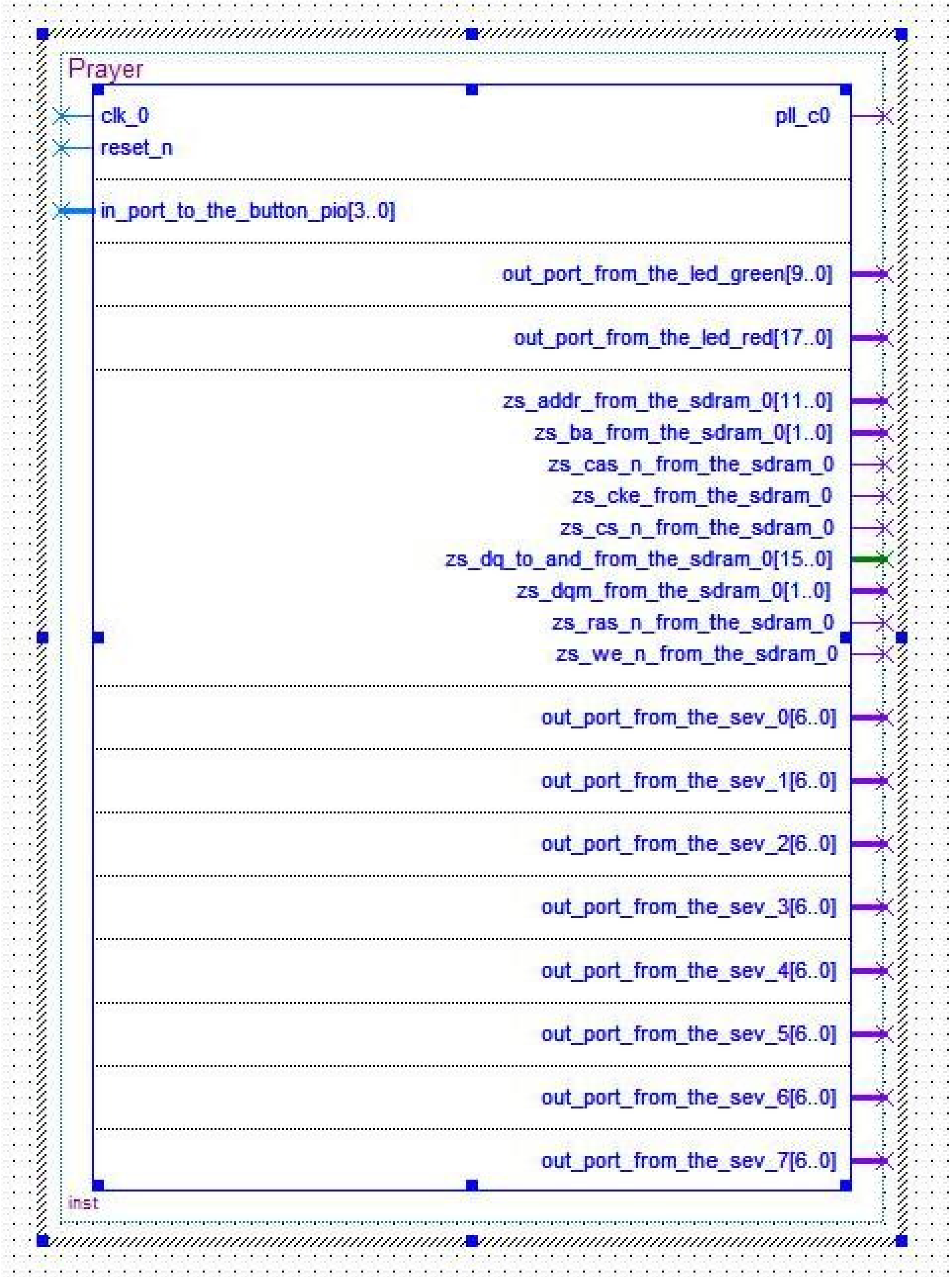
APPENDIX A

Hardware schematic diagram


Prayer
clk_0
reset_n
pll_c0
in_port_to_the_button_pio[3..0]
out_port_from_the_led_green[9..0]
out_port_from_the_led_red[17..0]
zs_addr_from_the_sdram_0[11..0]
zs_ba_from_the_sdram_0[1..0]
zs_cas_n_from_the_sdram_0
zs_cke_from_the_sdram_0
zs_cs_n_from_the_sdram_0
zs_dq_to_and_from_the_sdram_0[15..0]
zs_dqm_from_the_sdram_0[1..0]
zs_ras_n_from_the_sdram_0
zs_we_n_from_the_sdram_0
out_port_from_the_sev_0[6..0]
out_port_from_the_sev_1[6..0]
out_port_from_the_sev_2[6..0]
out_port_from_the_sev_3[6..0]
out_port_from_the_sev_4[6..0]
out_port_from_the_sev_5[6..0]
out_port_from_the_sev_6[6..0]
out_port_from_the_sev_7[6..0]
inst

APPENDIX B

Programming In C Language

a. *prayer.c* (Top-level file)

```
#include <stdio.h>
#include <math.h>
#include <unistd.h>
#include "altera_avalon_pio_regs.h"
#include "system.h"
#include "DE2.hch"
#include "header.h"

void main(void)
{
    int i,time,sub,syu,zho,asr,mag,isy;
    int h3,h2,h1,h0;
    int day,min,hour,lat,lon;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
    line = hex2ascii() @ sp @ sp @ sp @ P @ R @ A @ Y @ E @ R @ sp @
T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ B @ y @ sp @ : @ sp @ A @ Z
@ M @ A @ N @ blank_line<-152;
    DE2LCDDriver(line);

    DE2_SDRAM SDRAM;
    DE2ReadSDRAM(0x000003, hour, SDRAM);
    DE2ReadSDRAM(0x000004, min, SDRAM);
    DE2SDRAMDriver(&SDRAM);

    time=(hour*100)+min;


    while(1){
        DE2_SDRAM SDRAM;
        DE2ReadSDRAM(0x000005, sub, SDRAM);
        DE2ReadSDRAM(0x000006, syu, SDRAM);
        DE2ReadSDRAM(0x000007, zho, SDRAM);
        DE2ReadSDRAM(0x000008, asr, SDRAM);
        DE2ReadSDRAM(0x000009, mag, SDRAM);
        DE2ReadSDRAM(0x00000A, isy, SDRAM);
        DE2ReadSDRAM(0x00000B, lat, SDRAM);
        DE2ReadSDRAM(0x00000C, lon, SDRAM);
        DE2SDRAMDriver(&SDRAM);

        //real-time prayer
         while(i<60){
            if(button=0x7){
                tahun();
                bulan();
                hari();
                jam();
                minit();
                location();
                calc();
            }

               if(time>isy){
                    //display sub
                    DE2_LCD_LINE line;
```

```
                    line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ S
@ U @ B @ U @ H @ blank_line<-152;
                    DE2LCDDriver(line);

                    h3=sub/1000;
                    h2=(sub-(h3*1000))/100;
                    h1=(sub-(h3*1000)-(h2*100))/10;
                    h0=sub-(h3*1000)-(h2*100)-(h1*10);

                    h3=display(h3);
                    h2=display(h2);
                    h1=display(h1);
                    h0=display(h0);

                    DE2Set7SegDigit(3,h3);
                    DE2Set7SegDigit(2,h2);
                    DE2Set7SegDigit(1,h1);
                    DE2Set7SegDigit(0,h0);

                }

                else if(time>sub){
                    //display syu
                    DE2_LCD_LINE line;
                    line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ S @ Y
@ U @ R @ U @ K @ blank_line<-152;
                    DE2LCDDriver(line);

                    h3=syu/1000;
                    h2=(syu-(h3*1000))/100;
                    h1=(syu-(h3*1000)-(h2*100))/10;
                    h0=syu-(h3*1000)-(h2*100)-(h1*10);

                    h3=display(h3);
                    h2=display(h2);
                    h1=display(h1);
                    h0=display(h0);

                    DE2Set7SegDigit(3,h3);
                    DE2Set7SegDigit(2,h2);
                    DE2Set7SegDigit(1,h1);
                    DE2Set7SegDigit(0,h0);

                }

                else if(time>syu){

                    //display zho
                    DE2_LCD_LINE line;
                    line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ Z
@ O @ H @ O @ R @ blank_line<-152;
                    DE2LCDDriver(line);

                    h3=zho/1000;
                    h2=(zho-(h3*1000))/100;
                    h1=(zho-(h3*1000)-(h2*100))/10;
                    h0=zho-(h3*1000)-(h2*100)-(h1*10);
```

```
                h3=display(h3);
                h2=display(h2);
                h1=display(h1);
                h0=display(h0);

                DE2Set7SegDigit(3,h3);
                DE2Set7SegDigit(2,h2);
                DE2Set7SegDigit(1,h1);
                DE2Set7SegDigit(0,h0);

            }

            else if(time>zho){
                //display asr
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ A
@ S @ A @ R @ blank_line<-152;
                DE2LCDDriver(line);

                h3=asr/1000;
                h2=(asr-(h3*1000))/100;
                h1=(asr-(h3*1000)-(h2*100))/10;
                h0=asr-(h3*1000)-(h2*100)-(h1*10);

                h3=display(h3);
                h2=display(h2);
                h1=display(h1);
                h0=display(h0);

                DE2Set7SegDigit(3,h3);
                DE2Set7SegDigit(2,h2);
                DE2Set7SegDigit(1,h1);
                DE2Set7SegDigit(0,h0);

            }

            else if(time>asr){
                //display mag
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ M @ A
@ G @ H @ R @ I @ B @ blank_line<-152;
                DE2LCDDriver(line);

                h3=mag/1000;
                h2=(mag-(h3*1000))/100;
                h1=(mag-(h3*1000)-(h2*100))/10;
                h0=mag-(h3*1000)-(h2*100)-(h1*10);

                h3=display(h3);
                h2=display(h2);
                h1=display(h1);
                h0=display(h0);

                DE2Set7SegDigit(3,h3);
                DE2Set7SegDigit(2,h2);
                DE2Set7SegDigit(1,h1);
                DE2Set7SegDigit(0,h0);

            }
```

```
                else if(time>mag){
                    //display isy
                    DE2_LCD_LINE line;
                    line = hex2ascii() @ sp @ sp @ P @ R @ A @ Y @ E
@ R @ sp @ T @ I @ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ I
@ S @ Y @ A @ K @ blank_line<-152;
                    DE2LCDDriver(line);

                    h3=isy/1000;
                    h2=(isy-(h3*1000))/100;
                    h1=(isy-(h3*1000)-(h2*100))/10;
                    h0=isy-(h3*1000)-(h2*100)-(h1*10);

                    h3=display(h3);
                    h2=display(h2);
                    h1=display(h1);
                    h0=display(h0);

                    DE2Set7SegDigit(3,h3);
                    DE2Set7SegDigit(2,h2);
                    DE2Set7SegDigit(1,h1);
                    DE2Set7SegDigit(0,h0);

                }


if((time==sub)||(time==zho)||(time==asr)||(time==mag)||(time==isy)){

IOWR_ALTERA_AVALON_PIO_DATA(LED_RED_BASE,0xFFFF);

IOWR_ALTERA_AVALON_PIO_DATA(LED_RED_BASE,0x0000);}

                else{

IOWR_ALTERA_AVALON_PIO_DATA(LED_RED_BASE,0x8000);

IOWR_ALTERA_AVALON_PIO_DATA(LED_RED_BASE,0x0000);}

                h3=time/1000;
                h2=(time-(h3*1000))/100;
                h1=(time-(h3*1000)-(h2*100))/10;
                h0=time-(h3*1000)-(h2*100)-(h1*10);

                h3=display(h3);
                h2=display(h2);
                h1=display(h1);
                h0=display(h0);

                DE2Set7SegDigit(7,h3);
                DE2Set7SegDigit(6,h2);
                DE2Set7SegDigit(5,h1);
                DE2Set7SegDigit(4,h0);

                i++;
         }i=0;
         min++;
         if (min>59){
            min=0;
            hour++;
            if (hour>23){
```

```
                hour=0;
                day++;
                DE2_SDRAM SDRAM;
                DE2WriteSDRAM(0x000002, day, SDRAM);
                DE2SDRAMDriver(&SDRAM);
                calc();
            }

        }

        DE2_SDRAM SDRAM;
        DE2WriteSDRAM(0x000004, min, SDRAM);
        DE2WriteSDRAM(0x000003, hour, SDRAM);
        DE2SDRAMDriver(&SDRAM);
        time=(hour*100)+min;
    }
}
```

b. *header.h*

```
#ifndef HEADER_H_
#define HEADER_H_

int display(int);
void tahun(void);
void bulan(void);
void hari(void);
void jam(void);
void minit(void);
void location(void);
void calc(void);


#endif /* HEADER_H_ */
```

c. *header.c*

```
#include "altera_avalon_pio_regs.h"
#include "system.h"
#include "DE2.hch"
#include <math.h>

#define d2r 0.017453292519943295769236907684889  //degrees to radians
#define r2d 57.2957795130823208767981548141O5   //radians to degrees

int display(int a)          //display seven segment
{
    int h;
        if (a==0)
            h=0x0;
        if (a==1)
            h=0x1;
        if (a==2)
            h=0x2;
        if (a==3)
            h=0x3;
        if (a==4)
            h=0x4;
        if (a==5)
            h=0x5;
        if (a==6)
            h=0x6;
        if (a==7)
            h=0x7;
        if (a==8)
            h=0x8;
        if (a==9)
            h=0x9;

   return h;
}




void tahun(void)           //display year
{
    int a0,a1,a2,a3;
    int tahun;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
    line = hex2ascii() @ sp @ sp @ sp @ sp @ S @ E @ T @ sp @ D @ A
@ T @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ Y @ E @
A @ R @ blank_line<-152;
    DE2LCDDriver(line);

   while(1){
            DE2_SDRAM SDRAM;
            DE2ReadSDRAM(0x000000, tahun, SDRAM);   //tahun<=memory
            DE2SDRAMDriver(&SDRAM);

        //next button
        while(button=0xE){
```

```
    if(tahun>2060){
        tahun=2010;}

    a3=tahun/1000;
    a2=(tahun-(a3*1000))/100;
    a1=(tahun-(a3*1000)-(a2*100))/10;
    a0=tahun-(a3*1000)-(a2*100)-(a1*10);

    a3=display(a3);
    a2=display(a2);
    a1=display(a1);
    a0=display(a0);

    DE2Set7SegDigit(3,a3);
    DE2Set7SegDigit(2,a2);
    DE2Set7SegDigit(1,a1);
    DE2Set7SegDigit(0,a0);
    DE2Disable7Seg(7);
    DE2Disable7Seg(6);
    DE2Disable7Seg(5);
    DE2Disable7Seg(4);

    DE2_SDRAM SDRAM;
    DE2WriteSDRAM(0x000000, tahun, SDRAM);   //memory<=tahun
    DE2SDRAMDriver(&SDRAM);
    tahun++;
}

//previous button
while(button=0xD){

    if(tahun<2010){
        tahun=2060;}

    a3=tahun/1000;
    a2=(tahun-(a3*1000))/100;
    a1=(tahun-(a3*1000)-(a2*100))/10;
    a0=tahun-(a3*1000)-(a2*100)-(a1*10);

    a3=display(a3);
    a2=display(a2);
    a1=display(a1);
    a0=display(a0);

    DE2Set7SegDigit(3,a3);
    DE2Set7SegDigit(2,a2);
    DE2Set7SegDigit(1,a1);
    DE2Set7SegDigit(0,a0);
    DE2Disable7Seg(7);
    DE2Disable7Seg(6);
    DE2Disable7Seg(5);
    DE2Disable7Seg(4);

    DE2_SDRAM SDRAM;
    DE2WriteSDRAM(0x000000, tahun, SDRAM);   //memory<=tahun
    DE2SDRAMDriver(&SDRAM);
    tahun--;
}

//return to main
```

```
        if(button=0xB){
            return;}
    }


}




void bulan(void)            //display month
{

    int bulan;
    int a0,a1,day;
    int mon[13]={0,31,28,31,30,31,30,31,31,30,31,30,31};
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
    line = hex2ascii() @ sp @ sp @ sp @ sp @ S @ E @ T @ sp @ D @ A
@ T @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ M @ O @ N @ T
@ H @ blank_line<-152;
    DE2LCDDriver(line);

    while(1){

        DE2_SDRAM SDRAM;
        DE2ReadSDRAM(0x000001, bulan, SDRAM);      //bulan<=memory
        DE2SDRAMDriver(&SDRAM);

        //next button
        while(button=0xE){
            if(bulan>12){
                bulan=1;}

            a1=bulan/10;
            a0=bulan-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(5,a1);
            DE2Set7SegDigit(4,a0);
            DE2Disable7Seg(7);
            DE2Disable7Seg(6);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000001, bulan, SDRAM);  //memory<=bulan
            DE2SDRAMDriver(&SDRAM);
            bulan++;
        }

        //previous button
        while(button=0xD){

            if(bulan<1){
```

```
                bulan=12;}

            a1=bulan/10;
            a0=bulan-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(5,a1);
            DE2Set7SegDigit(4,a0);
            DE2Disable7Seg(7);
            DE2Disable7Seg(6);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000001, bulan, SDRAM);  //memory<=bulan
            DE2SDRAMDriver(&SDRAM);
            bulan--;
        }

        //go to hari
            day=mon[bulan];

        //return to main
        if(button=0xB){
            return;}
    }
}



void hari(void)             //display day
{
    int a0,a1,day;
    int hari;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
    line = hex2ascii() @ sp @ sp @ sp @ sp @ S @ E @ T @ sp @ D @ A
@ T @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ D @
A @ Y @ blank_line<-152;
    DE2LCDDriver(line);

    while(1){

        DE2_SDRAM SDRAM;
        DE2ReadSDRAM(0x000002, day, SDRAM); //day<=memory
        DE2SDRAMDriver(&SDRAM);

        //next button
        while(button=0xE){
            if(day>hari){
                day=1;}

            a1=day/10;
            a0=day-(a1*10);
```

```
            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(7,a1);
            DE2Set7SegDigit(6,a0);
            DE2Disable7Seg(5);
            DE2Disable7Seg(4);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000002, day, SDRAM);  //memory<=day
            DE2SDRAMDriver(&SDRAM);
            day++;
        }

        //previous button
        while(button=0xD){
            if(day<1){
                day=hari;}

            a1=day/10;
            a0=day-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(7,a1);
            DE2Set7SegDigit(6,a0);
            DE2Disable7Seg(5);
            DE2Disable7Seg(4);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000002, day, SDRAM);  //memory<=day
            DE2SDRAMDriver(&SDRAM);
            day--;
        }

        //return to main
        if(button=0xB){
            return;}
    }
}




void jam(void)               //display hours
{
    int a0,a1;
    int jam;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
```

```
    line = hex2ascii() @ sp @ sp @ sp @ sp @ S @ E @ T @ sp @ T @ I
@ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ H @ O @
U @ R @ blank_line<-152;
    DE2LCDDriver(line);

    while(1){

        DE2_SDRAM SDRAM;
        DE2ReadSDRAM(0x000003, jam, SDRAM);      //jam<=memory
        DE2SDRAMDriver(&SDRAM);

        //next button
        while(button=0xE){
            if(jam>23){
                jam=0;}

            a1=jam/10;
            a0=jam-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(7,a1);
            DE2Set7SegDigit(6,a0);
            DE2Disable7Seg(5);
            DE2Disable7Seg(4);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000003, jam, SDRAM);  //memory<=jam
            DE2SDRAMDriver(&SDRAM);
            jam++;
        }

        //previous button
        while(button=0xD){
            if(jam<0){
                jam=23;}

            a1=jam/10;
            a0=jam-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(7,a1);
            DE2Set7SegDigit(6,a0);
            DE2Disable7Seg(5);
            DE2Disable7Seg(4);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000003, jam, SDRAM);  //memory<=jam
            DE2SDRAMDriver(&SDRAM);
            jam--;
```

```
        }

        if(button=0xB){
            return;}
    }
}




void minit(void)                //display minutes
{
    int a0,a1;
    int minit;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    DE2_LCD_LINE line;
    line = hex2ascii() @ sp @ sp @ sp @ sp @ S @ E @ T @ sp @ T @ I
@ M @ E @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ M @ I @ N @ U
@ T @ E @ blank_line<-152;
    DE2LCDDriver(line);

    while(1){

        DE2_SDRAM SDRAM;
        DE2ReadSDRAM(0x000004, minit, SDRAM);      //minit<=memory
        DE2SDRAMDriver(&SDRAM);

        //next button
        while(button=0xE){
            if(minit>59){
                minit=0;}

            a1=minit/10;
            a0=minit-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(5,a1);
            DE2Set7SegDigit(4,a0);
            DE2Disable7Seg(7);
            DE2Disable7Seg(6);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000004, minit, SDRAM);  //memory<=minit
            DE2SDRAMDriver(&SDRAM);
            minit++;
        }

        //previous button
        while(button=0xD){
            if(minit<0){
                minit=59;}

            a1=minit/10;
```

```
            a0=minit-(a1*10);

            a1=display(a1);
            a0=display(a0);

            DE2Set7SegDigit(5,a1);
            DE2Set7SegDigit(4,a0);
            DE2Disable7Seg(7);
            DE2Disable7Seg(6);
            DE2Disable7Seg(3);
            DE2Disable7Seg(2);
            DE2Disable7Seg(1);
            DE2Disable7Seg(0);

            DE2_SDRAM SDRAM;
            DE2WriteSDRAM(0x000004, minit, SDRAM);  //memory<=minit
            DE2SDRAMDriver(&SDRAM);
            minit--;
        }

        //return to main
        if(button=0xB){
            return;}
    }
}




void location(void)                 //display location
{
    int i;
    float lon,lat;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);
    while(1){

        //next button
        while(button=0xE){
            if(i>6){
                i=0;}
            if(i==0){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ B @ A @ T @ U @
sp @ P @ A @ H @ A @ T @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.83333333;
                lon=102.93333333;}
            else if(i==1){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ J @ O @ H @ O @ R @
E @ sp @ B @ A @ H @ R @ U @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.46666667;
                lon=103.76666667;}
            else if(i==2){
                DE2_LCD_LINE line;
```

```
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ K @ O @ T @ A @ sp @
T @ I @ N @ G @ G @ I @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.73333333;
                lon=103.88333333;}
            else if(i==3){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ M @ E @ R
@ S @ I @ N @ G @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.41666667;
                lon=103.83333333;}
            else if(i==4){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @
M @ U @ A @ R @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.05000000;
                lon=102.56666667;}
            else if(i==5){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ P @ O
@ N @ T @ I @ A @ N @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.48333333;
                lon=103.38333333;}
            else{
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ S @ E @ G
@ A @ M @ A @ T @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.50000000;
                lon=102.83333333;}
            i++;
        }

        //previous button
        while(button=0xD){
            if(i<0){
                i=6;}
            if(i==0){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ B @ A @ T @ U @
sp @ P @ A @ H @ A @ T @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.83333333;
                lon=102.93333333;}
            else if(i==1){
                DE2_LCD_LINE line;
```

```
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ J @ O @ H @ O @ R @
E @ sp @ B @ A @ H @ R @ U @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.46666667;
                lon=103.76666667;}
            else if(i==2){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ K @ O @ T @ A @ sp @
T @ I @ N @ G @ G @ I @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.73333333;
                lon=103.88333333;}
            else if(i==3){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ M @ E @ R
@ S @ I @ N @ G @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.41666667;
                lon=103.83333333;}
            else if(i==4){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ sp @
M @ U @ A @ R @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.05000000;
                lon=102.56666667;}
            else if(i==5){
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ sp @ P @ O
@ N @ T @ I @ A @ N @ blank_line<-152;
                DE2LCDDriver(line);

                lat=1.48333333;
                lon=103.38333333;}
            else{
                DE2_LCD_LINE line;
                line = hex2ascii() @ sp @ sp @ S @ E @ T @ sp @ L @
O @ C @ A @ T @ I @ O @ N @ sp @ sp @ sp @ sp @ sp @ sp @ S @ E @ G
@ A @ M @ A @ T @ blank_line<-152;
                DE2LCDDriver(line);

                lat=2.50000000;
                lon=102.83333333;}
            i--;
        }

        //go to calculation
        DE2_SDRAM SDRAM;
        DE2WriteSDRAM(0x00000B, lat, SDRAM);  //memory<=lat
        DE2WriteSDRAM(0x00000C, lon, SDRAM);  //memory<=lon
        DE2SDRAMDriver(&SDRAM);
```

```
        //return to main
        if(button=0xB){
            return;}
    }

}



void calc(void)
{
    float B,L,R=120,H=380,D,T,G=18,Z,U,V,W,JD,I,J,K,M,N,RA;
    float sub,syu,zho,asr,mag,isy;
    int sub1,syu1,zho1,asr1,mag1,isy1,sub2,syu2,zho2,asr2,mag2,isy2;
    int a,b,c,e,f,year,mon,day;
    int button=IORD_ALTERA_AVALON_PIO_DATA(BUTTON_PIO_BASE);

    //declare month and day
    DE2_SDRAM SDRAM;
    DE2ReadSDRAM(0x00000B, B, SDRAM);       //lat<=memory
    DE2ReadSDRAM(0x00000C, L, SDRAM);       //lon<=memory
    DE2ReadSDRAM(0x000000, year, SDRAM);    //year<=memory
    DE2ReadSDRAM(0x000001, mon, SDRAM);     //mon<=memory
    DE2ReadSDRAM(0x000002, day, SDRAM);     //day<=memory
    DE2SDRAMDriver(&SDRAM);

   //calculation for Julian date
    a = year/100;
    b = a/4;
    c = 2-a+b;
    e = 365.25*(year+4716);
    f = 30.6001*(mon+1);
    JD= c+day+e+f-1524.5;

   //calculation for T and D
    I = JD - 2451545.0;                         // jd is the given
Julian date
    J = 357.529 + 0.98560028* I;
    K = 280.459 + 0.98564736* I;
    N = K + 1.915* sin(J*d2r) + 0.020* sin(2*J*d2r);
    N = N*r2d;
    M = 23.439 - 0.00000036* I;
    RA= cos(N*d2r)/15;
    RA= RA*r2d;
    D = asin((sin(M*d2r)*sin(N*d2r)));        // declination of the
Sun
    D = D*r2d;
    T = (K/15)-RA;                              // equation of time

    //calculation for prayer time
    Z=12+(R-L)/15+(T/60)-4.25;
    U=acos(sin(((-0.8333*d2r)-(0.0347*d2r))*pow(H,0.5))-
(sin(D*d2r)*sin(B*d2r))/(cos(D*d2r)*cos(B*d2r)))*r2d/15;
    V=acos((sin(G*d2r)-
(sin(D*d2r)*sin(B*d2r)))/(cos(D*d2r)*cos(B*d2r)))*r2d/15;
    W=acos((sin(1+tan((B-D)*d2r)))-
(sin(D*d2r)*sin(B*d2r))/(cos(D*d2r)*cos(B*d2r)))*r2d/15;

    //prayer time declaration
    sub=Z-U-0.0666666666;
    syu=Z-V-1.2833333333;
```

```
    zho=Z;
    asr=Z+W+0.7;
    mag=Z+V+1.25;
    isy=Z+U;;

    //convert to degrees and minites
    sub1=sub;
    sub2=(sub-sub1)*60;
    sub=(sub1*100)+sub2;
    syu1=syu;
    syu2=(syu-syu1)*60;
    syu=(syu1*100)+syu2;
    zho1=zho;
    zho2=(zho-zho1)*60;
    zho=(zho1*100)+zho2;
    asr1=asr;
    asr2=(asr-asr1)*60;
    asr=(asr1*100)+asr2;
    mag1=mag;
    mag2=(mag-mag1)*60;
    mag=(mag1*100)+mag2;
    isy1=isy;
    isy2=(isy-isy1)*60;
    isy=(isy1*100)+isy2;

   DE2_SDRAM SDRAM;
   DE2WriteSDRAM(0x000005, sub, SDRAM);  //memory<=sub
   DE2WriteSDRAM(0x000006, syu, SDRAM);  //memory<=syu
   DE2WriteSDRAM(0x000007, zho, SDRAM);  //memory<=zho
   DE2WriteSDRAM(0x000008, asr, SDRAM);  //memory<=asr
   DE2WriteSDRAM(0x000009, mag, SDRAM);  //memory<=mag
   DE2WriteSDRAM(0x00000A, isy, SDRAM);  //memory<=isy
   DE2SDRAMDriver(&SDRAM);

    return;
}
```