A Survey on the Developmental Tools Applied In Design of Embedded System

Chaithrapallavi,
Department of Electronics and Communication,
SDM Institute of Technology, Ujire, India.

Mahesh D S,
Department of Electronics and Communication,
SDM Institute of Technology, Ujire, India.

***Abstract* - Advancement in technology helped in making things simpler and easy to operate by the use of many electrical and electronic circuits and kits which are designed using embedded systems technology. The electronic system which integrates the hardware circuitry with the software programming techniques for providing project solutions is called as embedded systems. By using this embedded system technology, the complexity of the circuits can be reduced to a great extent which further reduces the cost and size. Different soft wares are used to design this. This paper describes some of the software tools used in the design of embedded system.**

Keywords :- Editor, Compiler, Debugger, Assembler, Linker, Simulator, Library, MATLAB, LabVIEW, Keil, Arduino, Visual video, PSpice, EasyEDA, Proteus, Altium, MPLAB.

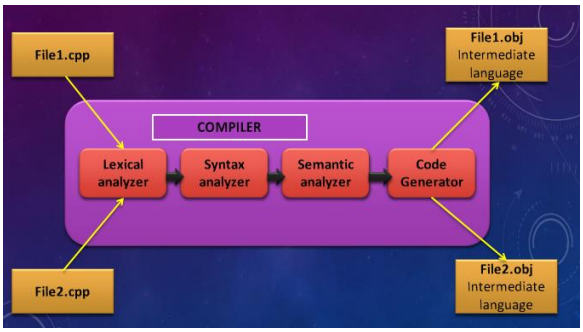
I. INTRODUCTION

Integration of hardware and software to perform a specific operation is an embedded system. The software used in the embedded system is set of instructions, termed as a program. The microprocessors or microcontrollers termed as hardware of embedded systems, are programmed to perform specific tasks by following the set of instructions. Embedded Software is the one which controls embedded operation, loaded into the microcontroller to control of all the operations which are running. For developing this software, a number of different tools are needed which will discuss further. These tools include editor, compiler, assembler and debugger.

i. *Editor:*

The first tool need for Embedded Systems Software Development is text editor, where code is written using programming languages like C or C++, which are referred to source code.

ii. *Compiler*:



The second among Embedded Systems Software Development Tools is a compiler. The function of compiler is to translate the computer code written in one programming language (the source language) into another programming language (the target language which is basically assembly language, object code or machine code) to create executable program. If the compiled program can run on a computer whose CPU or operating system is different from the one on which the compiler runs, the compiler is a cross-compiler. A bootstrap compiler is written in the language that it intends to compile. A program that translates from a low-level language to a higher level one is a de-compiler.

The operations performed by compiler includes, preprocessing, lexicalanalysis, parsing, seman tic analysis (syntax-directed translation), conversion of input programs to an intermediate representation, code optimization and code generation.

iii. *Debugger*:

A debugger or debugging tool is a computer program that is used to test and debug other programs (the "target" program). The code to be examined might alternatively be running on an *instruction set simulator* (ISS), a technique that allows great power in its ability to halt when specific conditions are encountered, but which will typically be somewhat slower than executing the code directly on the appropriate (or the same) processor. Some debuggers offer two modes of operation, full or partial simulation, to limit this impact.

iv. *Assembler:*

Assembler is the most important one among the Embedded Systems Software Development Tools. Its function is to convert a code written in assembly language into machine language, i.e. the mnemonics and data is converted in to op-codes and bits.

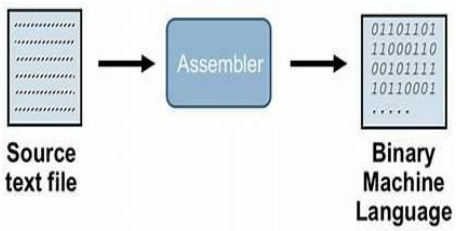


Fig 1: Working of Assembler

v. *Linker*:

A linker is a computer program that combines one or more object code files and library files together in to executable program. It is very common practice to write larger programs in to small parts and modules so as the job becomes simple and easy and to use libraries in program. All these parts must be combined into a single file for execution, which is achieved by a linker.

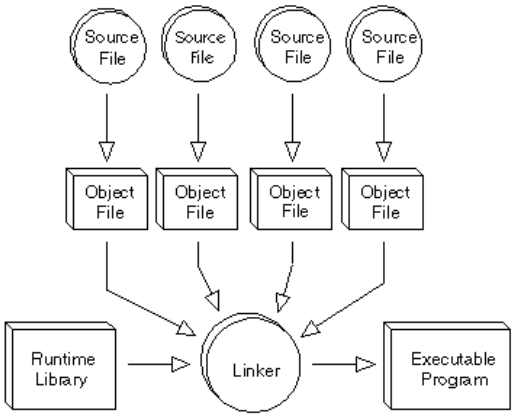


Fig 2: Working of Linker

vi. Libraries:

A library is a collection of implementations of behavior, written in terms of a language, that has a well-defined interface by which the behavior is invoked. designers who want to write a higher level program may use a library to make system calls, instead of implementing those system calls over and over again. The behavior is provided for reuse by multiple independent programs. A program invokes the library-provided behavior via a mechanism of the language. For example, in a simple imperative language such as C, the behavior in a library is invoked by using C's normal function-call. What distinguishes the call as being to a library function, versus being to another function in the same program, is the way that the code is organized in the system.

vii. Simulator:

Among all embedded software tools, simulating software is essential. Simulator helps to see how code will work in real time, also how sensors are interacting, can change the input values from sensors, and can see how the components are working and how changing certain values can change parameters.

II. INTEGRATED DEVELOPMENT ENVIRONMENT (IDE) EMBEDDED SYSTEMS SOFTWARE DEVELOPMENT TOOLS.

An Integrated Development Environment is a software which contains all the necessary tools required for embedded software development. To create a software for embedded system, we may require all tools. It is very helpful to have software which provides all of the necessary tools, from writing to testing of code, in a

single package. An IDE normally consists of a code editor, compiler and a debugger. IDE also provides a user interface. Commonly used IDE are Android Studio, Eclipse, Code Blocks, Blue J, X code and Adobe Flash Builder, etc.

Depending on type of microcontroller used in the design, we choose from many different software applications. Few of the software, which are used in the design of embedded system are,

i. *Arduino Software*

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, MAC OS, Linux), written in Java. It is used to write and upload source-code to Arduino compatible boards, also using 3rd party cores, other vendor development boards.

Fig 3: Software Development Environment

The source code for the IDE is released under the General Public License (GNU), version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library for wiring project, which provides many common input and output procedures. Programs composed by user requires two basic functions, for starting the design and the main program loop, which are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool, also included with the IDE distribution. The Arduino IDE employs the program to convert the executable code into a text file in hexadecimal encoding that is loaded onto the Arduino board by a loader program. [1]

ii. *MATLAB*

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and a proprietary programming language developed by Math Works. MATLAB allows operations like matrix manipulation, plotting functions and data, implementation of algorithms, creation of user interface, and interconnection with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

MATLAB is intended primarily for numerical computing. An optional toolbox uses the Mu PAD symbolic engine, allowing access to symbolic computing abilities as well. An additional package called Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

iii. *Keil:*

Keil is development tool for the 8051 Microcontroller Architecture, which supports every level of software developer from the professional application engineers to the students who learn embedded software development.

The industry standard tools like Keil C Compilers, Macro Assemblers, Debuggers, Real-time Kernels, Single-board Computers, and Emulators works for family of 8051. It also supports a wide range of microcontrollers including ARM7, C16x/ST10, etc.

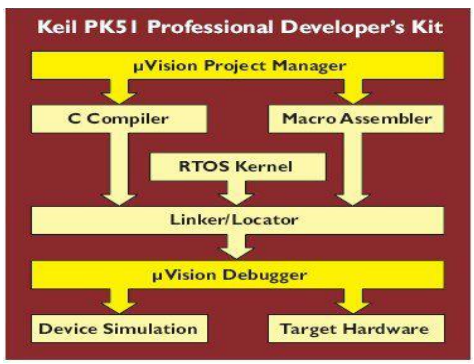


Fig 4: Keil PK5I Professional Developer's kit

iv. *LabVIEW*

Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW) is a graphical programming language by National Instruments (Austin, TX)[2]. LabVIEW implements a dataflow paradigm in which

the code is not written, instead drawn or represented graphically similar to a flowchart diagram. Program execution follows connector wires linking processing nodes together. Here functions or routines are stored as a virtual instrument (VI) having three main components namely, the front panel, essentially a form containing inputs and controls and can be displayed during run time, a block diagram where the code is edited and represented graphically, and a connector panel which serves as an interface to the VI when it is embedded as a sub-VI.

v. *PSpice:*

PSpice SPICE simulation technology combines industry-leading, native analog and mixed-signal engines to deliver a complete circuit simulation and verification solution. It meets the needs of designers as they progress in the changing design cycle by helping in design development and verification. Designed for use in conjunction with PSpice A/D, PSpice Advanced Analysis helps designers improve yield and reliability.

Customers of all sizes and in various industries are using PSpice SPICE circuit simulator to simulate the circuits to find and fix design issues before the designs go to the manufacturer. Such powerful simulation environment engineers gain confidence in the circuits which works as intended during design. This confidence leads to increased manufacturing yield, fewer prototypes, less time spent in the lab, and ultimately a reduced cost of the product, thereby increasing the potential profit.

vi. *EasyEDA:*

EasyEDA is a web-based EDA tool suite, used to design, simulate, share - publicly and privately - and discuss schematics, simulations and printed circuit boards. Other features include the creation of a Bill of Materials, Gerber and pick and place files and documentary outputs in PDF, PNG and SVG formats. EasyEDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts, and optionally, the manufacture of printed circuit boards.

vii. *Proteus*:

Proteus is a circuit analysis and physical simulation software launched by British Lab Center Company, which run on Windows platform and is made up mainly by the ISIS and ARES. ISIS's main function is schematic design and simulation, while ARES is mainly used for printed circuit board design. Its main features are as follows. [3]

- Friendly User-Interface.
- Wealth of Experimental Resources.
- Powerful Virtual Instrument
- Unique Simulation Approach

viii.*Visual Video:*

Microsoft Visual Studio is an IDE used to develop computer programs, as well as websites, web apps, web services and mobile apps. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both native code and managed code.

Visual studio includes a code editor supporting IntelliSence (the code compiler component) as well as code refactoring. The integrated debugger works both as a source-level debugger and a machine-level debugger. Other built-in tools include a code profiler, forms designer for building GUI applications, web designer, class designer, and database schema designer.

Visual Studio supports 36 different programming languages and allows the code editor and debugger to support (to varying degrees) nearly any programming language, provided a language-specific service exists. Built-in languages include C, C++, C++/CLI, Visual Basic, .NET, C#, F#, JavaScript, Type Script, XML, XSLT, HTML, and CSS. Support for other languages such as Python, Ruby, Node.js, and M among others is available via plug-ins. Java (and J#) were supported in the past.

ix. *Altium*:-

Altium Designer's suite encompasses four main functional areas: schematic capture, 3D PCB design, Field-programmable gate array (FPGA) development and release/data management. Nobel features referred to in the reviews include:

- Integration with several component distributors allows search for components and access to manufacturer's data

- Interactive 3D editing of the board and MCAD export to STEP
- Cloud publishing of design and manufacturing data
- Simulation and debugging of the FPGA can be achieved using the VHDL language and checking that for a given a set of input signals the expected output signals would be generated. FPGA soft processor software development tools (compiler, debugger, profiler) are available for selected embedded processors within an FPGA. [4]

x. *MPLAB:*

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and ds PIC microcontrollers, and is developed by Microchip Technology.

MPLAB X is the latest edition of MPLAB, and is developed on the Net Beans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit PIC and AVR (including ATMEGA) microcontrollers, 16-bit PIC24 and dsPIC microcontrollers, as well as 32-bit SAM (ARM) and PIC32 (MIPS) microcontrollers.

MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PIC Kit programmers are also supported by MPLAB. MPLAB X supports automatic code generation with the MPLAB Code Configurator and the MPLAB Harmony Configurator plugins.

III.CONCLUSION:

Embedded systems find numerous applications in various fields such as digital electronics, telecommunications, computing network, smart cards, satellite systems, military defense system equipment, research system equipment, and so on. Embedded system programmed or non-programmed to operate, organize, and perform single or multiple tasks based on the application. So these can be programmed using any of the software tools and should be known to every embedded software developer.

IDE	SUPPORTING LANGUAGES	OPERATING SYSTEMS	LICENSE
ARDUINO	JAVA , C, C++	Windows, Linux,	LGPL, GPL
MATLAB	C, C++, C#, Java, Fortran and Python.	Windows, macOS, Linux	Proprietary, Commercial software
KEIL	C/C++	Windows	Proprietary
LABVIEW	C, C++, .NET	Windows, macOS, Linux	Proprietary
PSPICE	C/C++	Windows (originally DOS)	Proprietary
EASYEDA		Linux, mac OS, Windows	Commercial software
PROTEUS	C, BASIC, Assembly	Windows	Proprietary

VISUAL STUDIO	C,C++, C++/CLI, VisualBasic.NET, C#, JavaScript	Windows 7 SP1 and later Windows Server 2012 R2	Freemium
ALTIUM	Delphi, C#, C++	Microsoft Windows	Proprietary
MPLAB	C++	Microsoft Windows	Proprietary EULA

IV. REFERENCES:

[1] MARK E. CAMBRON :- "Using the Arduino in Freshmen Design". Sixth Annual (FYEE) First Year Engineering.., 2014
[2] ELLIOTT, C., VIJAYAKUMAR, V., ZINK, W., & HANSEN, R. (2007).:- "National Instruments LabVIEW: A Programming Environment for Laboratory Automation and Measurement". Journal of the Association for Laboratory Automation, 12(1), 17–24.
[3] Fengjie Wu and Tangmei He:- "Application of Proteus in Microcontroller Comprehensive Design Projects". Instrumentation, Measurement, Circuits and Systems, 2012 – Springer.
[4] Angelo A. Beltran Jr., Cayetano D. Hiwatig, Nelor Jane R. Laguna–Agustin, Marjorie B. Villanueva :-"Teaching Electronic Circuits Using Altium Designer". International Journal of Scientific Engineering and Technology (ISSN: 2277 – 1581) Volume No. 3, Issue No. 10, pp: 1239 – 1243.