Integrated Approach for Designing an Efficient Embedded System

Abstract

Today embedded systems can be found in a large variety of applications; ranging from children's toys, consumer electronics, communications, automobiles, medical, defence, industrial, robotics to name a few. In general, an embedded system comprises of a number of cooperating components such as: processor, memories, RTOSs etc., which are obtained from different vendors that together implement the specific behavior. In addition, embedded system's design has to satisfy a number of constraints such as: time to market, cost, power consumption, real time requirements etc. To satisfy these constraints, the designer has to select the right components such as: Processor, IDE (Integrated Development Environments), RTOS (Real Time Operating System) and input/output components. For each component, several alternatives are available from different vendors with distinct features. Selecting the best suitable component from wide ranging alternatives for a specific embedded system is a multidimensional search problem, with each dimension corresponding to a component characteristic, which requires an exhaustive search with tremendous computing resources. It is a big challenge as the efficiency of the embedded system and its highly behavior depends on the chosen components. In this thesis, an attempt has been made to address these problems and provide a framework that helps in arriving at an efficient design of embedded systems.
Selecting the right processor involves many parameters such as: architecture, on chip components, and other technical and non-technical aspects of the processor. A large number of approaches have been proposed to select a suitable processor for a given application. In this thesis, different processor selection techniques have been classified along with their merits and demerits. Case studies were carried out to identify the practical problems faced by the designers. To overcome these problems, a framework has been proposed to select the suitable processor more easily and efficiently. To achieve this, we first extract the characteristics of the application using the Keil Integrated Development Environment. The database of processors is dynamically normalized using the application parameters. The extracted parameters are also translated into the characteristics of the processor specifications. Two standard algorithms – WS and KT methods are used to rank the processors in terms of their suitability. A comparative study of the two algorithms is made and the applicability of these algorithms in the selection of the processor is also suggested.

The IDEs available in the market have features ranging from simple tool chain to complex tool chain with RTOS support. While selecting the IDE several parameters such as: processor support, compiler features, debugging and simulation features, tool support etc., are to be considered. This makes the task of the designer difficult in choosing the right IDE with the desired features. The existing approaches only suggest the designers a set of parameters to be considered for selection, but does not provide an evaluation of IDEs based on the suggested parameters. The proposed framework uses the quantitative model for evaluation and selection. In order to show the evaluation and
selection criteria, commercially available IDEs have been considered and ranked based on different aspects. These results are analyzed with practical applications and observed that the practical results are correlating with the evaluation results. This framework helps the designers to arrive at the selection easily and efficiently.

Wide range of RTOSs is available to the designers ranging from RTOSs for robotics to home appliance, that includes micro kernels to commercial RTOSs. The design space available to any RTOS is very large and there is a set of characteristics such as: development methodology, scheduling algorithms, priority levels etc., which makes the task of the designer difficult. In this framework of RTOS selection, Simple Genetic Algorithm (SGA) is used by which the designer can choose the right RTOS for a given application efficiently.

An integrated approach for an efficient embedded systems design has been implemented as “PreDES, a Pre Design tool for Embedded Systems”, with the help of a user friendly interactive GUI. This tool helps the designers in selecting the suitable components, project management, and also serves as a portal for embedded system’s design. Thus it acts as a pre-design tool for designing efficient embedded systems.