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Embedded Systems: Scope in Engineering Education

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Abstract- ***This paper presents new perspective about embedded systems, what embedded systems are used for, why they are so popular in today's life, and especially the scope of embedded systems in engineering education. Now-a-days embedded systems are very popular and researches are being done in this field. It's a rapidly evolving field. This paper focuses on the basics of embedded systems and how it can be used in the field of engineering education. This paper also discusses a project that we are working on, which is an example of embedded system and can be used while doing other projects.***

Keywords— Embedded Systems, Robotics, Embedded C, Firebird V, Intelligent Robots

I. INTRODUCTION

In the day-to-day life we come across a wide variety of consumer electronic products. We are habituated to use them easily and flawlessly to our advantage. Common examples are TV Remote Controllers, Mobile Phones, FAX machines, Xerox machines etc. However, we seldom ponder over the technology behind each of them. Each of these devices does have one or more programmable devices waiting to interact with the environment as effectively as possible. These are a class of "embedded systems" and they provide service in real time. i.e. we need not have to wait too long for the action.

In this paper we are going to address the general idea behind the term 'Embedded Systems' and its advantages and applications for students in engineering field.

II. EMBEDDED SYSTEMS

A precise definition of embedded systems is not easy. Simply stated, all computing systems other than general purpose computer (with monitor, keyboard, etc.) are embedded systems. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. In many cases, their "embeddedness" may be such that their presence is far from obvious to the casual observer. Block diagram of a typical embedded system is shown in fig.

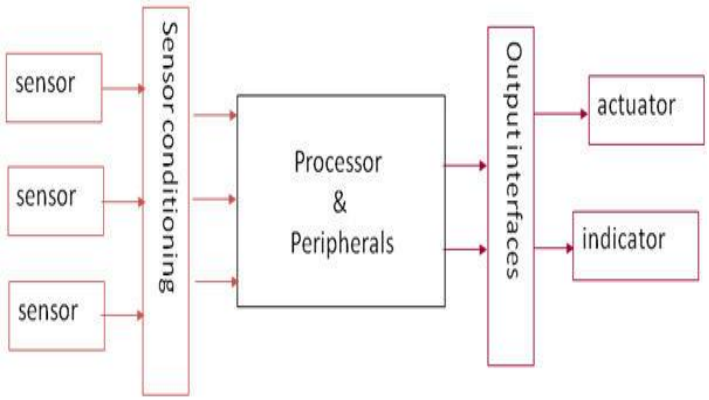

Fig.1-Block diagram of Embedded Systems

An embedded system is an engineering artefact involving computation that is subject to physical constraints (reaction constraints and execution constraints) arising through interactions of computational processes with the physical world. Reaction constraints originate from the behavioural requirements & specify deadlines, throughput, and jitter whereas execution constraints originate from the implementation requirements & put bounds on available processor speeds, power, memory and hardware failure rates. The key to embedded systems design is to obtain desired functionality under both kinds of constraints.[1]

A. Characteristics of Embedded Systems

a) Embedded systems are application specific & single functioned; application is known apriori, the programs are executed repeatedly.

b) Efficiency is of paramount importance for embedded systems. They are optimized for energy, code size, execution time, weight & dimensions, and cost.

c) Embedded systems are typically designed to meet real time constraints; a real time system reacts to stimuli from the controlled object/ operator within the time interval dictated by the environment. For real time systems, right answers arriving too late (or even too early) are wrong.

d) Embedded systems often interact (sense, manipulate & communicate) with external world through sensors and actuators and hence are typically reactive systems; a reactive system is in continual interaction with the environment and executes at a pace determined by that environment.

e) They generally have minimal or no user interface.[2]

III. SCOPE IN ENGINEERING EDUCATION

In engineering, use of embedded systems is very beneficial for students. Students will be able to improve their skills in the very field and work for the advancement of the technology. There may be two aspects as follows:

A. Developing Embedded Systems

In this aspect, students can study the basics of embedded systems and can learn how to design an embedded system. In this, students must be aware of the components to be used, especially the embedded processors.

Embedded processors can be broken into two broad categories. Ordinary microprocessors (μP) use separate integrated circuits for memory and peripherals. Microcontrollers (μC) have many more peripherals on chip, reducing power consumption, size and cost. In contrast to the personal computer market, many different basic CPU architectures are used, since software is custom-developed for an application and is not a commodity product installed by the end user.

Numerous microcontrollers have been developed for embedded systems use. General-purpose microprocessors are also used in embedded systems, but generally require more support circuitry than microcontrollers.[3]

Developing an embedded system may include developing some sort of robotic application. e.g. Surveillance Robot, Fire Fighting Robot etc. In such cases students must be aware of how to program the particular processor. Here students can learn different assembly languages for different processors or some embedded languages like 'Embedded C'[4] which will improve their skills in the field of Embedded Systems.

B. Using Readymade Embedded Systems

In this aspect, students can use the ready-to-use embedded systems available in the market. There are many such embedded systems available in the market which can be used for developing different applications. These systems can be modified and made available for our specific use. Students can study these systems and can use in their engineering application for their projects or for any further study.

Firebird V is one of the best examples of such ready-to-use embedded system. Students can study it well and can do their projects on this platform. It helps students to work in new domain and learn the topics which are not included in their curriculum. It helps in improving knowledge of students in the field of embedded systems.

IV. ADVANTAGES

There are various advantages of embedded systems in engineering applications. They may include Lab Development, Exposure for Students, Students Projects, and Reusability.

A. Lab Development

Lab development is a very good advantage. When students interestingly work on some real time embedded system, they will need a proper and well-equipped embedded system laboratory where they can efficiently work on their intended task. The newly developed system can also be the part of the laboratory and can be used in future. Robotics laboratory can be a good example of such laboratories.

B. Exposure for Students

This advantage plays an important role in improvement of student's knowledge towards new technologies. Students will learn different topics of embedded systems and its designing skills. They can use these skills during their academics and in their future career. They will be able to work in this different but very popular field.

C. Student's Project

Study of this different domain will promote and inspire students to work in the field of embedded systems and they can do their academic projects in this new domain. Students can do research on different topics and may come up with a very fresh idea which will be beneficial in real life application. A totally new embedded system may be developed by students. It will help students in their education and also to improve their knowledge about embedded systems.

D. Reusability

The systems built by students may be reused for further projects. Such adjustments can be done in a system to make it reusable. For example, a robotic platform can be designed in such a way that, it can be used for different purposes. Let's consider a robotic platform which is having different sensors and actuators. Students can program it's microcontroller to work as per their need. The program can be changed at any time. So with the help such platform

different application like surveillance robot, fire fighting robot, or line following fighting robot can be built. Such platforms are reusable and play very important role in engineering education.

V. CASE STUDY

We successfully worked on a Firebird V platform to create two different applications viz. Obstacle Avoiding Robot and Edge Avoiding Robotic Vehicle[5]. Now a day's Robotics is part of today's communication & communication is part of advancement of technology, so we decided to work on ROBOTICS field, and design something which will make human life today's aspect. There are different types of mobile robots which can be divided into several categories consists of wheeled robot, crawling robot and legged robot. This project deals with a wheeled autonomous ROBOT. It is the part of Automation; Robot has sufficient intelligence to cover the maximum area. This robot uses infrared sensor to detect the obstacle in between the path and then avoid them to complete its objective. It also avoids sharp edges to move more smartly in the surrounding environment. This robot is a reusable embedded system. It can be further extended to Line Following Robot or some other applications. This robot is advanced than the previously created obstacle avoiding robots. It uses multiple sensors and avoids multiple edges and obstacle at a single time. It more smartly finds its way to move towards mission objective. This is an attempt to do a project in totally new domain for us which will inspire other students to study the fields of Robotics and Embedded Systems and to work in these new domains. The robotic application is also reusable and can be used to create different applications.

VI. CONCLUSIONS

Finally, we conclude that, study of embedded systems will improve the quality of engineering education. There is a huge scope of embedded systems in engineering education. Engineers will become eligible for working in embedded system environment, in their career. It will also do advancements in today's technology and upcoming embedded systems will reduce human efforts by working smartly.

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