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An Overview of Task Scheduling on Arduino

Donald Rodriguez-Ubeda[1], Ricardo Rosales[2]

[1]Department of Mathematics, University of Sonora
[2]Autonomous University of Baja California

Abstract: **The Arduino family of microcontrollers is widely used today. However, few projects address the issue of scheduling tasks in these microcontrollers. This document presents the methods of scheduling tasks on these platforms.**

Keywords: **Task-scheduling, Arduino, microcontrollers.**

I. INTRODUCTION

The Arduino platform is one of the more generally used one due its simplicity, low cost, and ease of use; many developers are involved in projects based on Arduino, with applications in many different fields ranging from education, industry, transportation, agriculture and research [1-5] among others.

Just to mention some projects such as the one proposed by Candelas, et al. [1] Where they describe the planning and the development of laboratory activities for the course named "Introduction to Robotics Engineering," which is taken by the students of the Robotics Engineering Degree program offered by the University of Alicante. The main goal of their activities was to introduce basic concepts related to the working, designing and programming of robots, promoting the development of student skills to solve engineering problems and face off typical implementation troubles. Along the course, the students built a mobile robot, which can perceive and react to the obstacles found in the environment, using sensors and actuators, controlled with an Arduino based controller [1].

Another very interesting project is the electrical and hardware design of the mobile robot platform named ReMoRo, which is based on distributed input/output modules, proposed by [2] (Karimi, et al.). The goal of the project was to develop a low-cost, robust and extensible modular robot platform for research and educational purposes. In their paper describe an affordable robot structure that enables large-scale innovative, new curriculum, multi-robot research and multi robotics outreach to the computer and artificial intelligent students.

The devices, used on the ReMoRo platform, (sensors, motor drivers and device communication manager) were designed based on ARM Cortex M3 microcontrollers that run under Real-Time Operating System (freeRTOS) [2] to manage each module internal scheduling and activation control in communication bus.

Provided with a range of different sensors, cylindrical manipulator and omnidirectional locomotion system, RoMeRo can interact with the environment in multiple ways, handle common objects and therefore be used in various service robot scenarios like warehouse robots or multiagent mobile robots. They demonstrated the usability of their concept by quantifying the object-handling task and described the software design based on ROS framework for educational usage [2].

Both articles are very interesting and awaken the interest to know the difference in how they manage the execution of multiple tasks on both platforms. Since in [1], they do not mention any operating system to manage the execution of tasks, in [2] they mention a real-time operating system, through which they solve everything necessary for the concurrent execution of multiple tasks.

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Therefore it is considered relevant to investigate what proposals exist about the scheduling of tasks in Arduino as well as other elements that facilitate the development of applications based on the execution of multiple tasks satisfying time constraints. Fig. 1 depicts the Arduino boards, namely, ArduinoUno (R3).

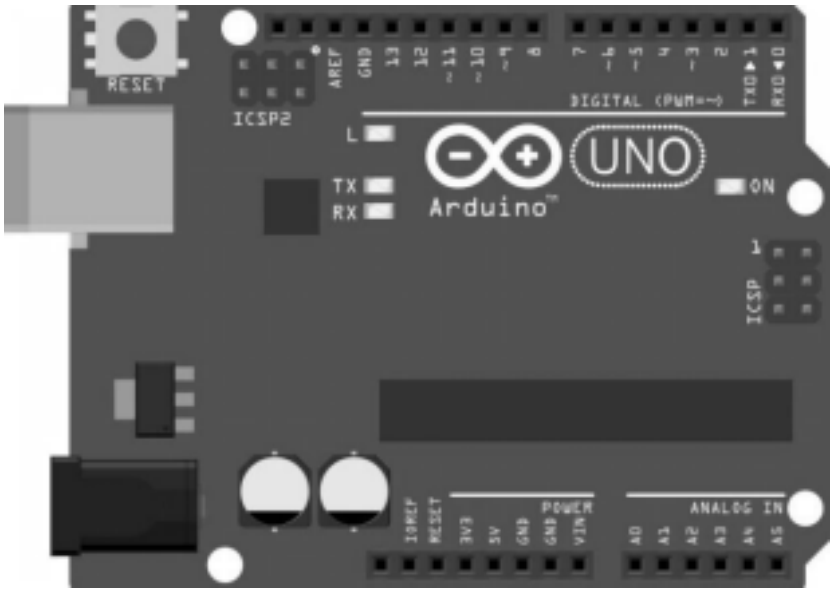

Fig. 1: Arduino Uno (R3)

The remainder of this paper is organized as follows: Section II Running tasks on Arduino, Section III Scheduling tasks on Arduino, Section IV Arduino use cases, Section V Conclusions and Section VI Future work.

II. RUNNING TASKS ON ARDUINO

Many projects based on Arduino are limited to run a few tasks on a first in first out order, just as they were programmed [3,4,5], for example [6] explained in their paper the design and implementation of a hybrid battery charging system. They implemented an algorithm on an Arduino microcontroller to control a charging system by sensing the voltage on the energy distribution network in order to select a solar PV charging system as an alternate power source.

Baraka et al. [3] In their paper they show an implementation of Home Automation techniques on a remotely controlled, energy-efficient and scalable Smart Home with basic features that safeguard the residents' comfort and security. The system consists of a house network (sensors and appliance actuators to respectively get information from and control the house environment). As a central controller, they used an Arduino microcontroller that communicates with the user interface running on Android. They programmed the events to be triggered under specific conditions, and at the same time, the system can suggest smart task scheduling reducing the total energy consumed by some appliances.

In [4] they propose a solution to the watering plants problem, their describes a prototype based on Arduino Uno R3 board which is easy to program and economical. Their prototype was programmed in such a way that it senses the moisture level of the soil and supply the water if required. Therefore, the microcontroller has coded the system to water the plants according to the reading from the moisture sensor which has been calibrated. Their prototype also is provided with the GSM communication technology, which enables the farmer to control the system remotely by sending and receiving the SMS (Short Message Service) messages.

In [5] propose a system to provide warnings to the driver under the presence of abnormal conditions or unsafe driving behaviour and can detect accidents. The system also has features like alerting the driver about vehicle's servicing schedule, abnormal engine temperature, over-speeding and rash driving situations. It allows to take pictures and send multimedia and text messages to predetermined users after the occurrence of an accident which has tremendous potential to reduce fatalities during road accidents due to its warning alerts to the driver and the communication of the event to emergency help-lines. The mentioned system is based on an Arduino ATMega32 microcontroller equipped with accelerometer, temperature sensor, speed sensor, keyboard, LCD, buzzer and a discarded cell phone model.

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Most projects focus on finding innovative solutions to real problems using the Arduino family of microcontrollers. Such projects propose control systems where they execute more than one task in the microcontroller and demonstrating their abilities to program solve on the fly and in a very ad hoc way the common problems that are presented in these cases (e.g. [4,5,6]), such as the concurrent execution of tasks, the scheduling of tasks and management of response time of tasks to ensure that their solutions meet the time constraints that each demand.

III. SCHEDULING TASKS ON ARDUINO

As we have seen, many projects that involve the execution of multiple tasks solve the problem of scheduling them on the fly. On the other hand the creators of Arduino propose the cooperative scheduling with the algorithm FCFS [7], which makes it easier for developers to schedule tasks.

In 2012 Barlow [8] wrote a basic TT scheduler which as he pointed "was really more of a 'proof of concept' and not really friendly for an everyday Arduino user" [8]. It was required a strong knowledge of C or C++ to use his library. Additionally needed Eclipse with an Arduino plugin to get it to work.

Then he wrote a proper Arduino library to demonstrate time-triggered scheduling to Arduino IDE users. The library followed the Arduino API Style Guide in order to make the library as familiar as possible.

As Barlow said, "the main idea behind time-triggered scheduling is to perform multiple functions without an operating system. It has been said that you should choose a Raspberry Pi (or a similar OS-based platform) over Arduino if you need to do more than two things [8]". He successfully demonstrated that is not always the case, [8] explain that it can be implemented just by splitting the code into small, predictable, rapidly-repeating segments of code (or 'Tasks').

IV. ARDUINO USE CASES

The features of Arduino to be compatible with other devices using compatible hardware allows it to be used in different cases of use, from the measurement of earthquakes, measurement of energy, measurement of temperatures, online services, etc. In online services companies such as Pachube.com, Google.com/powermeter, Sensorpedia.com, Open.Sen.se, offer services currently available for your projects to publish your information and environmental sensors. I.e., Google PowerMeter is a service that is highly mature, built with the primary focus of utility services (the electrical grid in particular). If your project is all about the electrical generation (be it solar, wind, geothermal, whatever) and usage, it is a great online service **[9].** Also, we can find simple projects, i.e., Power Monitoring Using Arduino & Log Into Google Sheet **[10],** as we can see today we can find infinity applications for Arduino in different areas.

V. CONCLUSION

Everything indicates that there is no operating system for the family of microcontrollers of the Arduino family and as far as the scheduling of processes is concerned, the team of Arduino developers suggest the use of a cooperative scheduler that they developed [7].

Definitely the proposal of Barlow constitutes an improvement on the schedule proposed by Arduino, although it has only tested it with Arduino Uno [8], its proposal allows to schedule tasks as a function of time and not in function of its coding order as it is the case of the FCFS schedule proposed by [7].

VI. FUTURE WORK

The publications analyzed in this document are definitely very motivating, in particular, we consider it important to explore other types of scheduling such as shortest task first, round robin and earliest deadline first.

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