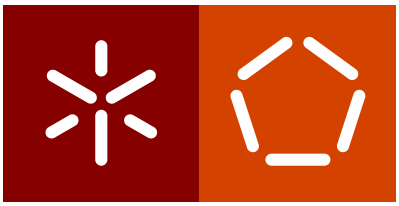

Universidade do Minho
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Nonlinear Dynamic Systems and Neural Networks

Autonomous Navigation: Report

Autonomous Navigation for mobile robots with modest computational resources

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1 Introduction

The present work illustrates the application of the two first stages of the Waterfall methodology — Analysis and Design — to develop a TV remote control. This type of project begins with the establishment of a contract between the client (Samsung company) and the project team, clearly defining the problem statement and deriving the product requirements and constraints associated to the project. It should be noted, however, that both roles are played out by the authors. A market research is performed to gain more insight over this market and the product placement, and the product overall characteristics.

In the analysis phase, the product requirements are derived — defining the client expectations for the product — as well as the project constraints — what the environments limits about the product. Finally, the theoretical foundations are outlined, providing the basic technical knowledge to undertake the project.

In the design phase, the product development starts, specifying the system in terms of hardware and software and its associated interfaces, the error handling required, and the design verification.

1.1 Problem statement

The first step of the project is to clearly define the problem, as a result of the contract established between the client and the project team, yielding, in this case, the following project statement:

"Design a remote control with three buttons that can remotely control the television (TV). It should be very light, powered by batteries and controls your TV via an infrared emitter. The TV has a built-in infrared receiver. A button on the remote control switches the TV on/off and will be labeled with the word "Power". The other two buttons are used to scroll up/down and select the available channels and they are labeled with the arrows up/down."

1.2 Market research

A TV remote is a device which is used to operate a television from distance in a wireless mode. It also makes the TV usage simpler, more user friendly with its suggestive buttons. These buttons control functions such

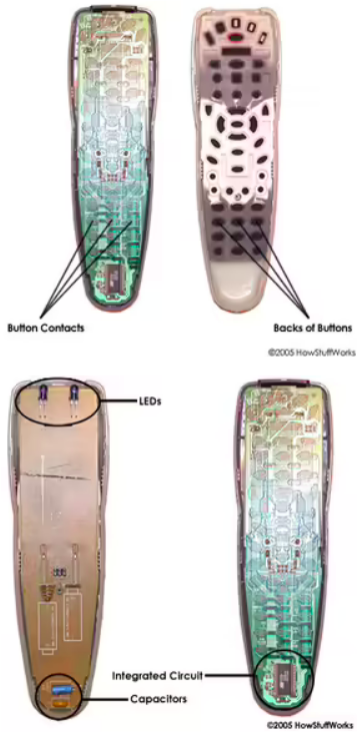

Figure 1.1: Bill of material in a TV Remote)* from [1])

as power, volume, channel switch and various other features.

TV remotes are composed by the TV remote Shell, the TV remote membrane, one LED and a data acquisition & Infrared emitter PCB, as illustrated in Fig. 1.1. The unit cost of universal TV remotes is about 3 to 5 EUR.

As can be seen in Fig. 1.2, the amount of televisions sold per year is about 200 million per year, with a tendency to increase over the next years. Thus, at least the same amount of TV remotes sells is expected, as each new TV requires one remote control, but it is expected to be exceeded due to TV remote replacement arising from its malfunctioning or bad usage.

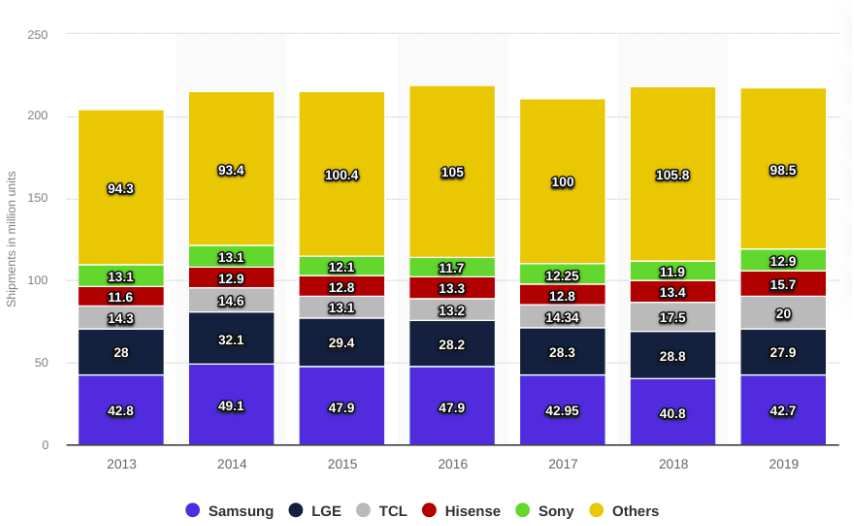

Figure 1.2: Global LCD TV unit shipments from 2015 to 2019, by vendor (in millions)* from [2])

2 Analysis

2.1 Requirements

- Remotely operated - Low weight - Powered by batteries - 3 buttons: 1) Power 2) Up 3) Down - Infrared emitter response time (system output response time): 100 ms - The TV remote may be upgraded in the future to use more buttons

2.2 Constraints

- Contains an infrared emitter (the TV already has an infrared receiver) - The TV remote control must supply the required data frames imposed by the TV manufacturer - Data frames may not be provided by the client - Security concerns are defined by the data frames and the specific communication frequency imposed by the TV manufacturer - 1 week deadline: 14 h - 2 people - Budget: - HW (parts acquisition and assembly): fixed costs — 1 EUR/unit - TV remote Shell - TV remote membrane - LED - Data acquisition & Infrared emitter PCB - Development: project - 20 EUR per hour per person: 20 * 14 * 2 = 560 EUR + IVA

2.3 Theoretical foundations

Pushing a button on a remote control sets in motion a series of events that causes the controlled device to carry out a command. The process works something like this:

1- Pushing the button on the remote control causes a touch to the contact beneath it and complete the button circuit on the circuit board. The integrated circuit detects this.

2- The integrated circuit sends the binary of the button function command to the LED at the front of the remote.

3- The LED sends out a series of light pulses that corresponds to the binary the button command.

Here's an example of this clicking on the "volume up" button on a Sony TV Remote:

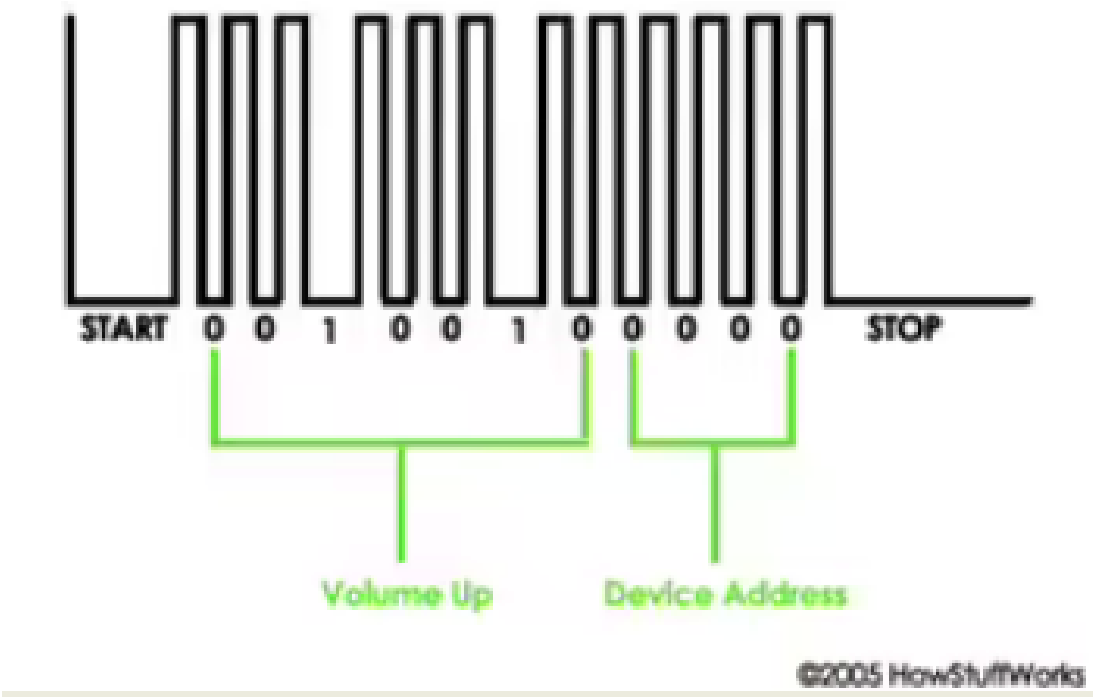

Figure 2.1: Example of wave generator for ”volume up” from [3])

The remote signal includes more than the command for ”volume up”. It sends several bits of information to the receiving device, including:

-> a ”start” command

-> the command code for ”volume up”

-> the device address (so the TV knows the data is intended for it)

-> a ”stop” command (triggered when you release the ”volume up” button)

In this case, the buttons that are needed and its codes are:

Power On = 001 0101

Power Off = 010 1111

Volume Up = 001 0010

Volume Down = 001 0011

3 Design

3.1 Hardware specification

- Block diagram with COTS components, if possible - List of constraints of functions to be implemented in HW or SW - Inclusion of a multiplexer may reduce SW burden - CPU peripherals: - PCA for wave generation

3.2 Hardware interfaces definition

- I/O ports - HW registers - Memory addresses for shared or I/O by memory mapping - HW interrupts

3.3 Software specification

Top-down methodology 1. Identify main subsystems 1. Signal input detector 2. Event handler 3. Output generator

3.4 Software interfaces definition

- Define the APIs in detail: - header files with: - functions prototypes - data structure declarations - class declarations

3.5 Start-up/shutdown process specification

3.6 Error handling specification

- Create error-handling routines - Watchdog timer can be used for system recovery

3.7 Design verification

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[1] Infrared remote controls: Inside. URL https://electronics.howstuffworks.com/remote-control1.htm. accessed: 2021-10-11.

[2] Lcd tv shipments worldwide by vendor 2015-2019. URL https://www.statista.com/statistics/668519/lcd-tv-shipments-worldwide-by-vendor/. accessed: 2021-10-11.

[3] Infrared remote controls: The process. URL https://electronics.howstuffworks.com/remote-control2.htm. accessed: 2021-10-11.