Deseño e implementación dunha gaita MIDI sen fíos en tempo real empregando software/hardware libre

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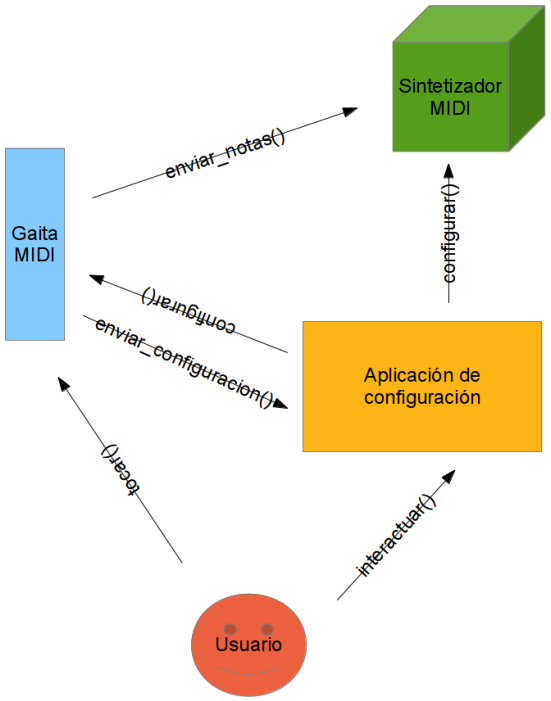
Introdución

- Obxecto
  - Simulación o máis fielmente posible dunha gaita galega
  - Recolleita e realización das esixencias do usuario
  - Análise do mercado
- Obxectivos principais
  - Sen fíos
  - Tempo real
  - Hardware e software libre
- Outros obxectivos
  - Estudo de viabilidade do mercado
  - Estudo de viabilidade das tecnoloxías
  - Estudo de viabilidade do software/hardware libre

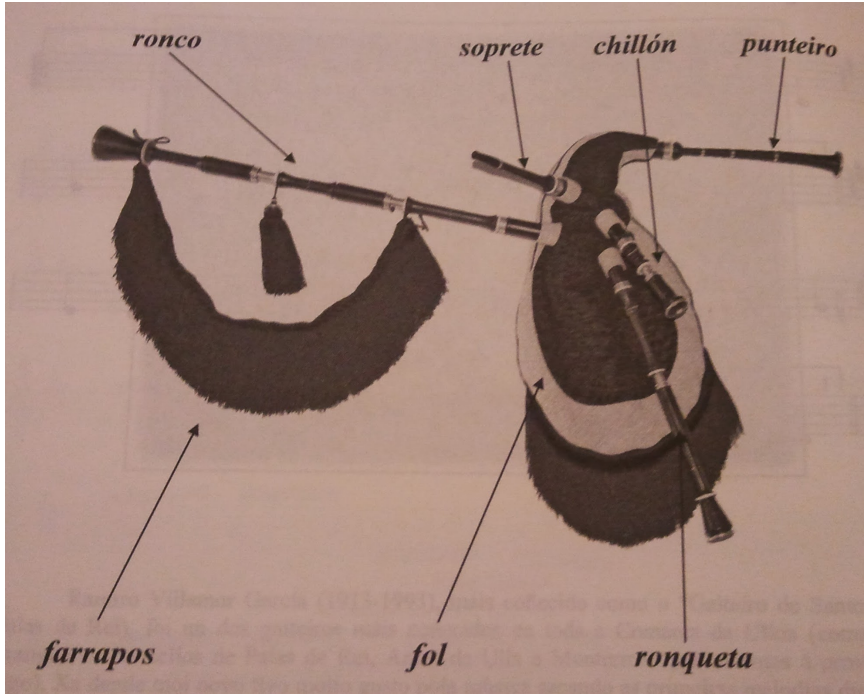
Introdución

- Motivación
  - Mistura de dous mundos académicos
  - Eivas constatadas no mercado MIDI
  - Problemáticas da gaita tradicional:
    - Ensaios no domicilio particular
    - Transcrición de melodías
    - Afinación en condicións desfavorables
    - Interpretación en varias tonalidades
    - Interacción automatizada con outros dispositivos
  - Conxunción de múltiples ramas da EI
  - Fomento da cultura libre

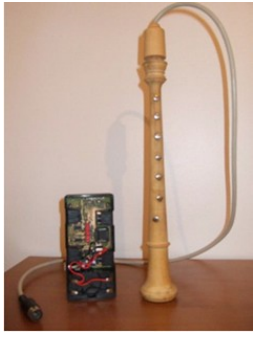
Visión xeral do sistema



Contextualización



Estado da arte



MIDI

- Musical Instrument Digital Interface
- Protocolo serie asíncrono dirixido por eventos que xeran mensaxes MIDI
- Mensaxe MIDI
  - Un byte de estado
  - Seguido de un ou máis bytes de datos
  - Exemplo:
    - 1001xxxx (Note on)
    - 00111100 (Valor 60 que corresponde á nota Do central ”C3”)
    - 0xxxxxxx (A velocidade ou intensidade co que se foi apretada a tecla)

Estudo de viabilidade

- Enquisa:
  - http://enquisa.proxecto-puding.org
  - Extracción de requisitos técnicos e económicos
  - Perfil do usario e coñecemento da competencia
    - Menor de 30 anos
    - Galego residente fóra das capitais
    - Gaiteiro medio con instrumento de seu
    - Predilección por preservar o tradicional con melloras tecnolóxicas
    - Coñece o concepto de gaita MIDI e algún modelo concreto e ten interese en mercar se o prezo é axustado
  - Favorable si, pero significativa?
    - Estimación da poboación total?
      - Problema de Fermi: 1500 gaiteiros
    - Tamaño da mostra necesaria?
      - Cálculo do tamaño mostral coñecido o tamaño da poboación: 90 gaiteiros (6% da poboación)
        -
    - Non significativa (mostra 10 < 90)

$$n = \frac{N}{1 + \frac{e^2(N-1)}{(z^2)pq}}$$

- Nivel de confianza do 95 %.
- $N = 1500$.
- $e = 0{,}1$.
- $z = 1{,}96$ ($\alpha = 0{,}05$).
- $pq = 0{,}25$.

Entón:

$$n = \frac{1500}{1 + \frac{0{,}1^2(1500-1)}{(1{,}96^2)0{,}25}} \approx 90$$

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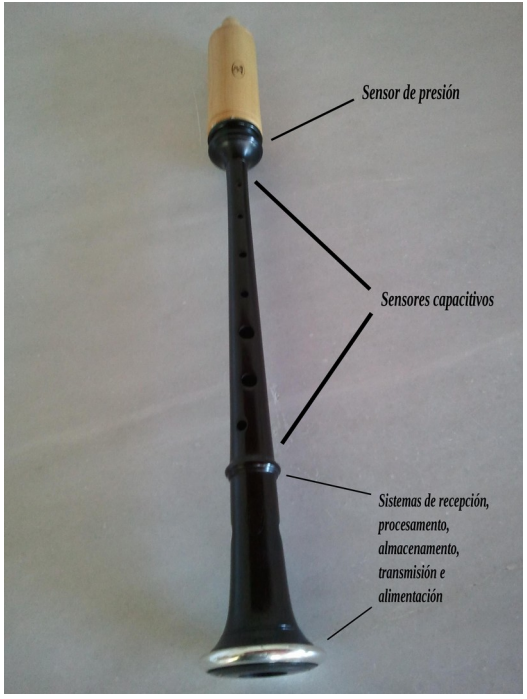
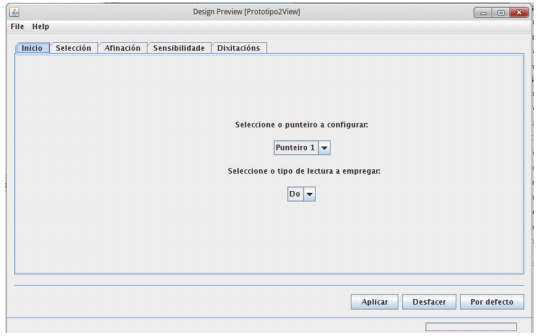
Primeiro prototipo

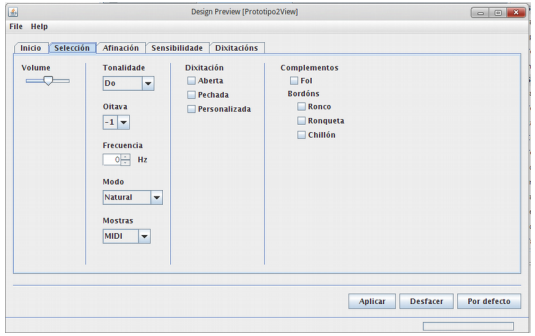


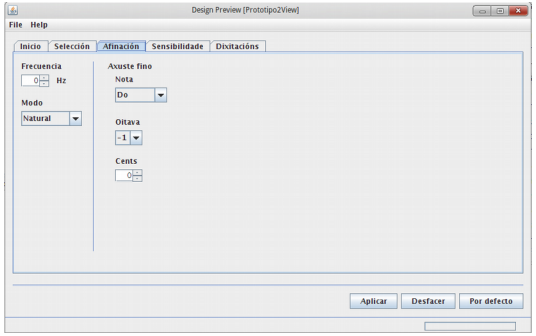
Análise de requisitos

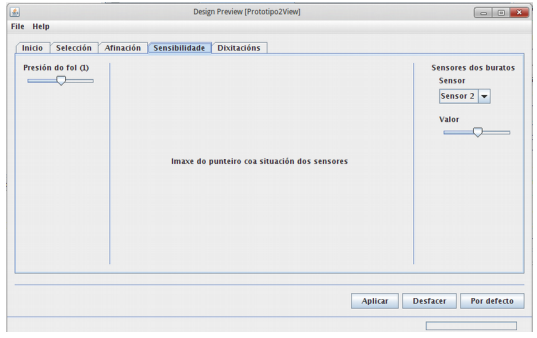
- Extracción de requisitos:
  - Por parte do proxectando
    - Coñecementos propios
  - Por parte de expertos
    - Sobre prototipos
  - Por parte dos usuarios
    - Enquisa

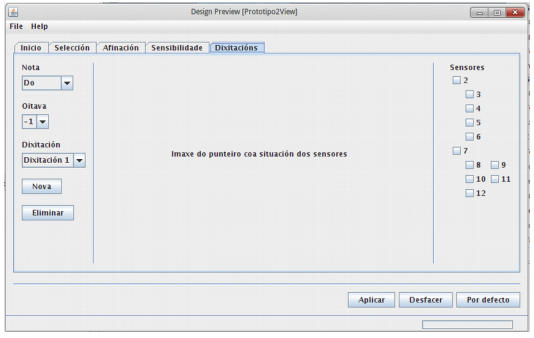
Segundo prototipo











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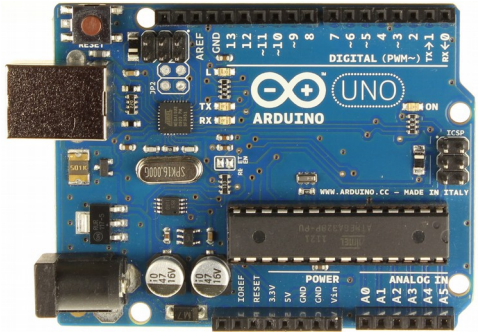
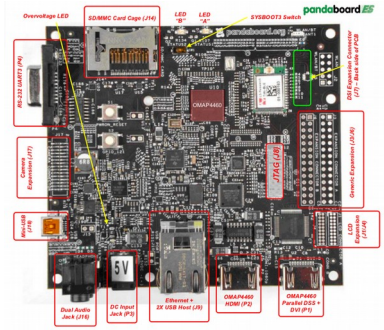
Deseño do sistema

- Hardware
- Software

Hardware avaliado





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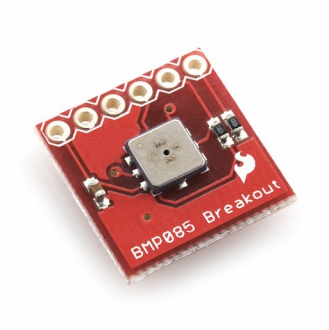
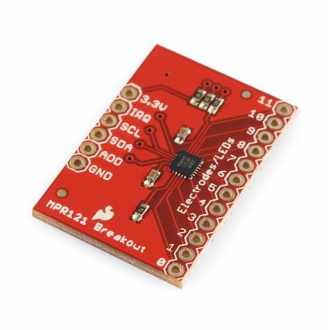
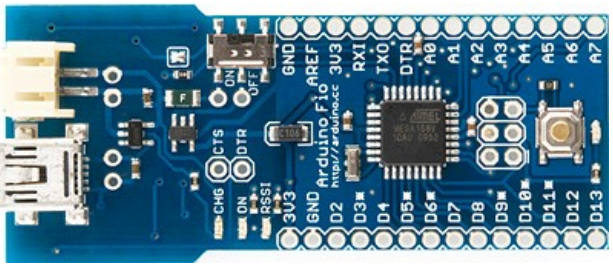
Hardware avaliado







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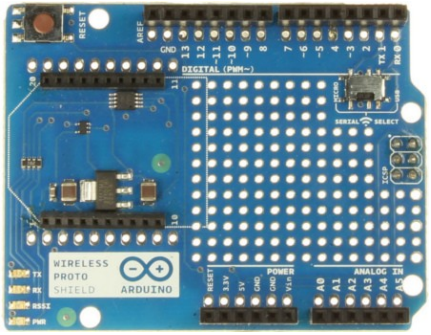
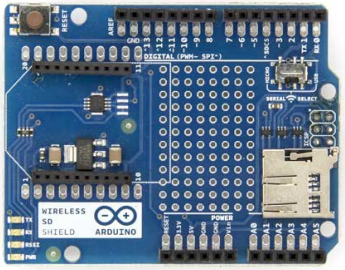
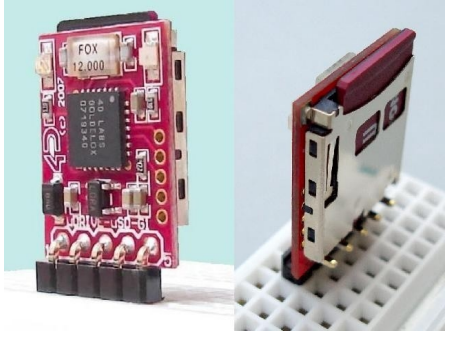
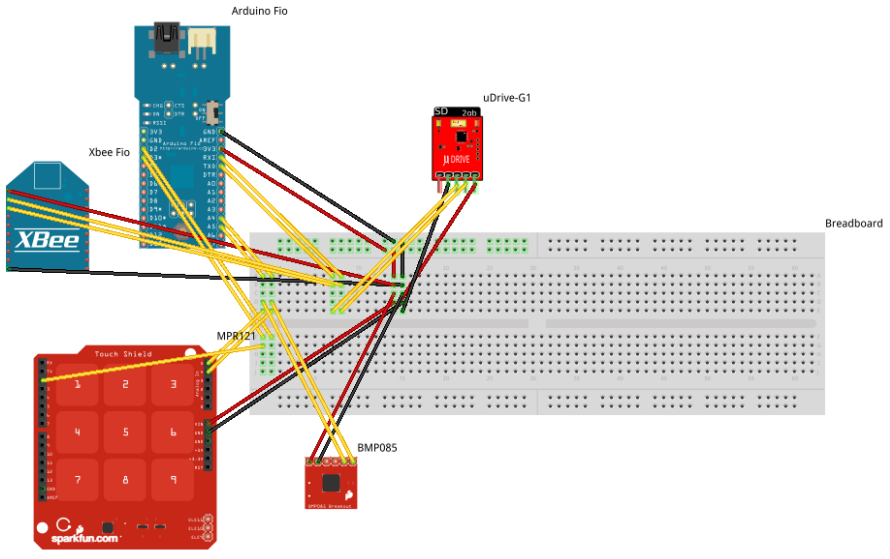
Hardware avaliado

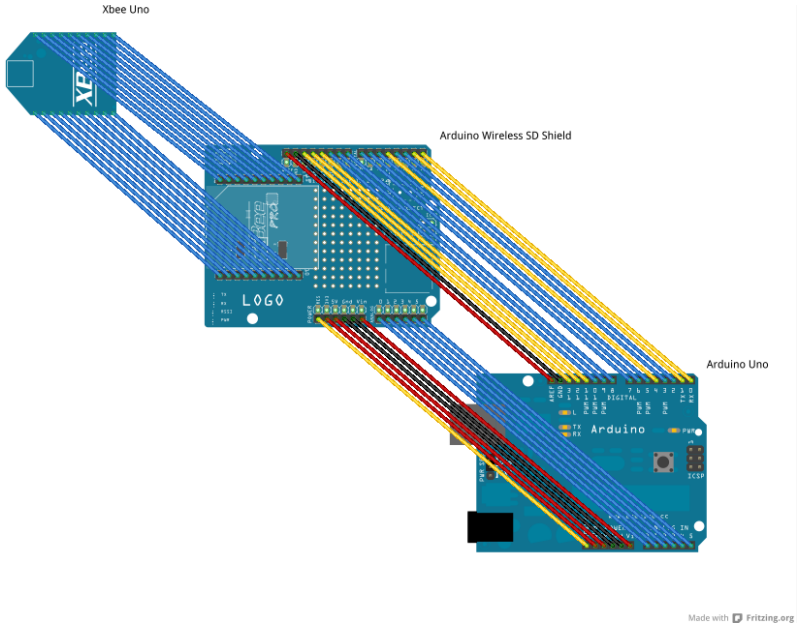




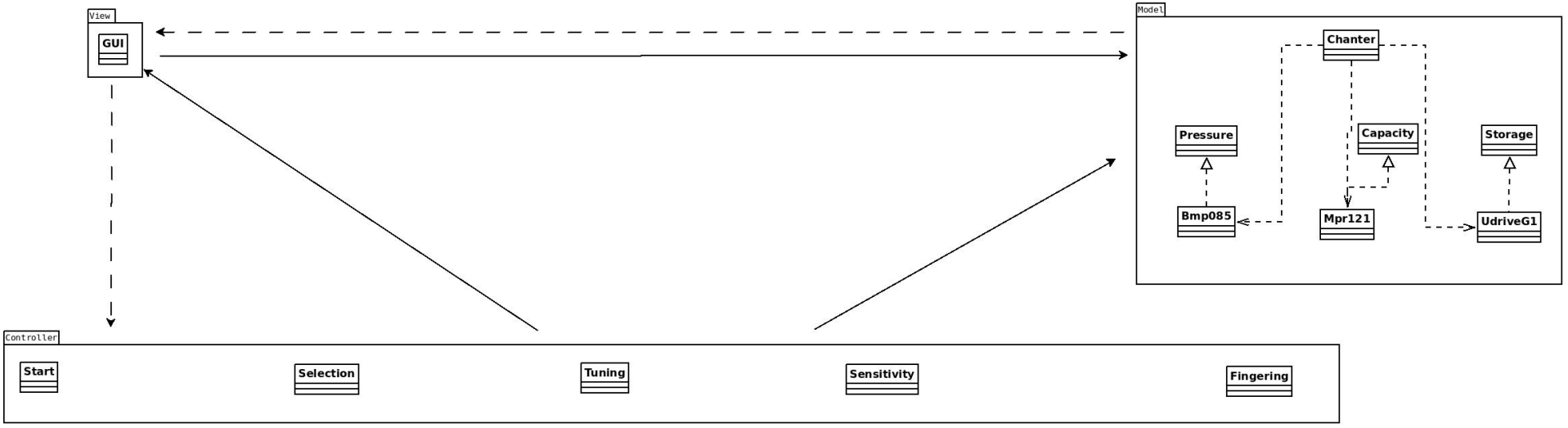


Deseño hardware





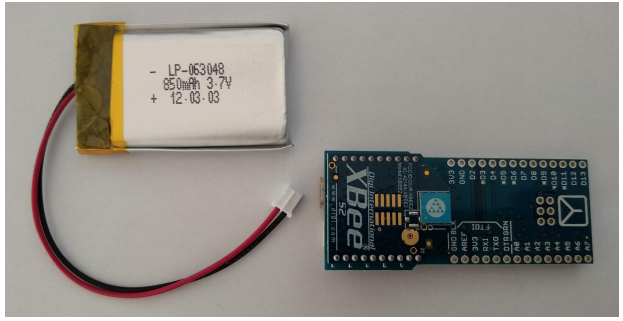
Deseño software

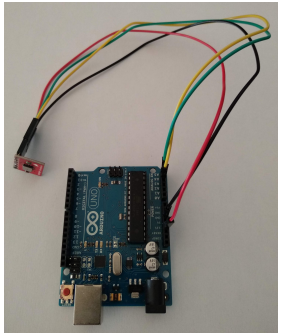


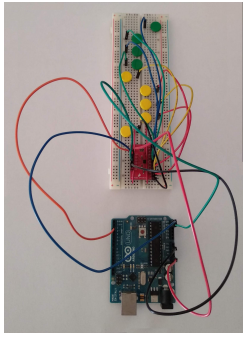
Desenvolvemento do sistema

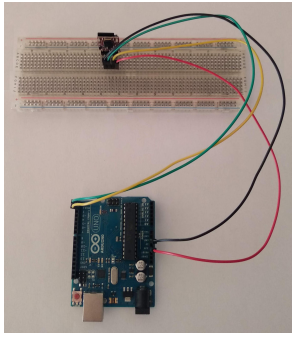
- Prototipo operacional
  - Hardware
  - Software
- Deseño detallado
- Ensamblado e codificación
- Probas (unidade, integración e aceptación)
- Documentación

Prototipo hardware operacional

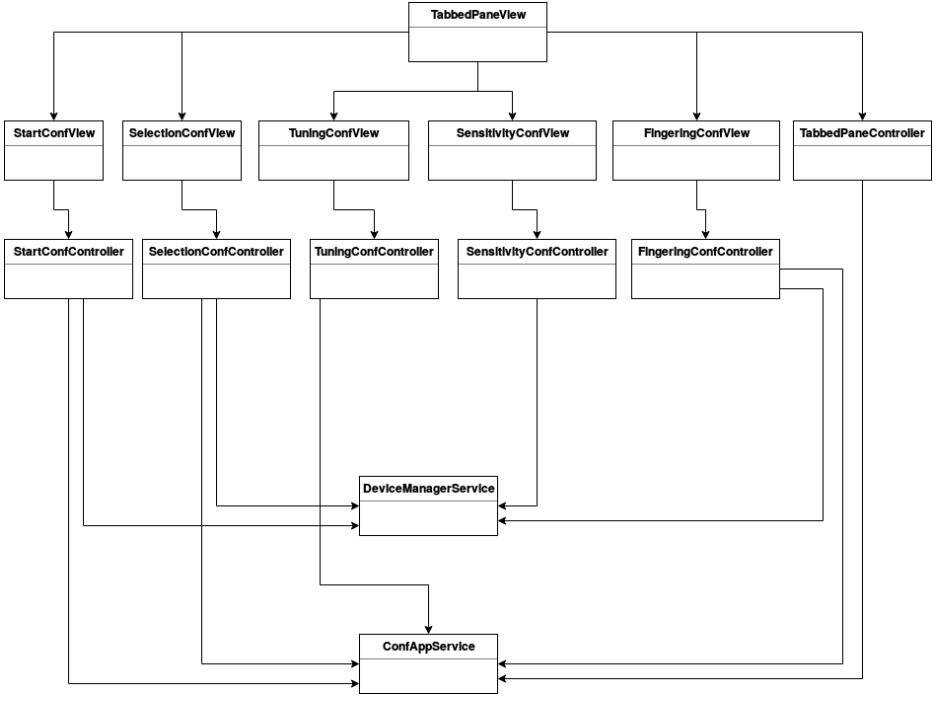








Prototipo software operacional



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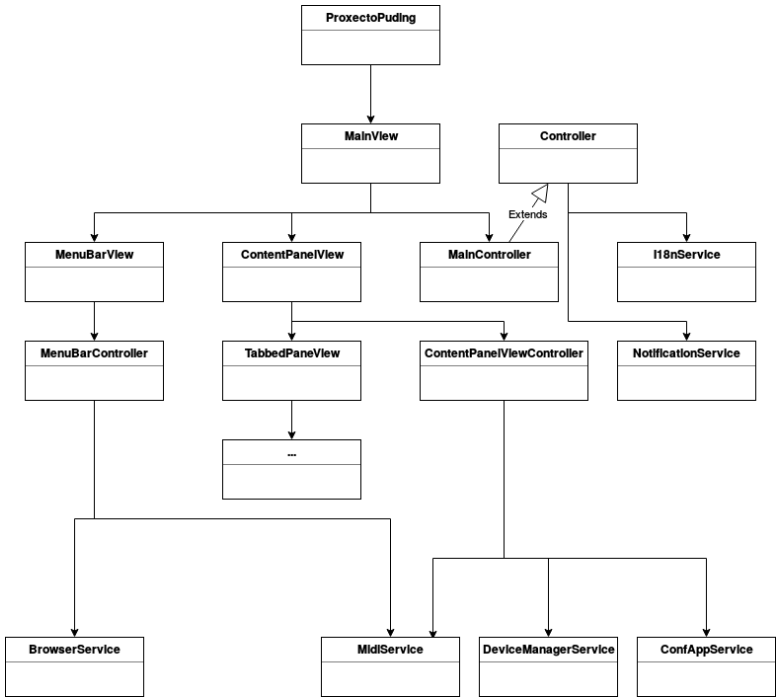
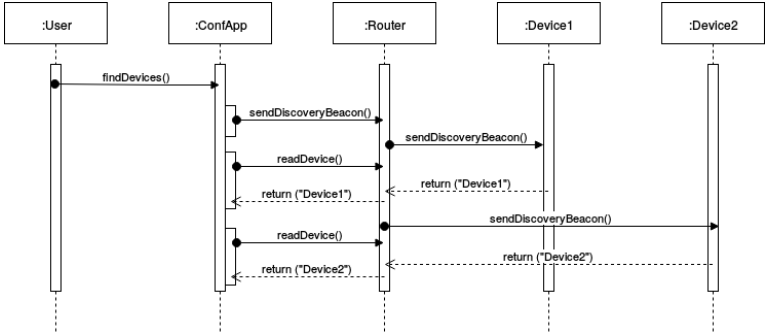
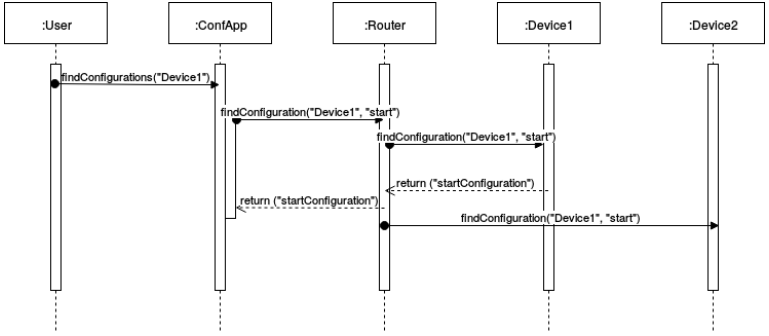
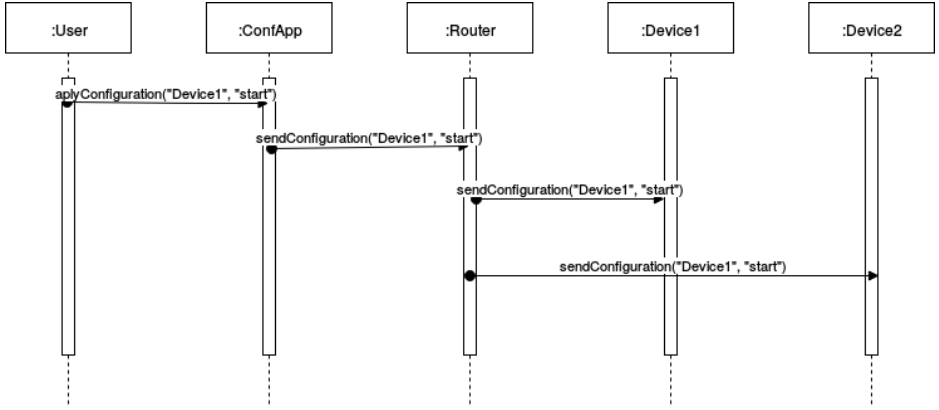
Deseño detallado



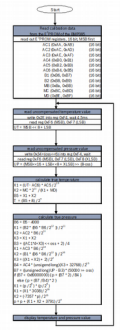
Deseño detallado

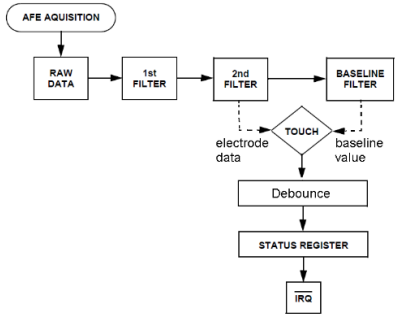




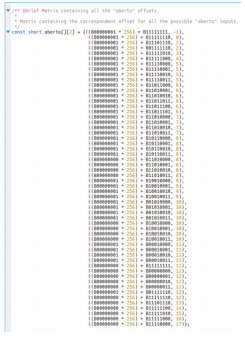


Ensamblado e codificación






```json
{
  "volume": 100,
  "fingeringTypes": [
    true,
    false,
    false
  ],
  "bagEnabled": true,
  "dronesEnabled": [
    true,
    false,
    false
  ],
  "productId": "A000000001",
  "action": "new",
  "type": "SELECT"
}
```



```
/** @brief Matrix containing all the "pechado" offsets.
 *
 * Matrix containing the correspondent offset for all the possible "pechado" inputs.
 */
const short pechado[][2] = {((B00000001 * 256) + B11111111, -1),
                            ((B00000001 * 256) + B11111110, 0),
                            ((B00000001 * 256) + B11101110, 1),
                            ((B00000001 * 256) + B11111100, 2),
                            ((B00000001 * 256) + B11111010, 3),
                            ((B00000001 * 256) + B11111011, 4),
                            ((B00000001 * 256) + B11110110, 5),
                            ((B00000001 * 256) + B11011010, 6),
                            ((B00000001 * 256) + B11011110, 7),
                            ((B00000001 * 256) + B10110110, 8),
                            ((B00000000 * 256) + B11011110, 8),
                            ((B00000001 * 256) + B10011110, 9),
                            ((B00000001 * 256) + B01011110, 10),
                            ((B00000000 * 256) + B10011110, 10),
                            ((B00000001 * 256) + B00011110, 11),
                            ((B00000000 * 256) + B11111111, 11),
                            ((B00000001 * 256) + B01111110, 12),
                            ((B00000000 * 256) + B11111110, 12),
                            ((B00000001 * 256) + B01101110, 13),
                            ((B00000000 * 256) + B11101110, 13),
                            ((B00000000 * 256) + B11111100, 14),
                            ((B00000000 * 256) + B11111010, 15),
                            ((B00000000 * 256) + B11111000, 16),
                            ((B00000000 * 256) + B11110000, 17)};
```

Ensamblado e codificación

MidiServerUnix.java

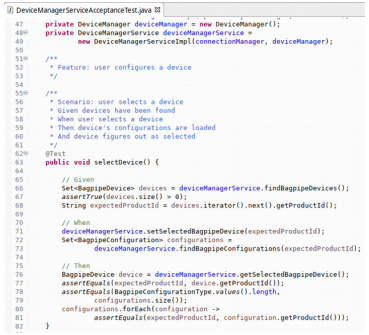
```java
package org.proxectopuding.gui.model.entities.midiServer;

import java.io.File;

public class MidiServerUnix implements MidiServer {

    private static final Logger LOGGER = Logger.getLogger(MidiServerUnix.

    private static final String REAL_SAMPLES = "--config-file=";
    private static final String FREQ_TABLE = "--freq-table=";
    private static final String VIBRATO = "--vibrato";
    private static final String CHORUS = "--chorus=n";
    private static final String DEF_CONFIG_FILE_PATH =
            "/etc/timidity/timidity.cfg";
    private static final String EXECUTABLE_PATH = "/usr/bin/timidity";
    private static final String TEMP_CONFIG_FILE_PATH = "/tmp";

    private final MidiServerGeneral midiServer;
    private String configFilePath;
    private String tablePath;

    public MidiServerUnix(MidiServerGeneral midiServer) {

        this.midiServer = midiServer;
        this.midiServer.setTempConfigFilePath(TEMP_CONFIG_FILE_PATH);
    }

    @Override
    public List<String> getCommand() {

        List<String> command = new ArrayList<String>();

        // Executable.
        command.add(EXECUTABLE_PATH);

        if (getConfiguration() != null) {
            // Real samples.
            if (getConfiguration().useRealSamples()) {
                configFilePath = getRealSamplesConfigFilePath();
                if (configFilePath != null) {
                    command.add(REAL_SAMPLES + configFilePath);
                }
            }

            // Tuning mode, tuning frequency and precise tunings.
            tablePath = getFrequencyTablePath(getConfiguration());
            if (tablePath != null) {
                command.add(FREQ_TABLE + tablePath);
            }

            // Continuous vibrato.
            if (getConfiguration().useContinuousVibrato()) {
                // Only for hardware not supporting manual vibrato.
                command.add(VIBRATO);
                command.add(CHORUS);
            }
        }

        return command;
    }
```

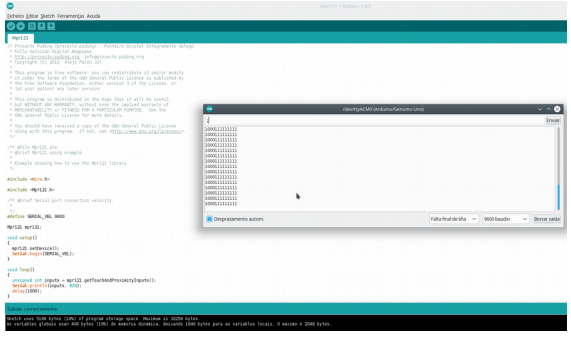
MidiUtils.java

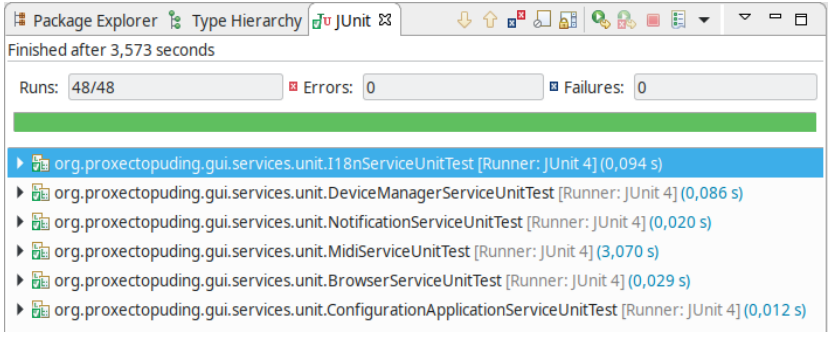
```java
package org.proxectopuding.gui.model.utils;

import java.io.File;

public class MidiUtils {

    private static final Logger LOGGER = Logger.getLogger(MidiUtils.class.getName());

    private static final String FREQ_TABLE = "freqtable.tbl";
    private static double[] pureIntonationRatios =
        {1.0/1, 16.0/15, 8.0/7, 6.0/5, 5.0/4, 4.0/3, 16.0/11, 3.0/2, 8.0/5,
            5.0/3, 7.0/4, 15.0/8};

    /**
     * Generate a table of tuning frequencies to be used by the MIDI server.
     * @param tone Base tone.
     * @param octave Base octave.
     * @param frequency Base frequency.
     * @param usePureIntonation Indicate if it is going to be used pure/just or
     * tempered intonation.
     * @param preciseTunings List of precise custom tunings for particular
     * notes.
     * @param path Directory path where the table is going to be stored.
     * @return The path to the generated table file.
     */
    public String generateFrequencyTable(int tone, int octave,
            int frequency, boolean usePureIntonation,
            Set<PreciseTuning> preciseTunings, String path) {
```

Probas

- Unidade, integración e aceptación
- Metodoloxías TDD/BDD
- 200 tests







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Demostración

Conclusións

- *“Os enxeñeiros somos como navallas suízas, valemos un pouco para todo aínda que non fagamos nada á perfección, pero a pouco que nos esforzamos, brillamos como ferramentas especializadas”*
- *Obxectivos principais*
  - *Sen fíos*
  - *Tempo real*
  - *Hardware e software libre*
- *Outros obxectivos*
  - *Estudo de viabilidade do mercado*
  - *Estudo de viabilidade das tecnoloxías*
  - *Estudo de viabilidade do software/hardware libre*
- *Cuantitativamente*
  - *Código: 18000 liñas*
  - *Tempo: 966 horas*
  - *Documentación: 400 páxinas*

Traballo futuro

- Lector de tarxetas
- Memoria
- Actualización do hardware
- Actualización da interface (Swing → JavaFX)
- Proxectando, doutorando, comunidade?

Traballo futuro

- Proxecto Puding
  - PUnteiro Dixital Integramente Galego
  - http://proxecto-puding.org

Agradecementos

- *“A aqueles que manteñen viva a nosa cultura e, en especial, ós que promoven que dita cultura sexa libre”*

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Deseño e implementación dunha gaita MIDI sen fíos en tempo real empregando software/hardware libre

Alejo Pacín Jul

Setembro 2018

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