

<b>BENTI</b> <small>DIGITAL AUDIO R&amp;D</small>	<b>DEMOCRACY DEV BOARD MATLAB SUPPORT</b>	heig-vd
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# Democracy DEV Board MATLAB Support

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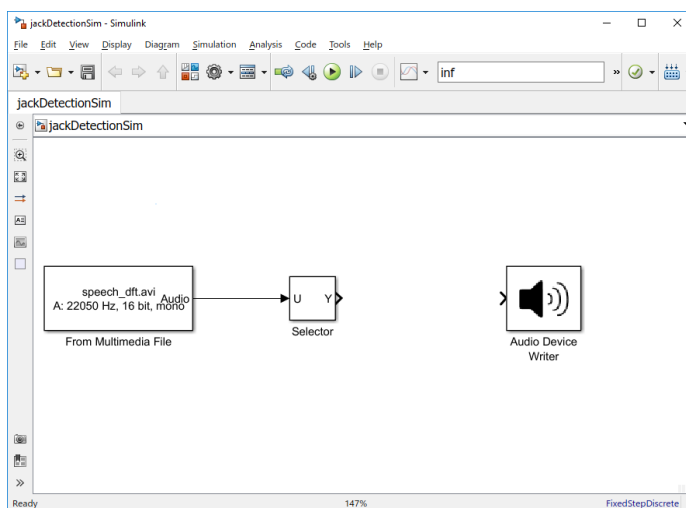
## 1. Audio processing rapid prototyping on the Democracy DEV Board with MATLAB

The MATLAB environment is a general purpose numerical computing environment, which allows you to model, simulate and test algorithms in a very wide range of application areas. Specifically, you can develop audio/sound processing algorithms that can be easily deployed on the Democracy DEV board for real time rapid prototyping.

You will find all the demo files (MATLAB R2016b release) in the “software/ML” folder of the USB stick. Please copy such folder into a working directory of your host computer.

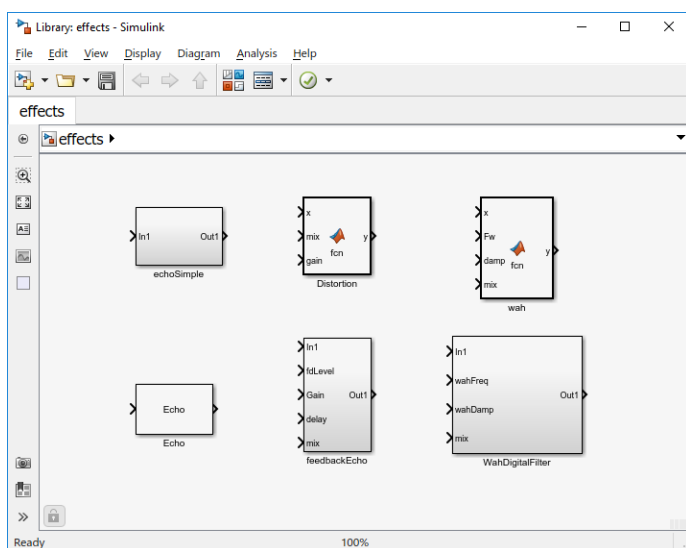
### 1.1. Simulating an audio processing algorithm in MATLAB environment

The Simulink model “jackDetectionSim.slx” is a template model to simulate audio processing algorithms on your host computer.



**Figure 1:** template Simulink model to simulate audio processing algorithms on the host computer.

You can find some simple digital audio effects in the “effects.slx” library.

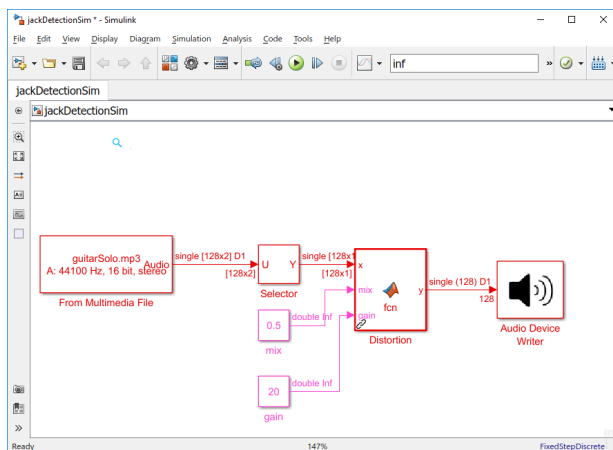


**Figure 2:** template Simulink model to simulate audio processing algorithms on the host computer.

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For example, you can simulate the distortion effect on the input audio file (also available in the same “software/ML” folder of the USB stick) by copying and pasting the Distortion block from the library to the template model. You can choose a specific value of the “mix” parameter (between 0 and 1) which sets the dry/wet signal weights, while the “gain” parameter ( $> 0$ ) determines the distortion amount.

Please give a look to the figure below for an example on how to connect the distortion block into the template model.

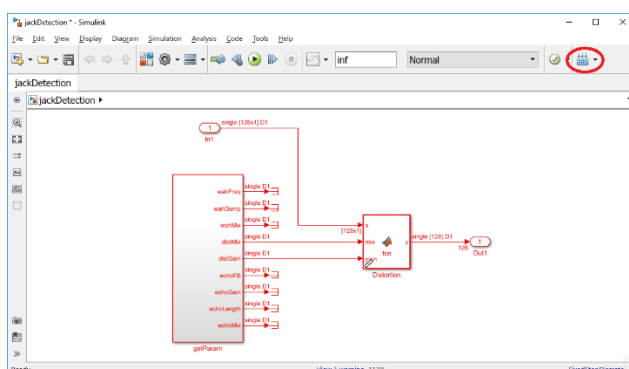


**Figure 3:** Simulink model to simulate the distortion effect on the host computer.

## 1.2. Deploying the algorithm on the Democracy DEV board<sup>1</sup>

Once you are happy with the developed audio processing algorithm, you can now run it on the Democracy DEV board by following the steps described below. Open the template model “jackDetection.slx”. Such second template is specifically dedicated to algorithm deployment on the Democracy DEV board. You will notice this model contains the “getParams” subsystem, whose purpose is to support parameters data tuning from MATLAB, as explained in Section 1.3.

Copy your algorithm into such model and connect the parameters ports to the getParams subsystem. The figure below is showing an example for the distortion effect.



**Figure 4:** Simulink model to deploy the distortion effect on the Democracy DEV board.

<sup>1</sup> Running audio processing algorithms on the Democracy DEV board requires MATLAB Coder, Simulink Coder and Embedded Coder add-ons on the host computer for C code generation.

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After that, click the “Deploy to Hardware” button in the top right of the model (marked with a red circle in Figure 4). This will generate the code to be executed on the Democracy DEV.

When the code generation process has finished, you can download the code on the Democracy DEV board. Make sure the Democracy DEV board is switched on and connected to your computer. To download the code, run the following script in the MATLAB command window<sup>2</sup>:

```
>> codeDownload
```

Now, connect to the Democracy DEV board as root (“sudo su”) through SSH and go into “/home/pi/Morpheus/mldemos/effect” folder.

Here, run the following scripts to compile the code, configure the Democracy DEV board and execute the audio application:

```
root@raspberrypi:/home/pi/morpheus/mldemos/effect# ./compileScript.sh
root@raspberrypi:/home/pi/morpheus/mldemos/effect# ./startup_process.sh -stop
root@raspberrypi:/home/pi/morpheus/mldemos/effect# ./startup_process.sh -start
root@raspberrypi:/home/pi/morpheus/mldemos/effect# ./detectionClient
```

Finally, connect your audio source (for example the guitar jack) to the “Guitar In” port, and get the audio out from the Amp Out port, for example by connecting a guitar amplifier – see Figure 2, page 6 of Democracy DEV board specification document for details on the connections.

You will be able to listen to the audio effect on the guitar signal running real time.

### 1.3. Run time parameter tuning

When you run the application, the parameters are set to default value. It is possible to change parameters values from MATLAB through an UDP connection to the application running on Democracy DEV.

An example MATLAB GUI is available to tune the audio effects from your host computer run time. It is assumed that the host computer is still connected to the Democracy DEV board through an Ethernet cable.

On the MATLAB command window, enter the following:

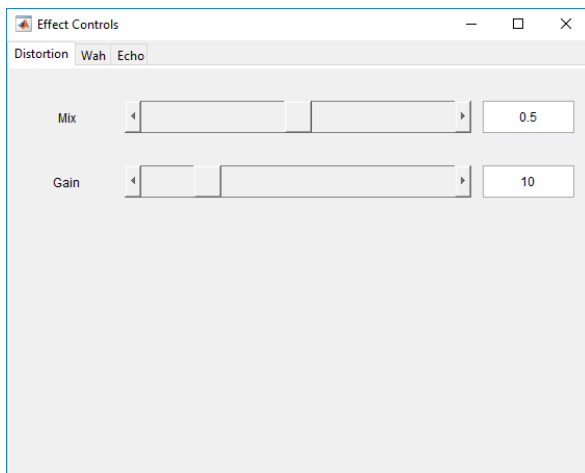
```
>> effectParamApp
```

<sup>2</sup> codeDownload script requires the freely available Simulink Support Package for Raspberry Pi Hardware installed in your host computer. To install the Support Package, please look at the documentation available at <https://www.mathworks.com/help/supportpkg/raspberrypi/ug/install-target-for-raspberry-pi-hardware.html>

Otherwise, you can open a SSH session to copy the needed files manually **from the host to the Democracy DEV board**:  
./jackDetection\_ert\_rtw/jackDetection.c -> /home/pi/morpheus/mldemos/effect/jackDetection.c  
./jackDetection\_ert\_rtw/jackDetection.h -> /home/pi/morpheus/mldemos/effect/jackDetection.h

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A GUI will open allowing you to tune the parameters of the audio effect (the distortion mix and the distortion gain in our example)



**Figure 5:** Example MATLAB GUI for run time parameter tuning.