Yusef Alimam – Summer 2021 Projects

# Design and Print Backplate

* Requirements:
  + Design and print a backplate capable of mounting the following devices
    - Dual radars with proper spacing and standoff heights
    - Cascade radar board
    - Mountable onto:
      * MJ45 and MJ50 track
      * Possibly also onto [Axidraw V3 XLX](https://shop.evilmadscientist.com/productsmenu/883)
  + Hardware:
    - [DCA1000EVM](https://www.ti.com/tool/DCA1000EVM)
    - Cascade Radar
      * [MMWAVECAS-RF-EVM](https://www.ti.com/tool/MMWCAS-RF-EVM)
      * [MMWAVECAS-DSP-EVM](https://www.ti.com/tool/MMWCAS-DSP-EVM)
    - [IWR6843ISK](https://www.ti.com/tool/IWR6843ISK)
    - [MMWAVEICBOOST](https://www.ti.com/tool/MMWAVEICBOOST)
    - [IWR1642BOOST](https://www.ti.com/tool/IWR1642BOOST)
    - MJUNIT MJ45 and MJ50 linear actuators
    - Standoffs
    - 3-D printer
* Deliverables:
  + CAD design(s) of backplate
    - Make sure this is very clean
  + Detailed instructional guide (with pictures) for printing from the 3D printer
    - This will be helpful for you and will help for the future
  + Documentation on the backplate regarding the position of each holes
    - Create a user manual for the backplate describing where to mount each radar
  + Printed backplate for mounting
  + Tested backplate on each of the requirements and working
* Tasks:
  + Dual Radars
    - Measure the radars and the exact antenna positions
    - Create design such that we mount two DCA1000EVM’s to the backplate and the antennas align perfectly in the vertical dimension
    - Purchase the proper hardware to ensure that the antennas are also at the same exact position “above” the backplate. You may need to purchase new standoffs with different heights to make this work properly
  + Single Radar
    - Reuse one of the locations for the dual radar
    - No changes necessary if dual radar holes are already created
  + Cascade Radar
    - Create the four holes necessary for the cascaded board
  + MJ45 & MJ50 Platforms
    - Measure the mounting hole locations on each platform and make necessary holes in the backplate
  + Axidraw Drawer
    - Devise a plan for mounting the radar to the drawer
    - May have to create a separate custom backplate for this that only uses one radar depending on the acceptable load on the drawer
  + Documentation
    - Create a user manual for the backplate describing how/where to mount each radar

# Axidraw Drawer Software

* Requirements:
  + Develop software to control the position of the drawer and look into its “up-down” ability to determine if it should be included as well
  + Create MATLAB software to perform necessary tasks
* Deliverables:
  + MATLAB software to control the position of the drawer written with OOP
    - Use the provided template for controlling the AMC4030 (our current scanner)
  + Documentation on using the MATLAB software you develop
    - Include how to control the device from MATLAB (which functions/methods to call and their arguments etc.)
    - Include how the MATLAB software controls/sends input to control the drawer itself
  + Documentation on how to install the axidraw software if necessary
* Tasks:
  + Understand the current axidraw control software
    - [Axidraw CLI (command line interface) software](https://axidraw.com/doc/cli_api/#introduction)
      * Look through this documentation and see if we can call functions from the command line (this is possible from within MATLAB) to send single commands to the drawer, e.g. move 10 mm in the x-direction, etc.
      * If it does have that functionality, then implement it into MATLAB code in the template and test all the various cases
      * If it does not have that functionality, then look into the python API
      * Ideally, however, we will completely bypass the axidraw CLI or python and communicate directly with the drawer
      * Deliverables:
        + Assessment whether we can directly call the CLI commands to control the device
        + MATLAB software calling the CLI commands

Well commented

* + - * + Documentation
        + MATLAB and documentation are not necessary if we can just directly communicate with the drawer
    - [Axidraw python API](https://axidraw.com/doc/py_api/#introduction)
      * Look through this documentation to see how the python communicates with the device
      * We want to just communicate directly with the drawer. Try to learn how the python code connects to the device and sends commands. If this is something we can recreate in MATLAB, implement the same type of functions in MATLAB in the template
      * Deliverables:
        + MATLAB code to control the drawer position

Well commented

* + - * + Documentation
        + Test that everything is working as it should
    - Provided
      * Josiah has made a template for the MATLAB code for you to fill in different sections with your code

# Build Scanners

* Requirements:
  + Build the 8020 frame
  + Mount the MJUNIT actuators
    - Need to interface with the [UTD machine shop](https://machineshop.utdallas.edu/) to get adapters for connecting the MJUNIT actuators to the 8020 frame
  + Mount the various electronic devices
    - AMC4030 motion controller
    - Stepper drivers
    - Power supplies for stepper motors, radars, etc.
    - HW trigger
  + Wiring
    - VERY CLEAN wiring between every device
    - Wiring to connect radars is out of the way of the scanner and very neatly done
      * Radars need multiple USB cables, ethernet cables, and simple connections to HW trigger
    - Might need to modify/extend radar power supplies cable length
    - Wiring needs to connect power to the stepper motors and stepper drivers. Need to connect homing switches to the AMC4030. More below
  + Create documentation for any finicky parts of the design. Anything that you think someone else would need to know in order to operate the mechanical portion of the scanner. Include the wiring of the AMC4030, stepper drivers, and stepper motors
  + Hardware:
    - 8020 frame
    - MJUNIT actuators
    - Adapters to mount the MJUNIT actuators on the 8020 frame
    - AMC4030 motion controller
    - 2x stepper motors
    - 2x stepper drivers
    - 2x homing switches
    - Power supplies for radar
    - Power supply for stepper motors (connects to stepper drivers)
    - Various USB/ethernet cables
    - Power strips, USB hubs, etc.
    - Might need to order nice cable wraps, cable mounting equipment.
* Deliverables:
  + Completed scanner
  + Tested all mechanical components and working as expected
  + Documentation
    - Include the wiring of the AMC4030, stepper drivers, and stepper motors with pictures to recreate in the future
* Tasks:
  + Start with the small scanner first, then build the downward-facing scanner later
  + Get the 8020 materials
  + Get the MJUNIT actuators
  + MJUNIT adapters
    - Take measurements on the 8020 frame and MUNIT connectors
    - Give simple (not CAD) design to the [UTD machine shop](https://machineshop.utdallas.edu/)
    - Get back finished adapters from machine shop
  + While waiting for the adapters from the machine shop, test the MJUNIT actuators, stepper motors, stepper drivers, and AMC4030
    - Connect the AMC4030 in the same way as for the current small scanner
      * Mount homing switches to MJUNIT
      * Connect homing switches to the AMC4030
      * Connect the pulse outputs from the AMC4030 to the stepper drivers
      * Connect to the PC using USB
    - Connect the stepper motors
      * Mount the stepper motors to the MJUNIT actuators
      * Connect the stepper motors to the stepper drivers in the same way as the current small scanner
    - Test the system using the MATLAB software developed by Josiah
  + Build the scanner
    - Build the 8020 frame from the design
    - Mount the MUNIT actuators with the machined adapters
    - Mount the stepper drivers, AMC4030, and power supply to the frame
    - Mount the stepper motors to the MJUNIT actuators
    - Mount the homing switches to the MJUNIT actuators
    - Wiring the stepper drivers
      * Connect the stepper motors to the stepper drivers as in the current small scanner
      * Connect power from the power supply (ensure voltage is appropriate)
    - Wiring the AMC4030
      * Connect the homing switches to the AMC4030
      * Connect the stepper drivers to the AMC4030
      * Connect the AMC4030 to the PC over USB
    - Test the movement first without the radars
    - Mount the radars to the horizontal MJUNIT actuator
    - Wiring the radars
      * Connect the radar USB and ethernet cables
      * Ensure that these cables are out of the way when the scanner is moving and make sure they don’t catch on anything when it is in motion
      * Use cable wraps, zip ties, mounting equipment etc. to make sure these will not cause any problems
    - Test the movement with the radars mounted
    - Test the entire system with the HW trigger (synchronizer) that Ben is designing
  + Repeat for the downward-facing scanner
  + Provided:
    - See [Muhammet’s paper](https://ieeexplore-ieee-org.libproxy.utdallas.edu/document/9136646), especially Fig. 6, for more detailed look on the system and wiring diagrams

# Important notes:

* Keep track of EVERYTHING
  + Every day you work, keep a diary (use OneNote or Word) of what you are trying and what works/doesn’t work with screenshots (+Shift+s [is an easy shortcut that lets you select where to screenshot and puts it onto your clipboard to paste anywhere you want](https://www.nextofwindows.com/windows-shift-s-new-way-to-take-screenshots-windows-10-creators-update)), links, etc.
    - This is most important if you are debugging someone else’s code or learning the API. Keep track of links that were helpful in a diary or things that were recommended by various people. Also keep track of things that you notice that aren’t working properly or are finicky
  + Remember the goal is always that someone could come behind you and repeat exactly what you did, but with ease
  + Use GitHub and a private repository for each task
  + As you are developing code, document it well with comments in the code, function descriptions, and a “user manual” for understanding the various functionalities