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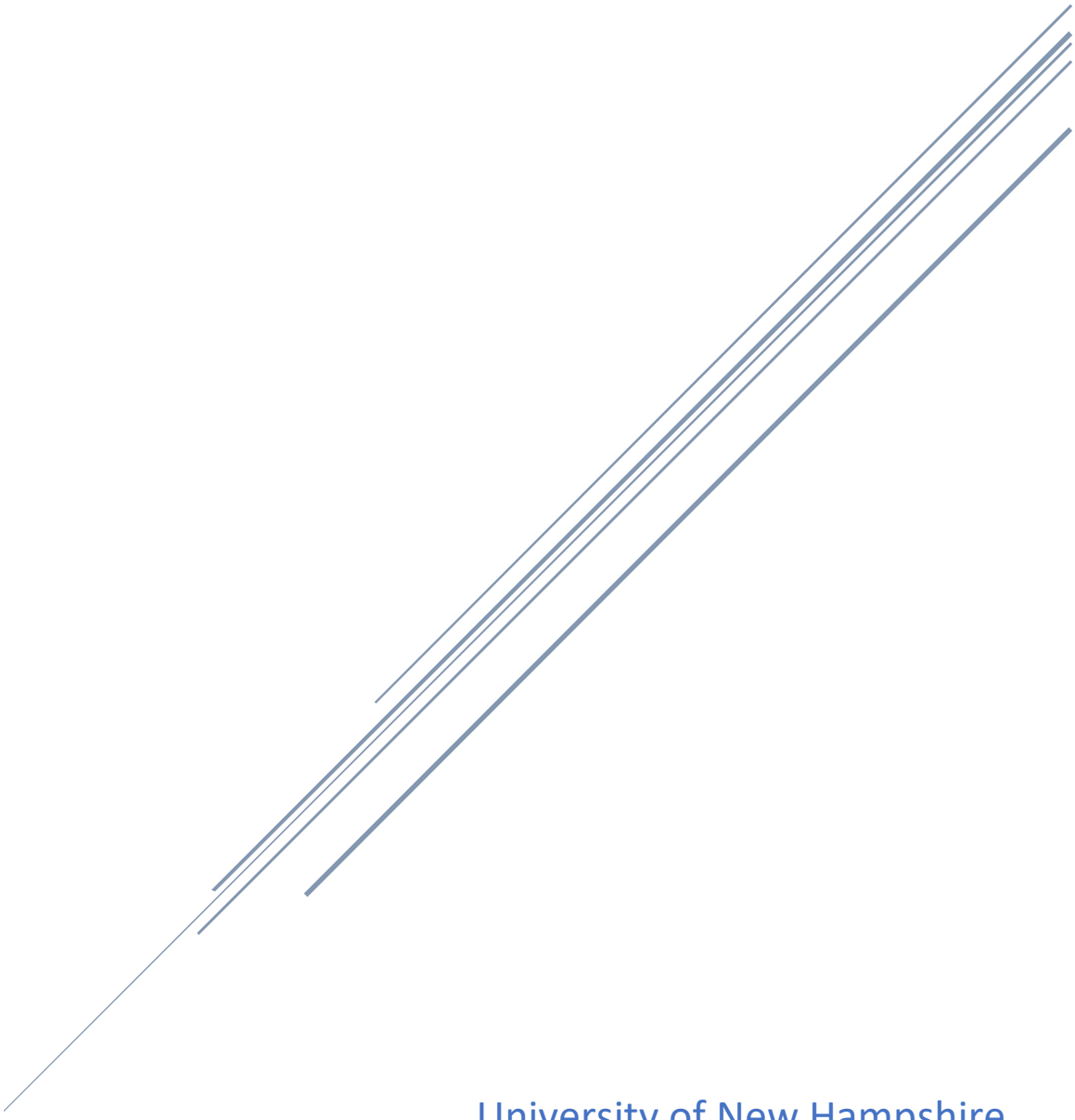

University of New Hampshire
Chase 185

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Daily Operation:

Guide on how to run the wavemaker's systems for lab use

Mechanical:

Operating the mechanical side of the wavemaker

Initial setup:

1. Prior to operation, ensure Initial Setup: Mechanical and Per-Operation Maintenance have been completed in entirety. These procedures can be found by referencing this document (See Page **INSERT PAGE**) and "Wave Maker Maintenance Guide" respectively.

Positioning the Wavemaker:

1. Pick up wavemaker and place frame slot over end wall of wave tank
   {INSERT MEDIA}
2. Ensure wavemaker is pushed as far forward into the tank as necessary to accommodate bottom limit trigger finger to move freely
   {INSERT MEDIA}
3. Adjust frame to ensure wedge is centered and straight down the wave tank
   {INSERT MEDIA}
4. Manually move wedge to its limits ensuring nothing is hitting unexpectedly

Getting Ready to Run:

1. Plug wavemaker into a GFCI protected outlet
2. Twist panic button to power on electronics
   {INSERT MEDIA}
3. If necessary, clamp wavemaker down to tank cart

Software:

Guide on how to use the wavemaker code to produce waves

Initial Setup:

1. Prior to running Arduino code make sure to complete Initial Setup: Software. This procedure can be found by referencing the Initial Setup section in this document (See Page **INSERT PAGE**)

Computer:

1. Check that toggle switch is OFF (unlit)
   {INSERT MEDIA}
2. Plug Arduino into computer via the USB A to B cable
   {INSERT MEDIA}
3. Open the most recent version of "WaveMaker" Arduino code
   {INSERT MEDIA}
4. Check *Arduino->tools->board* to make sure the board is recognized

Making Waves:

1. Under "Wave Properties" input values
   {INSERT MEDIA after updating code}

   Note: Ensure that *Period* ≥ 0.15×*Amplitude* to prevent calibration failure (Soon to be automatically done in code)

   Note: Check that *Center_cm+Amplitude* ≤ 0.5×*limit_distance* to prevent mechanical crashing (Soon to be automatically done in code)

2. Verify code prior to uploading to Arduino
3. Upload code to Arduino
4. Open Serial Monitor
5. Wavemaker will begin homing sequence (Watch Serial Monitor for details)
   {INSERT MEDIA}
6. Software calibration will run to fine tune movement (Watch Serial Monitor for details)
   {INSERT MEDIA}
7. Once calibration is complete use toggle switch to run or pause movement
   {INSERT MEDIA}
8. Turn off toggle switch prior to unplugging Arduino from computer

Common issues:

1. Can’t upload code
    a. Check your Arduino is recognized on the correct port
    b. Check for typos from adjusting parameters
2. Wavemaker won’t move
    a. Check that toggle is in the ON (lit) position
    b. Ensure the panic button has not accidentally been triggered
    c. Check wiring to Arduino for loose wires

Initial Setup:

How to setup wavemaker for use after storage or transportation.

Note: wavemaker should not be in tank.

Mechanical Setup:

How to setup the mechanical constituent of the wavemaker

Initial Setup:

1. Ensure all components are present
    a. Frame
    b. Wedge
    c. Belt and sled assembly (on frame)
    d. Electronics Shelf
    {INSERT MEDIAS}

Wedge:

1. Check wedge for cracks or deep cuts
    a. If cracked, apply solvent weld to crack and allow to dry 12 hours then sand
2. Bring sled to middle position
    {INSERT MEDIA}
    Ensure 4 mating bolts are completely flush with the back of the sled
    {INSERT MEDIA}
3. Place O-rings onto each bolt shanks
    {INSERT MEDIA}
    Note: the O-ring should be squished between sled acrylic and back acrylic of wedge. Apply O-ring grease if necessary
4. Take off wedge lid
5. Slide wedge, pointing down, onto bolts
    {INSERT MEDIA}
6. Place washers inside wedge against back wall acrylic
    {INSERT MEDIA}
7. Gently start each wingnut onto the four bolts

{INSERT MEDIA}

Note: These bolts are ALUMINUM and can strip very easily so take care

8. Finger tighten the wingnuts in a circular pattern until each nut is two-finger tight
9. Ensure all bolt head lay flush against the back plate of sled assembly

{INSERT MEDIA}

10. Replace wedge lid

{INSERT MEDIA}

Belt:

1. Gently set wedge at bottom position
2. Check that zip-ties holding belt ends are tight and in good condition

{INSERT MEDIA}

3. Path belt around pulleys, motor, and rotary encoder
    a. Around bottom
    b. Bottom part of belt straight up over white pulley
    c. Pull belt around motor pulley
    d. Over top of rotary pulley
    e. Under black pulley
    f. Around top pulley

{INSERT MEDIA}

4. Ensure the pulley is correctly pathed <u>IF IT ISN'T STUFF CAN BREAK</u>
5. Loosen wingnuts on black idler

{INSERT MEDIA}

6. Slide black idler against pulley until belt is taught (roughly ½" of give when pressed

{INSERT MEDIA}

7. Tighten wingnuts on black idler
8. Check that the belt is riding on white idler
    a. If idler isn't engaged, loosen wingnuts and slide white idler forward until belt engages.

{INSERT MEDIA}

9. Check that the wedge can be easily moved up and down manually (gentle so as not to crash the limit switches)

Electronics Shelf:

1. Loosen all six bolts as far as possible
   {Insert Media}
2. Ensure rails are loose
3. Slide 80/20 rails into top of frame sliding shelf assembly as far back as possible
   {Insert Media}
   Note: The motor/encoder/limit wires like to get pinched between frame and shelf assembly so take care SHOULD ONLY REQUIRE LIGHT PRESSURE TO SLIDE
4. Firmly tighten down all six bolts

   Note: To remove shelf, do process in reverse.

Electronics:

1. Plug in components
   i. Motor
   ii. Upper limit
   iii. Bottom Limit
   iv. Rotary Encoder
   v. Toggle Switch
2. Check all Electrical connections
   {Insert Media}

Software Setup:

How to get a new computer ready to run the wavemaker

Arduino:

1. Install Arduino IDE on local system
   https://www.arduino.cc/en/software
2. Run Arduino IDE

Libraries:

1. Open Arduino IDE
2. Click Tools->Manage Libraries

{INSERT MEDIA}

3. Install libraries
    a. *“AccelStepper”*
    b. *“Encoder”*

    {INSERT MEDIA}

Note: These libraries can also be found on project repository

Firmware Integration:

1. Ensure toggle switch is off
   {INSERT MEDIA}
2. Plug Arduino into computer
   {INSERT MEDIA}
3. Click Tools and check that the board is recognized
   {INSERT MEDIA}

Maintenance

How to keep the wavemaker in tip-top shape.

Per-Operation Maintenance:

Perform prior to plugging in wavemaker

1. Belt Tension
    a. Check belt is sufficiently taught (should deflect a maximum of ½" when pressed)
    b. Ensure black idler is tight
    c. Ensure White idler is tight
    {insert media}

2. Rotary Encoder Engagement
    a. Check that rotary encoder pulley is contacting the belt
    b. Manually move wedge up and down to check that the pulley tracks without skipping
    {insert media}

3. Wiring Connections
    a. Ensure no jumper wires have detached from Arduino
    b. Check that all ribbon cables are firmly attached to breakout board
    c. Check limit switch wiring
    {insert media}

4. Frame Alignment
    a. Manually move wedge up and down within tank to check for collisions
    {insert media}

5. Switch Triggering
    a. Manually move wedge to top limit
    b. Listen for top switch to click crisply
    c. Manually move wedge to bottom limit
    d. Listen for bottom switch to click crisply
    {insert media}

6. Panic Button
    a. Plug in wavemaker
    b. Twist panic button
    c. Check that the wedge cannot be easily moved manually
    d. Press panic button firmly
    e. After brief delay ensure wedge can now move freely
    f. If wedge remains firmly in place after panic switch is pressed do not operate wavemaker

    {insert media}

Weekly Maintenance

Remove wavemaker from tank prior to maintenance

1. Recoating Wedge [TREAT WEDGE]:
    a. Spray light coat of white lithium grease onto a paper towel
    b. Wipe paper towel over wedge surface
    c. Buff wedge surface with paper towel until grease splotches are no longer visible
    {insert media}

2. Cleaning Water [CLEAN WATER]:
    Note: Only compete as needed
    a. Drain old water from tank
    b. Refill with new water
    c. Add treatment media

3. Lubricating Rails and Axels [LUBRICATE RAILS & AXLES]
    a. Ensure wavemaker is powered off
    b. Move wedge to bottom limit
    c. Spray light coat of white lithium grease into rails above wedge
    d. Moe wedge to top of movement
    e. Spray light coat of white lithium grease into rails below wedge
    f. Wipe away excess with paper towel
    g. Use excess to gently lubricate top and bottom axle bearing points
    {insert media}

4. Checking Wedge Seal [CHECK WEDGE SEAL]
    a. Check that wingnuts inside wedge are finger-tight
    b. Ensure O-rings are properly squished
    c. Check for any cracks in wedge acrylic
        i. If cracked, flood crack with solvent weld and allow to dry for 12 hours. If crack still leaks, coat crack with gel based super glue and allow to cure.

    {insert media}

Monthly Maintenance:

Remove wavemaker from tank prior to maintenance

1. Check Fasteners are Tight [CHECK ALL FASTENERS]
    a. Use 5/32 Allen to ensure all frame brackets are tight
    b. Use 5/32 Allen to ensure axle bearings are right
    c. Use fingers to gently ensure wedge fasteners are all tight
    d. Use 7/16 socket to ensure electronics sled is tight
    e. Use {GET MEASUREMENT} to ensure motor bracket is tight
    f. Use Philips screwdriver to ensure limit brackets are tight

2. Check Rail Parallel [CHECK RAIL PARALLEL]
    a. Use calipers to measure top rail spacing
    b. Use calipers to measure bottom rail spacing
    c. If necessary, loosen frame brace wingnuts and adjust top/bottom spacing
    d. Repeat until rails are parallel

    {insert media}

3. Cleaning Belt and Idlers [CLEAN BELT & IDLERS]
    a. Loosen black idler
    b. Disengage belt from pulleys
    c. Use damp towelette to wipe down pulley
    d. Wipe down pulleys and idlers
    e. Reengage belt
    f. Tension Belt

    {insert media}

4. Check for Wear [CHECK PARTS FOR WEAR]
    a. Check linear slides, rotary encoder pulley, lower limit trigger, and idlers
    {insert media}

Pre-Lab Shutdown Maintenance:

1. Remove Tension from Belt [SLACKEN BELT]
    a. Loosen black idler
    b. Ensure belt is loose
    {insert media}

2. Dry and Store Wavemaker [DRY & STORE]
    a. Use paper towels to wide standing water from wavemaker surface
    b. If available use pressurized air to dry thoroughly
    c. Depress panic button
    d. If necessary remove wedge
        i. Loosen wingnuts inside wedge completely
        ii. Pull wedge from sled
        iii. Place all loose hardware inside a zip-lock inside the wedge
        iv. Ensure no O-rings have been misplaced
    e. Coil cord loosely around frame
    f. Store in upright position do not store resting on wedge or power supply unit
    {insert media}

Future Features:

A place to track future feature ideas and needs

Time Series Rotary Encoder Data

The ability to output the rotary encoder time series date to an array would be beneficial for experiment precision. This could be achieved through an interrupt handler(?). Or more directly by creating a master slave setup between the Arduino UNO and a Raspberry PI.

Improved Microcontroller

A faster microcontroller would allow for a broader spectrum of movement speeds. Currently the minimum period is directly proportional to the amplitude of movement. With a faster microcontroller the max step speed wouldn't be hindered on a firmware side. An Arduino DUE would be optimal, however, with enough pain and suffering, the same thing could be done with a Raspberry Pi.

Freeform Movement Input

Consider only after upgrading the microcontroller. It may be possible to take a signal generator input in as an analog input and interpret that waveform as a position vs time function. Using that interpreted signal software could mimic the movement. This upgrade to the hardware and code would essentially allow for much more complicated waveforms than just sinusoids.