1.txt = lid closed room temp 2.txt = li open room temp 3-7.txt = lid open slightly warm

TRR feedback

- worried about coatings -
- thermal model: mesh and nodes -
- pcituers of model not clear at all
  - high and low temp in graph
  - were the results good or bad?

Concerns with project in general

uers of model not clear at all
- thermal model run time
-

Upcoming deadlines * **AIAA Paper due to Wingate** --- March 8th ------ 2 Weeks (end of TRR 2week) * **AIAA Paper due to Class** ----- March 15th ------ 3 Weeks * **Last day to Machine**---------- March 22nd ------ 4 Weeks

Todo

- AIAA
  - Started
  - What can be improved
  - Whats Missing
- Finish placing thermocouples on intial test bed
- Wire 2 cameras with longer wires for test.
- Capture grid images for image processing and get thermocouple temps
  - This will help with IP tiling and quantify roughly how close camera measurements are to actual (thermocouple) measurements.
- Revisit machining schedule and make sure there are enough hours to complete by march 22
- Talk about timeline for inital coatings test
  - Need to capture grid images first.
  - Need to have the DAQ for thermocouples (have it for 2 weeks)
  - Test on a tuesday most likely.
  - Would be best to have image processing working up to the point of making control decisions. i.e. being able to map and tile images after stitching for comparison to the thermocouple data.
- Distribute the load of soldering to 1-2 people other than jake
  - micah
  - pierre (?)
  - start soldering power resistors and connectors to pcbs
  - This should be done by march 22nd so we can fully assemble the stack

- Lepton Thermal management test
  - need to recieve and solder pcb for RaspberryPi
  - Finish software (not much progress so far but isnt complicated)
  - heat and cool thermistor. check that power resistor turns on/off at proper time
  - also check that power resistor is outputting proper amount of heat
  - check that power resistor doesnt continue heating for too long.
  - i.e. "heat inertia" isnt too high.

AIAA Notes

- pierre -- place thermocouples
- nash -- setup daq with wires
- justin -- labview programs
- Jake -- wire cameras with longer wires
- d

Long wire test planning

- starting with 15 ft length of wire
- 4.57m
- Materials: 1 Lepton, Pi, breadboard, wires,
- Procedure:
- start with 4.57 m length wire.
- plug lepton into breadboard and stripped wires into breadboard
- Other end of wires will be semi permanently attached to pi
- A video image will be transmitted over this connection with SPI.
- if video data is not corrupted, test is successful
- if video data is corrupted, test is unsuccessful and a shorter wire length is needed
- test with incrementally shorter wirelength at the sizes specified below.
-

Update

- Manufacturing almost done
  - Assembly of test bed next
- long wire test in progress. may need more supplies
  - Take test images of grid
- reference data system hardware almost done
  - Software close to being done?
  - Once software is done, thermistor adhesive tests needs to be done
- Update on Lepton Thermal Management system
  - individual testing once pi pcb is done
-
-

Todo

. email GA about scheduling chamber testing
. talk to nabity about chamber availability (jake)
. finish up image stitch module
.

April 7th-13th

- Complete assembly of testbed by Friday
- functional testing of all systems.
- Room temperature full test on sunday.

Todo: * instrument thermistors * solve calibration problem with thermistors * finish machining and putting together test bed * mount cameras * run functional camera->IP->results test * Prepare removable walls * 1 grid wall * other coating wall(s) * Come up with LED indicator solution (actual LED pcb wont be here on time) * * new sd card for Pi. Error analysis for thermistor system by

- How were project goals achieved and to what extent
- Discuss design changes since TRR and overview systems
- FOCUS IS ON VERIFICATION AND VALIDATION
-

• Questions to address:

. what is the projects purpose
. what were its specific objectives
. how was success measured
. What were Critical Project Elements for meeting success criteria
. Key design requirements and how they were verified
. How was overall performance validated?

OUTLINE

Project Purpose and Objectives (5%)

- Describe field of applications
- problem addressed.
- potential impacts
-
- Levels of success. which lvls did we reach in each category
- tie lvls of sucess with tests in later sections
-

- # Design Description (15%)

- high level description of final project design.
- major changes since TRR
- CPE's ## Test Overview (15%)
- Describe testing. which tests and why. label and organize tests in terms of their importance.

- # Test Results (45%)

- Tests results, analysis.
- Compare results to expected outcomes from previous analysis/calculations
- Show how results validate design decisions, proper functionality, etc.
- Include uncertainty estimates and how it may affect validation.
-

- # Systems Engineering (10%)

- sumarize systems engineering approach use the V.
- identify and explains main issues and challenges during execution.
- key lessons learned at sys eng lvl.

- # Project Management(10%)

- Summarize project management approach.
- Show key management successes and difficulties
- lessons learned in terms of management?
- Show comparison between planned budget (CDR) and actual budget
- Calculate industry cost of project assuming 65000 salaries for 2080 hours of work. include overhead rate of $200 per hour

Agenda Tue Jan 15

Organization

. Discuss meeting times
. Intro availability spreadsheet
. Discussion on how to make this semester more productive

Status Update

Mechanical / Manufacturing

- Standoffs how

- how to fasten bay walls. l-brackets, l-bar.
- rubber seal?
- camera mount, make 2 into 1.
- rubber feet

Electronics

- power regulation for OTheRS
- Reference data system
- Heat control system
- basic off / on full stack Control

Controls

- Whats left to control? Indicator LED's handled by IP.

Software

- Image Processing Progress: A start to stitching, but ned images @ correct skew angles to test.

Thermal Modeling

- Solid works model of test bed?
- Thermal Desktop?
- Ansys?
- Ask trudy about

Todo

. Evaluate progress and assign more specialized roles

. Finalize number of heaters to drive at one time

- Then finish and finalize PCB design. order asap.

. Conduct in depth software review and assess where more help is needed

Week3 -- General Notes

. ~~make appointment with matt to go over final design and workout details~~
. Create BOM and get materials ordered/finish any design details so we can get things ordered
. Set detailed manufacturing schedule
. get weekly availability for team outside of normal class time
. Create Meeting Agenda

Test Bed Manufacturing Q's and Concerns

- Rubber gasket along the wall?
- Wiring connector holes in each tray, clarify if we need D-type
- Pass through location for stack. how to manufacture
- Pass through location bay. Floor or side wall. (thinking wall)
- 96 + 36 wires through the bay passthrough. ways to secure
- How are we going to construct bay walls. L-bracket? discuss other methods
- how will we harness thermistor wires
- how will we insulate the thermistor nodes from radiation and convection
- take off tabs on front and back
- thermistor connector on each tray

Wingate answers

- start coming up with cabling/wiring diagrams, gauge size, color, connector type, etc.
- Overall wiring for each subsystem possibly.
- look at CDR for Vantage or Ghost to look at wiring diagrams
- ask trudy about insulating
- electrical epoxy??
- use zip ties to keep wires together
- aluminum tape
- ***Use Scotch Weld***
- Have criteria for examination.
- reflection?

- temperature?

- dimple the thermistor location?

Test thermistor connection

- fasten thermistor to plate, heat to known temperature, then check that measurement doesnt interfere.

- test multiple fastening methods

- come up with concrete criteria to test for each Coatings

Coatings Test Plan

- 4 general ideas
- simple reverisble
  - sticky notes

    - tape spray paint
    - calibration stickers
- Surface roughness
    - slowly increase surface roughness by sanding
- change material i the slot
    - plastics,
    - metals,
- Coatings
    - if we can even do it.

Solidify test plans, esp. how we will calibrate, validate, and otherwise

- Have a **WELL DEVELOPED** coatings test plan for MSR
- ask matt what he expects to see from an MSR.

- Setup a meeting with Wingate & Jackson about thermal modeling. ASAP

- Focus on test plans

- get presentation done early to make tweaks later.

Initial coatings test setup

- This week design test
- next week start reinstrumenting thermocouples, make sure we have all the hardware

todo

- MSR by next thursday
- wiring diagrams
- coatings test plans
- Tuesday meeting: IP presentation, electronics.
- Follow up about wiring diagrams
- devise thermistor fastening test.
- Outline MSR presentaiton
- Find out what needs to be done to inital test bed to get it up and running
- Tweak gannt chart and add detail as needed based on new manufacturing changes

adrian.stang@colorado.edu email about workshop with availablility

MSR expectations

- informal briefing
- review/ status update of progress
- highlight top req's if helpful
- reminder of design

- color code solidworks to show parts that are done/in progress/not started.
- ^^ same with electrical and software. Wiring diagrams and overall flow chart for software. Colorcode where possible
- Clear as possible, tryto anticipate questions
- Are there divergences from initial design and why
- what challenges have been encountered. plans for mitigation, etc.
- hint at TRR (i.e. small look forward to what we can expect by TRR)
- pictures of real results where applicable
- talk aout procuerment progress/ manu progress etc
-
- print camera mount create .STL file
- form labs form 2 3-d printer

Week3 -- MSR Notes

. Includes Manufacturing, Electrical, Software, etc.
. Updated CPE's
. Project status update
. Justify the way we are spending time and how things are being scheduled.
. Describe what will be manufactured and why. emphasize critical aspects.
. Explain how every manufactured item works in the system.
. Whats left to do? manufacturing wise.
. Current Status: schedule, budget, procurement.
. Not required to attend MSR or TRR
. Show progress
. Avoid high level/ambiguous statements. Be detailed and specific.
. What are we struggling with
. Are things going as expected
. What are you worried about
. No fluff. for real.

Format:

(same for TRR) SFR is like CDR, but can ask questions. - 25 min presentation including questions - plan to talk for 20 min. PAB can interrupt. - need to be concise and clear, to avoid too many questions. - 20 ish slides

Sections

- Project Overview [10%]
- Schedule Update [20%]
- Manufacturing Status [60%]
- Budget Update [10%]

Meetings

- agenda
- quad chart to show overall status
- normal stuff

Week 4 Agenda Jan 22nd, 2019

. **Weekly Update**
. **Software Catch up/Review**
. **Electronics Review**
. **MSR assignments/details/discussion**
. **Stack Design Update and Review**
. **Identify Project Main Concerns**

To-do's

- cable length test -- lepton
- thermistor adherance Test
- Create thermistor fixturing Test
- needed: adc, arduino, thermistors.
- get 2-3 fixturing compounds
- imagej -- basic IP for coatings testing
- Coatings testing
- get thermocouples working again
- IP software needs to be ready
- Really good slide about coating plan
- "Things we needed to address at CDR SLIDE"
- Coatings test plan
- how to stitch based on lopez's recommendation
- Reach out to justin and get on with
- Be ready to answer questions about wire harnessing (backup slides)
-
- 2 slides
- schedule up to TRR
- schedule

Notes

Weekly Updates

- name
- note

MSR

- What to include in the Overview
- MSR should have detailed, color coded diagrams

- Schedule should clearly show progress, identify concerns

- **Include**

. Coatings test plan
. Full Wiring diagrams
. Concrete software results / progress

Software Catch Up

- 2 sides to Software
  - getting info from lepton 75%
  - IP
  - image stitching --library ypicked Outline
  - actually merging images has not been done
  - After analysis
    - nothing?
  - Software for pwm drivers 0%
  - Software for thermistors 0%
  - Need hardware

Software Organization

. Get 1 lepton running on pi
. Get 2 leptons running on pi
. Stitching

- how to hard code geometry
- one time spatial calibration method?

. Cutout Data

- how will we recognize which parts of the image are the stack

. Warp

- research. will this affect data fidelity?

. Calibrate

- is lepton default temp calib. satisfactory?

. Extract Data into x file format

- research

.

Use main script to link everything together

bash script or crontab to schedule operation

Week 4 Agenda Jan 22nd, 2019

. **MSR**

To-do's

•

Notes

. **Manufacturing**

- Camera mount
  - done
- tray
  - prototype in progress
  - 0/6 trays.
- bay
  - 0/1 bay
- major materials ordered

. **Software**

- Heater control Software
- Reference Data software
-

. **Electronics**

Notes From Thermal Model meeting -- Jan 31st

- Model only 1 tray
- Make plan for what we would do if we had time and money
- Make sure we have a case that we can validate
- Run model, then run test for camera
- model coatings? probably not-- absolutely not
- WIth model: try to make sure that the solution is grid independent: (because sims are approx. distance btw points are related to errors in the gradients.) --make sure btw 2 mesh sizes (half size of grid). btw successive simulations, temps are within the accuracy of what makes sense for the system we are validating

- Need to figure out what temperature range we are expecting to compare. Come up with a method to estimate temperature
- Simple model of a plate with heater underneath, then do that test to compare and validate relative model accuracy
- Simple resistance model? --get a ball park idea of what to expect from the more detailed solid works model.
- BOTE calc.
-

TLDR; make a simple model. validate it with a test. then add a piece, test, etc.Overall break the model down into individual components that could be pieced together into a more complex model once validated.

Week 8 Feb 7th,2019 * AIAA abstract revisions * prepare intial test bed for camera testing - mounting solution for top Camera - print 2 revised camera mounts * reinstrument thermocouples on intial test bed * Thermistor test - glue testing 3 glue types. - insulation? research ().

* Boards - ordered from china - heater driver boards - thermistor boards -

Notes for TRR

1. Identify Saftey Aspects in the project (Dr.G really wants to see this) - Grounding - how safe is our testbed from inaccuracy. i.e. explain the assumptions we are making and reasons why we are reasonably confident these assumptions will not negatively affect test results. - Example: we are assuming cameras dont move at all, get inadvertantly bumped, etc. Does our test environment allow for this? and are there any checks in place to make sure this doesnt happen. - Safety concerns for coatings application. fumes, acids melting your face off, etc. - All safety aspects such as the examples above need to be included in the main presentation

2. Need to see a model and tests to validate the model (i.e. our only model is the thermal model so we will need to have results from that as well as details on how it will be validated.

3. Tests - PAB wants to see performance testing. i.e. quantifying the test performance not just not just whether or not we hit any given requirment. How well did it meet the requirement? - Ideas: coatings performance, processing time, how well are the images being stitched, etc. - It will be especially important to go over our thermal chamber testing as it will be our final and most comprehensive test.

4. Explicitly tie all tests

Comments from MSR that need to be integrated into TRR

1. Update CONOPS to reflect design changes 2. More clarity in testbed design, have dimensions with pictures. (they didnt understand the design until we went to the backup slides) 3. MARGINS MARGINS MARGINS: wanted to see schedule margins, budget margins, how much time and money would it take to rebuild important aspects of the project (i.e. margins), other margin things i cant think of right now. 4. Talk about how assembly/manufacturing choices will affect the thermal model. i.e. using thermal paste in the tray joints. 5. Do we have time to remake pcb's? (also a margin thing). 6. Do we have enough money to get a new Lepton? 7. The test bed slide was to much to absorb in a few seconds 8. Better explaination of how the testbed will be assembled.

Finally, a dump of my original notes if you want to look at how messy

Notes for TRR

- Identification of Safety
- Grounding in main presentation
- See a model and a test to validate the model or test plan for model validation

- ^^ Use the thermal model ^^
- Some type of performance testing. i.e. how does it compare to requirments, not just whether or not it met the requirement. Quantification of tests
- ^^ performance testing with coatings
- How well are we stitichig images, how well are we measuring temperatures etc..
- processing time.
- Talk through thermal chamber tests
- Plan for final tests ^^
- Set up a meeting with the TA's to go over TRR _- explicityly tie tests to requriements
- Need a thermal model to be done before TRR
- Need to have image processing working on the raspberry pi. (atl least rudimentary)

MSR comments: - CONOPS needs to be updated. - didnt undersatnd manufacturing intially - Margin in budget to buy IR camera - confused about overview. Why IR camera vs system - slide 3 needs dimensions - schedule was good. - Need to know Schedule margin - test bed slide was too much to absorb in a few seconds - electricalsystem good - need safety in presentation - how to assume cameras dont get bumped. do we check that every time? - coating application safety - When talking about thermal model if using thermal paste, then mention that - lots of questions about various margins - Better explaination of how testbed will be assembled - Do we have time to remake pcb's - need better margins on everything, cost time, time to remake important components, etc. - SAFETY STUFF

Notes for TRR

- Identification of Safety
- Grounding in main presentation
- See a model and a test to validate the model or test plan for model validation
- ^^ Use the thermal model ^^
- Some type of performance testing. i.e. how does it compare to requirments, not just whether or not it met the requirement. Quantification of tests
- ^^ performance testing with coatings
- How well are we stitichig images, how well are we measuring temperatures etc..
- processing time.
- Talk through thermal chamber tests
- Plan for final tests ^^
- Set up a meeting with the TA's to go over TRR _- explicityly tie tests to requriements
- Need a thermal model to be done before TRR
- Need to have image processing working on the raspberry pi. (atl least rudimentary)

MSR comments: - CONOPS needs to be updated. - didnt undersatnd manufacturing intially - Margin in budget to buy IR camera - confused about overview. Why IR camera vs system - slide 3 needs dimensions - schedule was good. - Need to know Schedule margin - test bed slide was too much to absorb in a few seconds - electricalsystem good - need safety in presentation - how to assume cameras dont get bumped. do we check that every time? - coating application safety - When talking about thermal model if using thermal paste, then mention that - lots of questions about various margins - Better explaination of how testbed will be assembled - Do we have time to remake pcb's - need better margins on everything, cost time, time to remake important components, etc. - SAFETY STUFF -

Upcoming deadlines

- **Self Evals** ---------- March 1st ------ 1 Week
- **TRR** ---------- March 4th ------ 1 Week + 1 weekend
- **AIAA Paper due to Wingate** --- March 8th ------ 2 Weeks (end of TRR week)
- **AIAA Paper due to Class** ----- March 15th ------ 3 Weeks
- **Last day to Machine**---------- March 22nd ------ 4 Weeks

Project Status and Concerns

. **Image Processing**

- Current methods have some serious issues
  - See powerpoint slides to visualize issues.
- Assigning areas of research and testing for each person in IP.
- Problems Encountered in Testing
  - Initial test bed is not good enough to provide accurate mounting
  - High emmisivity stickers start bubbling when aluminum is heated
- Need testing/information on how well the temperature is being read across the skewed image
  - before deciding how to change geometry (if neccessary) need to know if high skew is going to give good enough accuracy
  - Would be best to simplify mounting geometery (i.e. reduce number of angles involved in image) to make it easier and likely more accurate to get temperature data.

. **Testing that still needs to be addressed**

- Need to test Leptons with long wires (3m).
  - Aquire the long wires (order today if ready)
  - Be prepared for alternatives
    - different signalling protocol
    - place pi inside of test bed with a thermal regulation solution.
- Test Thermistor Adhesion methods

    - Is any one working on this?
    - Make an assignment to research and choose 2-3 best methods
    - Run test
    - elements to consider:
        - should dimples be used in final design
        - is it necessary to insulate thermistors from incident radiation
        - Best solution for verifying temperature measurements externally
- Testing new solutions found for image stitching

. **TRR**

- upate conops
- update schedule
- update budget
- Testing (ryan)

. **AIAA Paper**

- Start an outline, wait for more results from testing
- Prioritize testing as much as possible to accomodate AIAA paper.
- Brainstorm outline, what should be highlighted in the paper
    - Focus on potential benifits of IR cameras vs thermistors
    - present methods for doing so (IR camera and IP mostly)
    -

TRR Improvement

-

. resinstrument thermocouples
. get two cameras working together
    - long wires
    -
. run tests to determine wattage/ time to heat
. get script running to stitch image halves.
. long wire test
. email ian and christine about time slot on saturday
.

Test: Longwire -> 2 camera -> thermistor adhesive -> model validation

Longwire test materials

- 4 ethernet sockets

- 10 ethernet connectors

- ~6m cable

- : destructive test. start longer go shorter?

Image Processing Outline

. Stitch Images.
. Map images to grid that centers on thermistors
. ^^(warp?)
. geomtericCalibration (gui to choose center line)
. control decisions (tray per tray, too got too cold)
. serial communication
. glue script