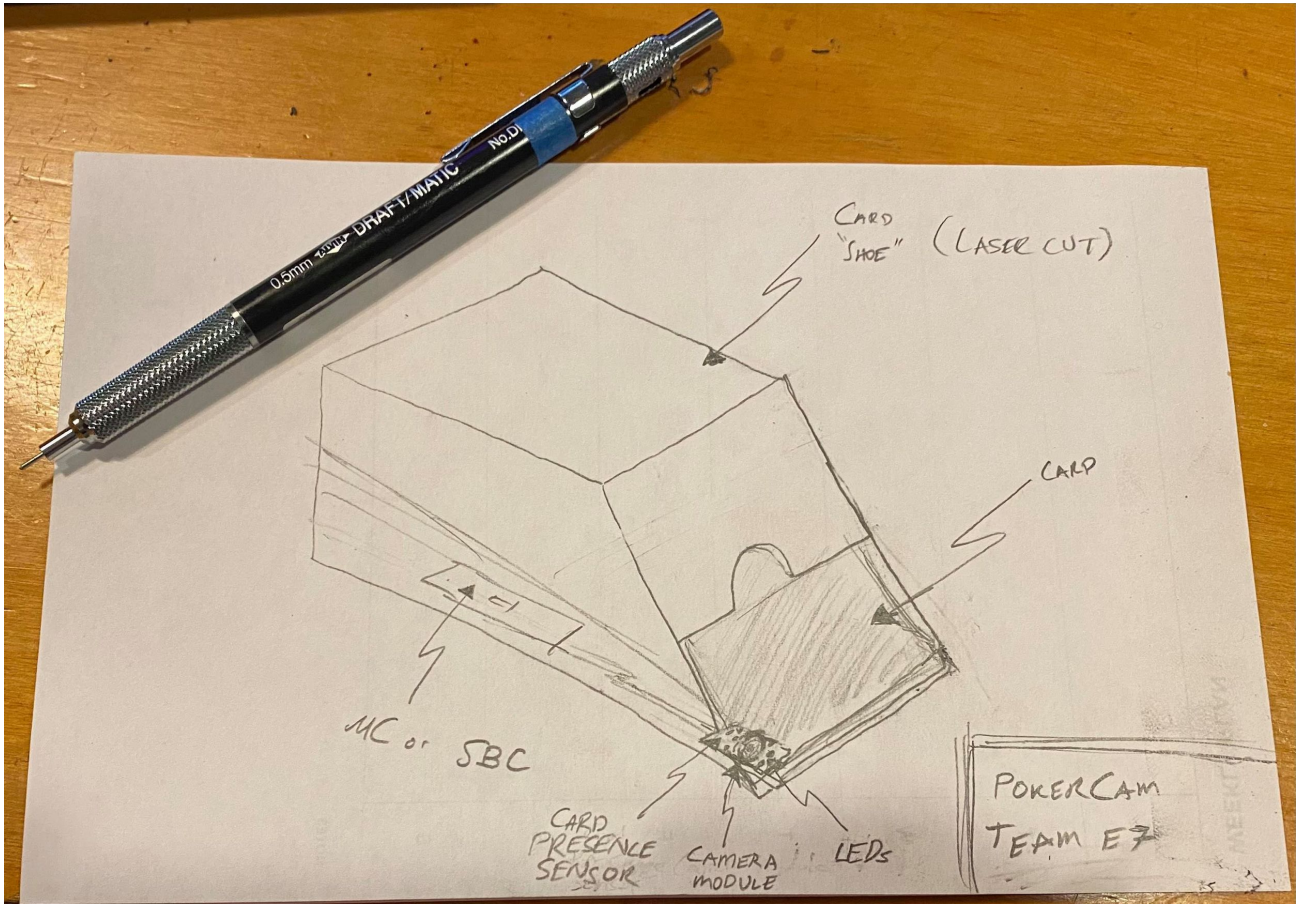
Spring 2021 - Team E7

Jeremy Klotz, Ethan Rich, and Sid Domala

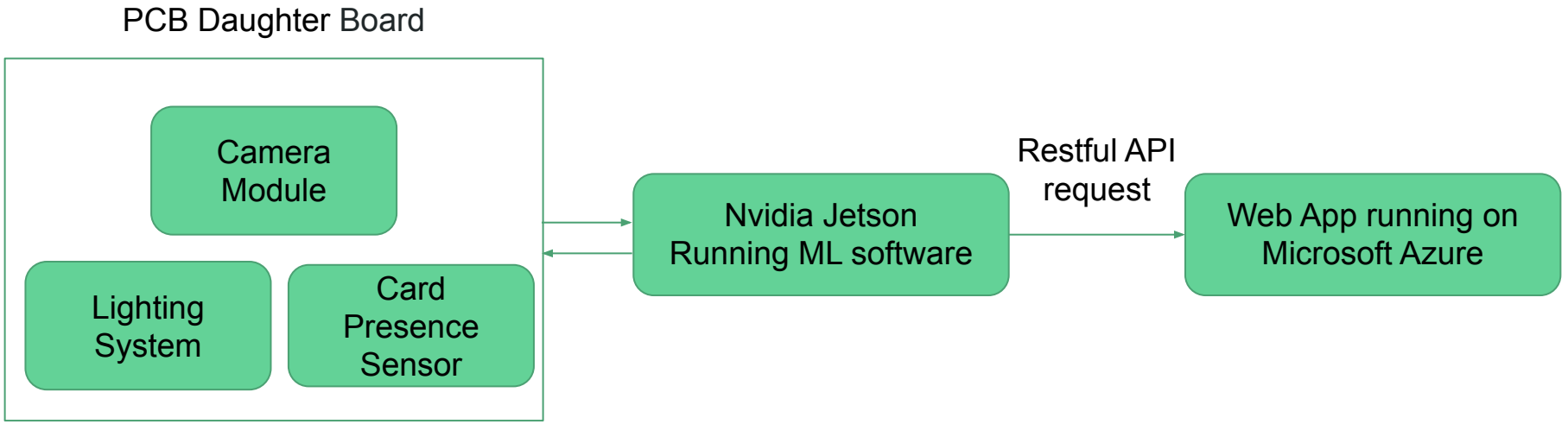
Background and Use Case

- Most professional card games analyses are not automated
- Our system:
  - Images cards as they are dealt
  - Provides a web interface to visualize hands

Our Design


0.5mm
DRAFT-MATIC
No.DI
CARD "SHOE" (LASER CUT)
CARD
MC or SBC
CARD PRESENCE SENSOR
CAMERA MODULE
LEDs
POKERCAM
TEAM E7

System Flow Diagram



Requirements

- No user input
- Camera images playing card retrieved over a 0.5 second period
- Web app updates game state within 2 seconds of dealing card
- System can classify 52 cards (1 deck) retrieved over 26 seconds in even intervals within 104 seconds
- Card classification accuracy at least 94%
- Power system lasts 1 hour, imaging 312 cards (six decks of cards)
- No false imaging triggers

Technical Challenges

- Image Processing
  - Lighting, camera geometry, and camera optics
  - Lens distortion correction
  - Image segmentation
  - Identify images to use for classification
- Machine Learning and Software
  - Tuning model and hyperparameters for accuracy and throughput requirements
- Hardware
  - Build/configure fabricate boards, spec controllers/SBC’s, and hardware trigger
  - Drivers
  - Unobtrusive camera/reader

Solution Approach - Camera System & Image Processing

- Lens distortion correction offline in MATLAB
- Controlled lighting to compensate for uncontrolled environment and high framerate
- Segmentation and edge detection to identify suit and rank, improving classification accuracy

Solution Approach - Software

- OpenCV, Tensorflow, and/or PyTorch for image processing on Jetson Nano
- Host web app on Azure and interact with web app through RESTful API requests

Solution Approach - Hardware

- SBC and camera module eval board inside card “shoe” as an early prototype
- PCB Daughter Board containing all external sensors and hardware (camera, lighting, presence detector, etc.)
- Use findings from evaluation hardware to influence PCB design
- Time budgeted for two revisions of PCB

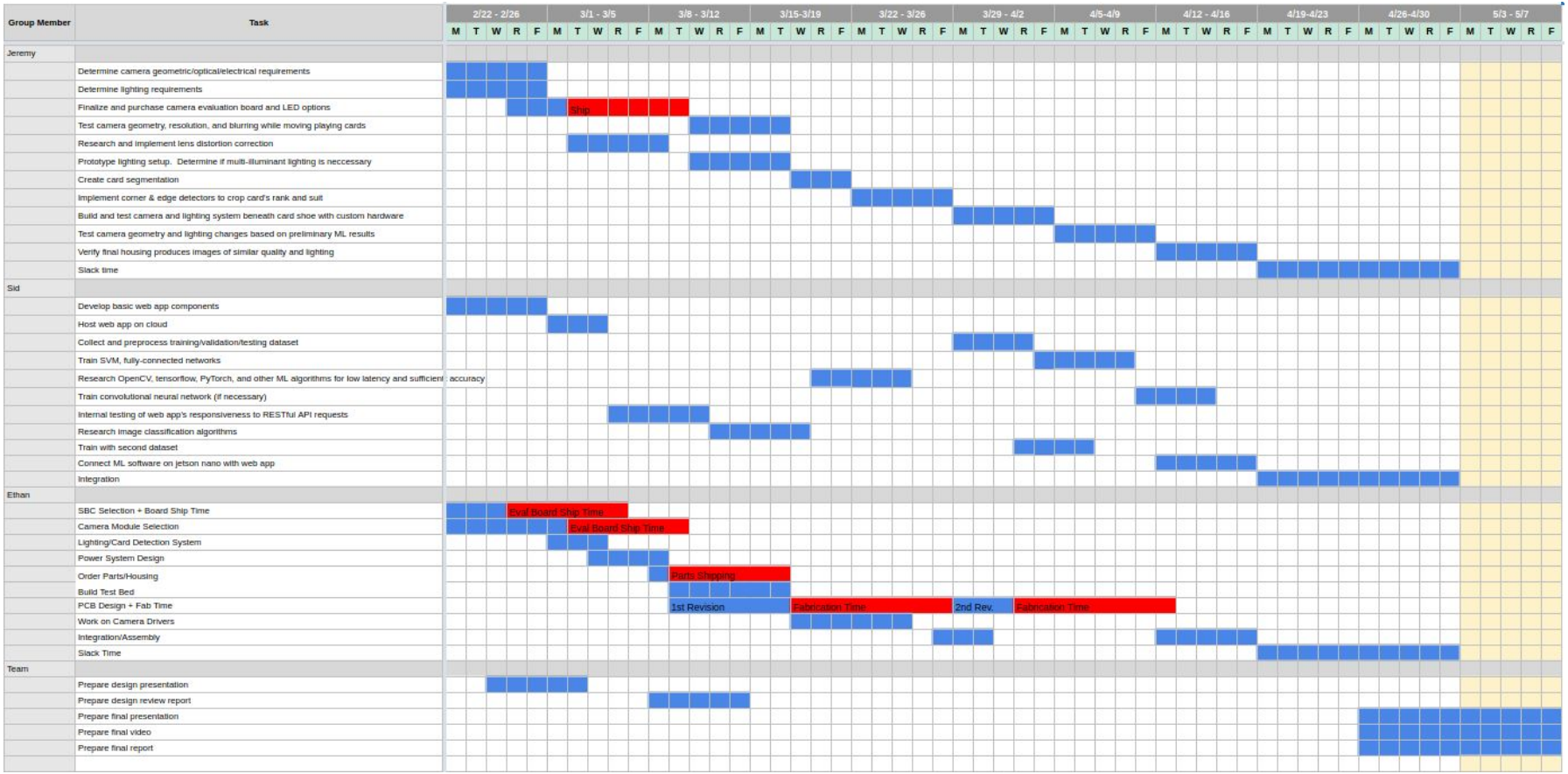
Testing, Verification, and Metrics

- Image Processing
  - Manually inspect image quality from camera
- ML/Software
  - Confusion matrix will give classifier accuracies
- Hardware
  - Test latency between card trigger and classification
  - Ensure SBC has enough memory to classify an entire card deck in 104 seconds

Tasks and Division of Labor

- Jeremy
  - Configure optical and electrical requirements for camera
  - Building imaging system
  - Image preprocessing
- Sid
  - Utilize OpenCV, PyTorch, and/or Tensorflow to train multiple ML models
  - Develop web app for visual display
- Ethan
  - Write drivers
  - Design and order PCB’s
  - Configure SBC’s
  - Build hardware trigger

Schedule


Group Member
Task
2/22 - 2/26
3/1 - 3/5
3/8 - 3/12
3/15-3/19
3/22 - 3/26
3/29 - 4/2
4/5-4/9
4/12 - 4/16
4/19-4/23
4/26-4/30
5/3 - 5/7
M T W R F
Jeremy
Determine camera geometric/optical/electrical requirements
Determine lighting requirements
Finalize and purchase camera evaluation board and LED options
Ship
Test camera geometry, resolution, and blurring while moving playing cards
Research and implement lens distortion correction
Prototype lighting setup. Determine if multi-illuminant lighting is neccessary
Create card segmentation
Implement corner & edge detectors to crop card's rank and suit
Build and test camera and lighting system beneath card shoe with custom hardware
Test camera geometry and lighting changes based on preliminary ML results
Verify final housing produces images of similar quality and lighting
Slack time
Sid
Develop basic web app components
Host web app on cloud
Collect and preprocess training/validation/testing dataset
Train SVM, fully-connected networks
Research OpenCV, tensorflow, PyTorch, and other ML algorithms for low latency and sufficient accuracy
Train convolutional neural network (if necessary)
Internal testing of web app's responsiveness to RESTful API requests
Research image classification algorithms
Train with second dataset
Connect ML software on jetson nano with web app
Integration
Ethan
SBC Selection + Board Ship Time
Eval Board Ship Time
Camera Module Selection
Eval Board Ship Time
Lighting/Card Detection System
Power System Design
Order Parts/Housing
Parts Shipping
Build Test Bed
PCB Design + Fab Time
1st Revision
Fabrication Time
2nd Rev.
Fabrication Time
Work on Camera Drivers
Integration/Assembly
Slack Time
Team
Prepare design presentation
Prepare design review report
Prepare final presentation
Prepare final video
Prepare final report