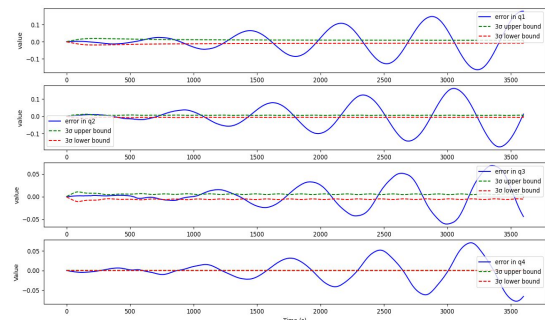




# Weekly Quad Chart - 1/11

## Updates



Incorrect MEKF error plots : error builds

```
##properties:
##initial_conditions:
# = [1.550e+0, 2018.335e+0, 209.176e+0] # kg[m]
# = [100.532e+0, 2.380e+0, 2010.050e+0] # kg[m]
# = [209.176e+0, 2108.650e+0, 1.854e+0] # kg[m]
# = [175.080e+0, 0, 0] # kg
# = [0.0, 0.0, 0.0] # kg
# = [0.0, 0.0, 0.0] # kg

##gravity:
# spherical_harmonic_gravity_model: true # 1
# gravity_order: 0 # 1
# gravity_degree: 0 # 1

##environment:
# drag_model: true # 1
# atm_model: true # 1
# gravity_gradient_model: true # 1

##initial_orbital_elements:
# time: 0.00000000 # s
# a: 0.00000000 # m
# ecc: 0.00000000 # 1
# incl: 1.5708000000000000 # rad (90.000000)
# raan: 2.2270804514700 # rad (127.000000)
# argp: 1.0000000000000000 # rad (57.295779)
# nu: 0.0000000000000000 # rad (0.000000)

##initial_attitude_conditions:
# q1: 1.0, q2: 0.0, q3: 0.0, q4: 0.0 # 1
# roll: 0.0, pitch: 0.0, yaw: 0.0 # 1

##parameter_parameters:
# epoch: "2018-12-01 00:00:00.000000" # epoch (datetime)
# dt_initial: 0.0 # dt
# dt_attitude: 0.05 # dt
# dt_environment: 0.1 # dt
# time_final: 0.1 # days

##sensor_parameters:
# type: "imu" # type
# imu_type: "imu" # imu_type
# imu_type: "imu" # imu_type
# imu_type: "imu" # imu_type
# imu_type: "imu" # imu_type
```

Sample config file for sim

## Blockers and Requirements

### Blockers

- Jetson Orin for power consumption of EKF, MEKF on different modes and frequencies
- Wire AWG selection and material for Helmholtz cage

### Requirements

- Crash course by Zac on MEKF

## Weekly Results and Plan

### Weekly Results

- Studied MEKF course resources and papers
- Implemented MEKF
- Compute benchmarking on Raspberry Pi
- SW Eng work for simulator
  - Defined modular structure for sim. Came up with yaml config file based approach for simulation configuration, initialization and runs.
  - Implemented config parser script and created sample config file.

### Next week

- Improve on orbit estimation by adding more complexity
- Debug MEKF and study more resources
- Generate simulated ground truth data for MEKF with angular velocity dynamics
- Implement SGP4 Orbit propagation utilizing TLE data.
- Power analysis on Jetson
- Continue finalize the cage simulation by adding wire awg information

## Interface dependencies

### Avionics:

- Fprime development on Pycubed; Communication with Jetson for estimation

### Mechanical:

-

### Vision:

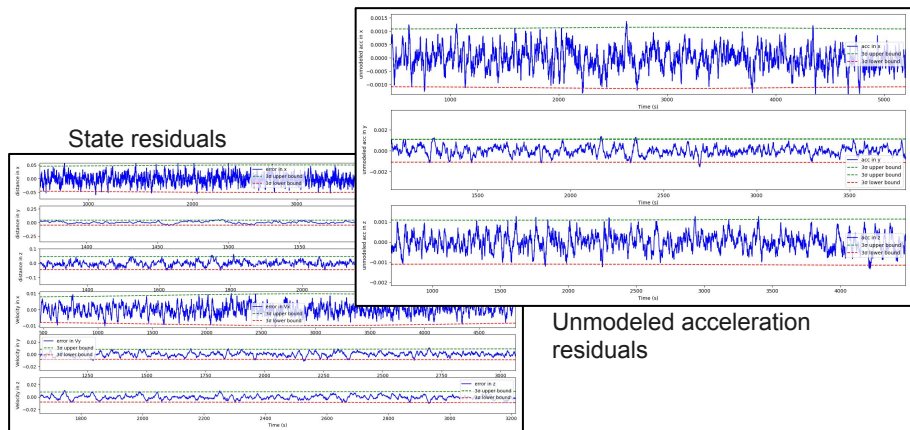
- Discuss any major changes or updates to output of vision system

### COMOPS:

- Communication protocol & Commands

# Weekly Quad Chart - 25/10

## Updates



## Blockers and Requirements

### Blockers

-

### Requirements

- Crash course by Zac on MEKF
- Pycubed board to start twiddling with software frameworks

## Weekly Results and Plan

### Weekly Results

- Implemented EKF for orbit estimation following version 1 method
- Implemented EKF for orbit estimation with unmodelled acceleration in states
- Started the design of HIL devices for magnetometer, magnetorquer and sun sensor
- Explored slew maneuvers using magnetorquers.

### Next week

- Improve on orbit estimation
- Implement simple MEKF

## Interface dependencies

### Avionics:

- Finalize computer framework and sensor selections

### Mechanical:

-

### Vision:

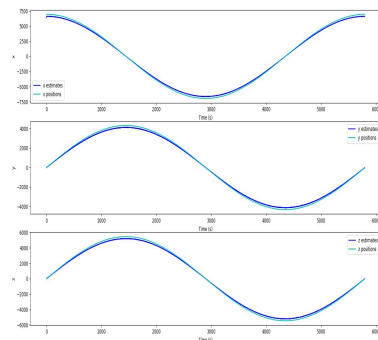
- Discuss any major changes or updates to output of vision system

### COMOPS:

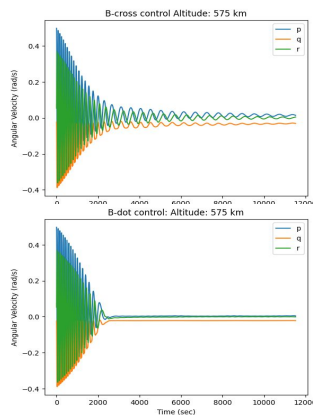
- Communication protocol & Commands

# Weekly Quad Chart - 11/10

## Updates



Kalman filter for orbit estimation



B-cross control for detumbling

B-dot control for detumbling

## Blockers and Requirements

### Blockers

-

### Requirements

- Crash course by Zac on MEKF
- Pycubed board to start twiddling with software frameworks

## Weekly Results and Plan

- Implemented Kalman filter for orbit estimation
- Implemented b-cross control for detumbling. Ran some experiments to compare the performance of b-dot and b-cross control
- Started listing risks and potential mitigations
- Fprime compatible with PyCubed board

### Next week

- Implement simple MEKF
- Formally compare the performance of the detumbling control techniques in a Monte carlo sim.
- Continue risk analysis
- Basic workflow/state machine using Fprime on PyCubed
- Start evaluating options for estimation architecture with vision inputs
- Keep implementing more risk analysis

## Interface dependencies

### Avionics:

- Finalize computer framework and sensor selections

### Mechanical:

-

### Vision:

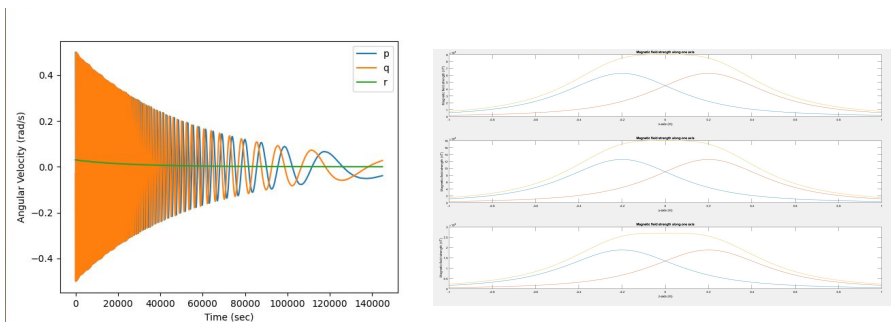
- Discuss any major changes or updates to output of vision system

### COMOPS:

- Communication protocol & Commands

# Weekly Quad Chart - 4/10

## Updates



Implemented a detumbling simulation with a BDot controller.  
Magnetic field in 3-axis Helmholtz coils

## Blockers and Requirements

### Blockers

-

### Requirements

- Crash course by Zac on MEKF
- Pycubed board to start twiddling with software frameworks

## Weekly Results and Plan

### Weekly Results

- Solved wabhas problem with CVX, SVD, q-method and gauss newton method
- Implemented a detumbling simulation with a BDot controller. Sim models translational and rotational kinematics and dynamics for the cubesat.
- Finished the Helmholtz coil's matlab simulation, which can give the magnetic field on 3-axis

### Next week

- Implement simple MEKF
- Add sensor noise, bias, sensor filtering for sim

## Interface dependencies

### Avionics:

- Finalize computer framework and sensor selections

### Mechanical:

-

### Vision:

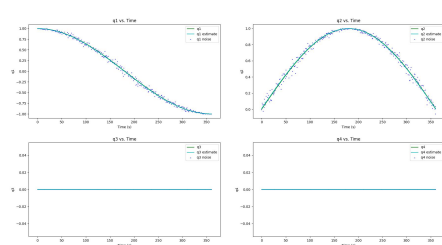
- Discuss any major changes or updates to output of vision system

### COMOPS:

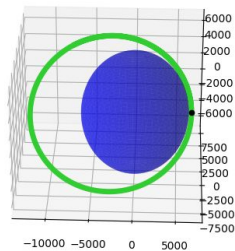
- Communication protocol & Commands

# Weekly Quad Chart - 27/09

## Updates



Simple attitude determination in quaternions



Simulating orbit propagation with two-body dynamics

## Blockers and Requirements

### Blockers

-

### Requirements

- Crash course by Zac on MEKF
- Pycubed board to start twiddling with software frameworks

## Weekly Results and Plan

### Weekly Results

- Implemented simple EKF for attitude determination
- Studied and implemented quaternion operations in python required for MEKF
- Trade study between CircuitPython vs FPrime
- Simulated orbit propagation with two-body dynamics
- Studied HIL testing for magnetometer, magnetic torquer, and IMU

### Next week

- Study attitude determination course notes
- Implement first version of attitude estimator
- Start playing around with chosen architecture
- Start designing the Helmholtz cage for HIL simulation

## Interface dependencies

### Avionics:

- Finalize computer framework and sensor selections

### Mechanical:

-

### Vision:

- Discuss any major changes or updates to output of vision system

### COMOPS:

- Communication protocol & Commands

# Weekly Quad Chart - 20/09

## Updates

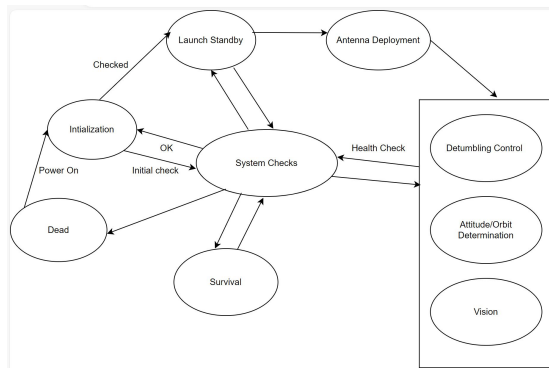


Figure: Basic state machine diagram

## Blockers and Requirements

### Blockers

-

### Requirements

- Recorded satellite sensor(sun,magnetometer) measurements
- Crash Course by Zac

## Weekly Results and Plan

### Weekly result

- Studied resources on quaternions and MEKF
- Initiated development on attitude estimation with basic quaternion operations
- Developed basic state machine
- First version of simulation for satellite position based on Newton's law of gravity and RK4

### Next week

- Implement simple attitude estimator
- Progress on subsystem interfaces
- Meeting with Comms for functional partitioning and protocol
- Meeting with Avionics for hardware choices
- Iterate on State machine design and simulation

## Interface dependencies

### Avionics:

- Software framework/ baseline computer system
- Kernel functionality
- Sensors & Actuators drivers

### Mechanical:

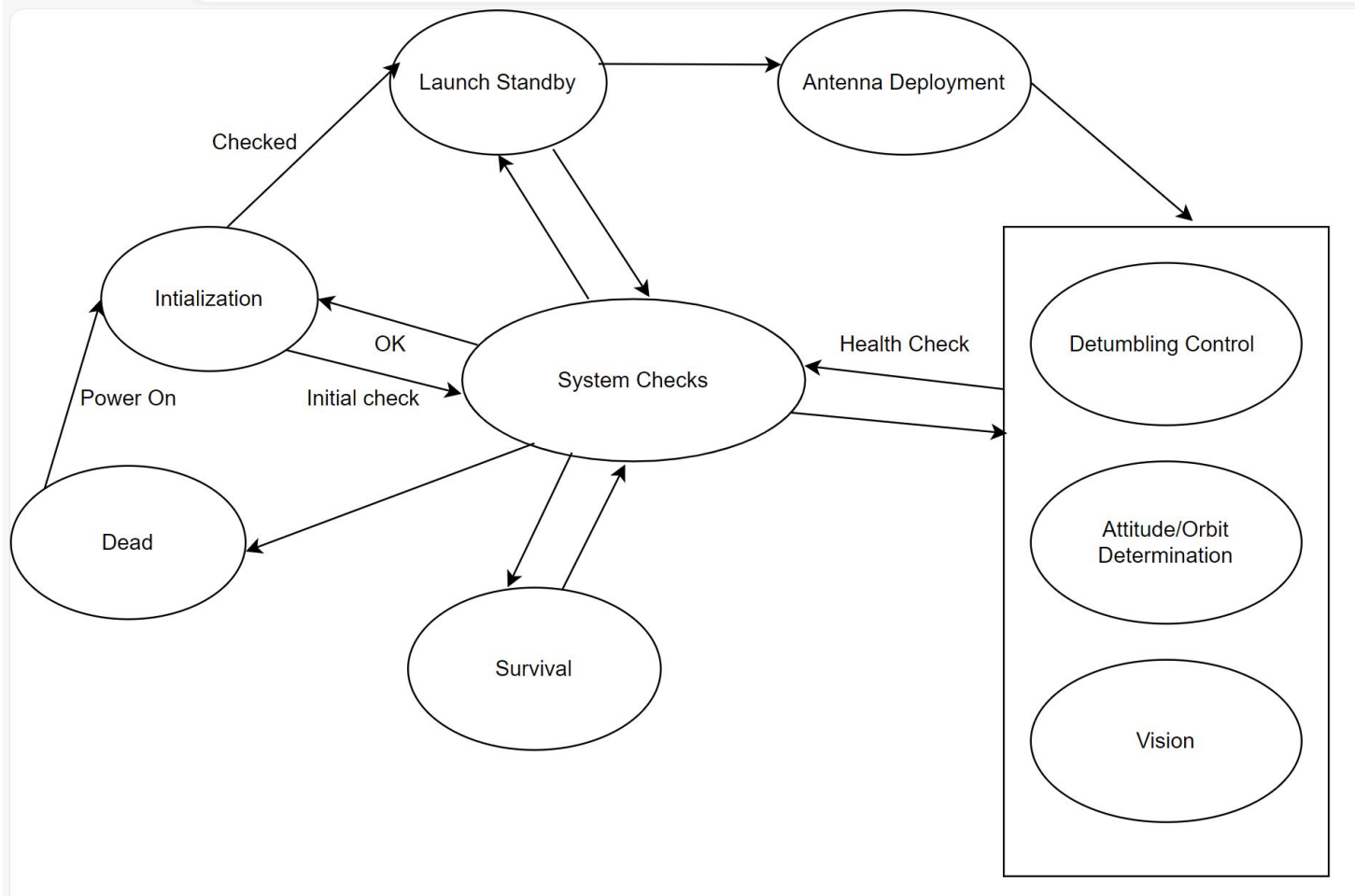
- Mass estimate
- Moment of inertia
- Mechanical layout

### Vision:

- Discuss any major changes or updates to output of vision system

### COMOPS:

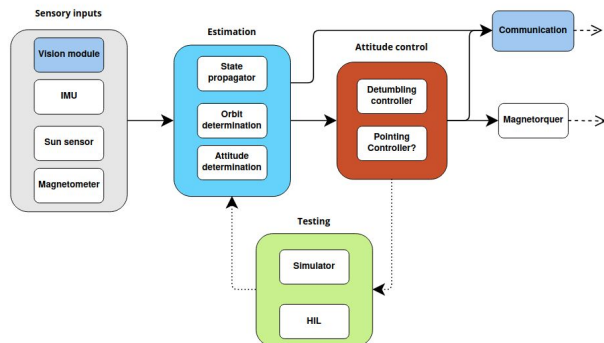
- Communication protocol & Commands





# Weekly Quad Chart - 12/09

## Updates



- Developed first draft of attitude and orbit determination architecture

## Blockers and Requirements

### Blockers

- Coming up with specific numbers in the requirements (sensors)
- Lack of background in orbital and attitude dynamics (simulation, estimation, attitude control)

### Requirements

- None

## Weekly Results and Plan

### Weekly result

- Refined the level 2 requirements
- Developed initial block diagram for estimation
- Studied material about Kalman filter, spacecraft attitude determination and control system
- Preliminary actuator and sensor selection

### Next week

- Develop milestone chart
- Study resources given by Zac on attitude determination and (M)EKF
- Start development of simple EKFs
- Simulation rigid-body dynamics (2 body and attitude)
- General flight software architecture
- Design first draft of cyber physical architecture for estimation module
- Create first draft of software design document for attitude control

## Interface dependencies

### Avionics:

- Software framework/ baseline computer system
- Power budget?
- Sensors & Actuators drivers

### Mechanical:

- Mass estimate
- Moment of inertia
- Mechanical layout

### Vision:

- Vision system output to finalise orbit and attitude determination design architecture. Set up meeting this week

### COMOPS:

- Type of antenna and influence on pointing requirement

