That's So Fetch

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Use Case

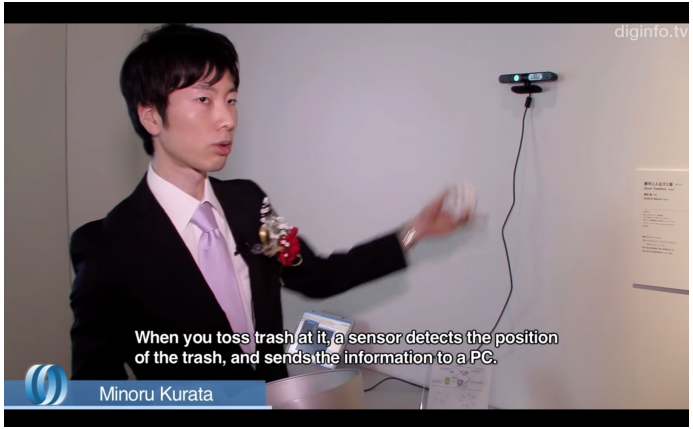
- Want a puppy? Allergic? Problem solved!
- This toy simulates playing fetch with a dog. Using user-worn motion detectors, our device will calculate and anticipate the object thrown, recieve it, and bring it back to the user.
    - To replace the irreplaceable bond between man and man's best friend.
- Areas: Software, Signals, Circuits

Requirements

Process	Specs
Success rate, measured by # balls thrown vs. # balls received	> 50%
User ball throwing range (distance between user and device)	2m radius
Device feasible retrieval range	1m radius
Device basket	25cm diameter
Projected (prethrow) angle vs. actual angle	< 5%
Tilting reaction time to prethrow	< 3 s
IMU-Motor communication latency (standard Bluetooth delay)	< 200 ms
Once ball is caught, drive back to user	< 5s

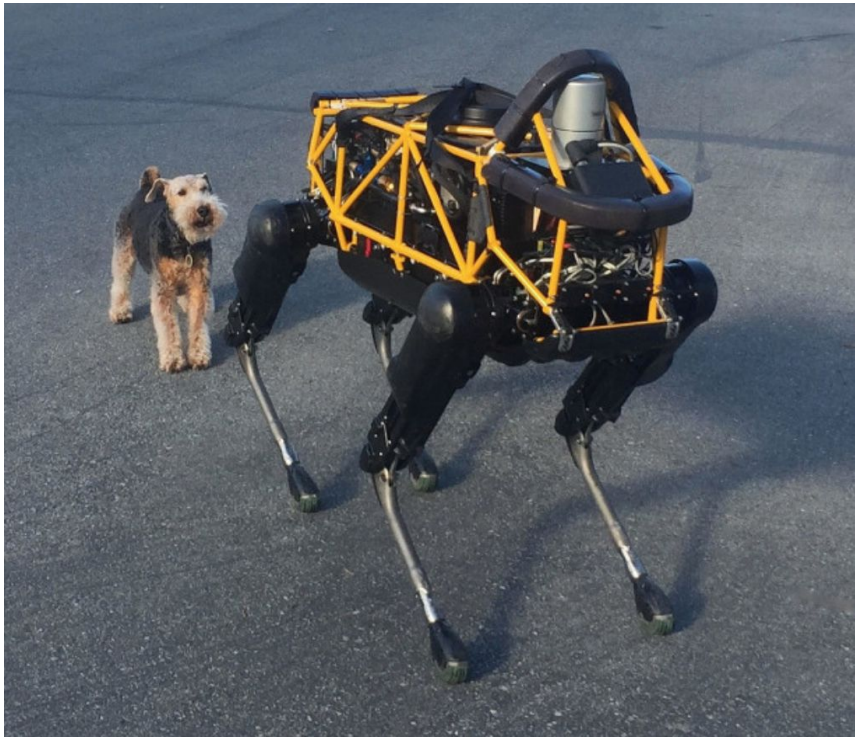
Previous Projects

- Minoru Kurata - Smart Trashbox
- Team B4 before B4
  - (Smart Trash Can F19)
- Previous projects present “smart” trash
  - Dependent on CV and have no more than a 50% success rate
- Our project will strive for a catch system entirely powered by motion capture through IMUs



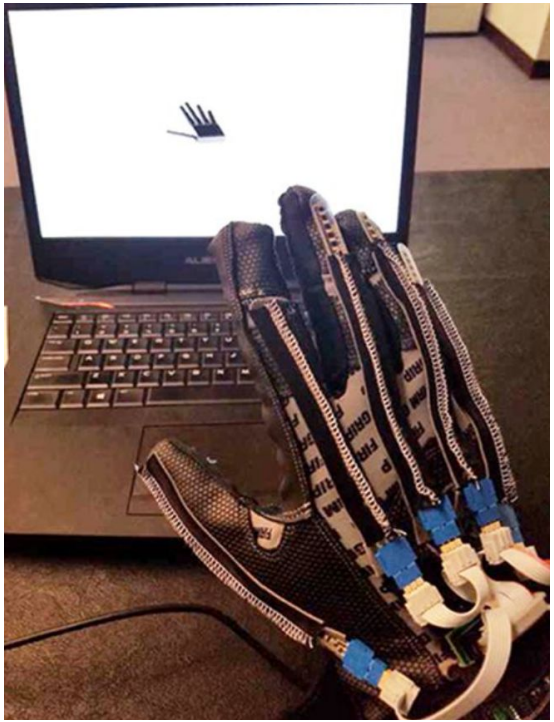
Solution Approach - Woof

- Dog simulator:
  - Metal chassis with 5 motors, an IMU, motion sensor, and a basket/lid
  - 4 motors for wheels (possibly omnidirectional), 1 motor to tilt basket
  - Motion sensor used for closing basket lid
  - IMU used for following thrower after catch



Solution Approach - Hand

- 5+ IMUs placed on throwing arm
  - 2+ on hand, 1 on wrist, 1 on elbow, one 1 shoulder
- Arm IMUs provide the angle, acceleration, and beginning position of the ball
- Applying common physics parabolic equations allows us to estimate the ball's terminal position and angle of impact.

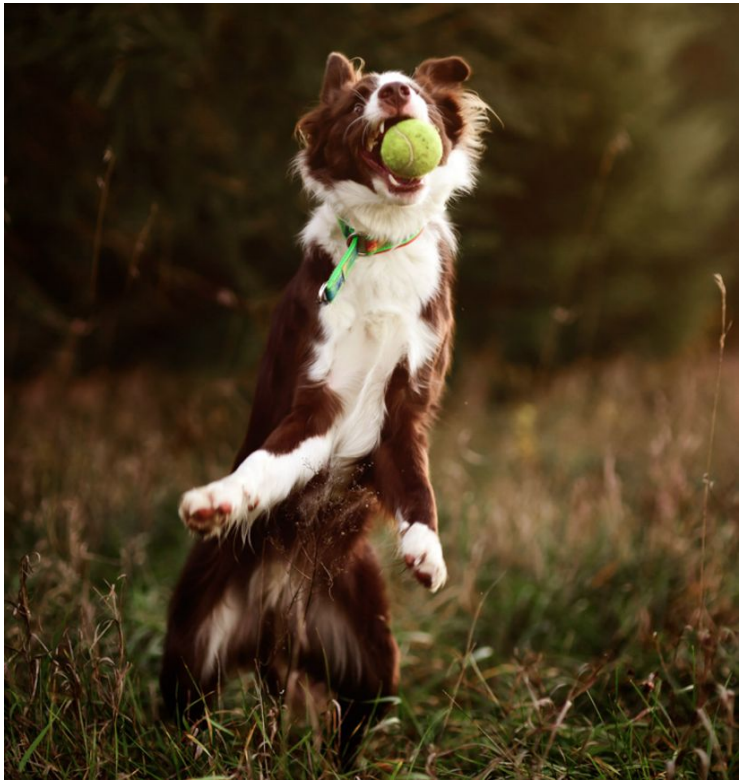


Solution Approach (Cont.)

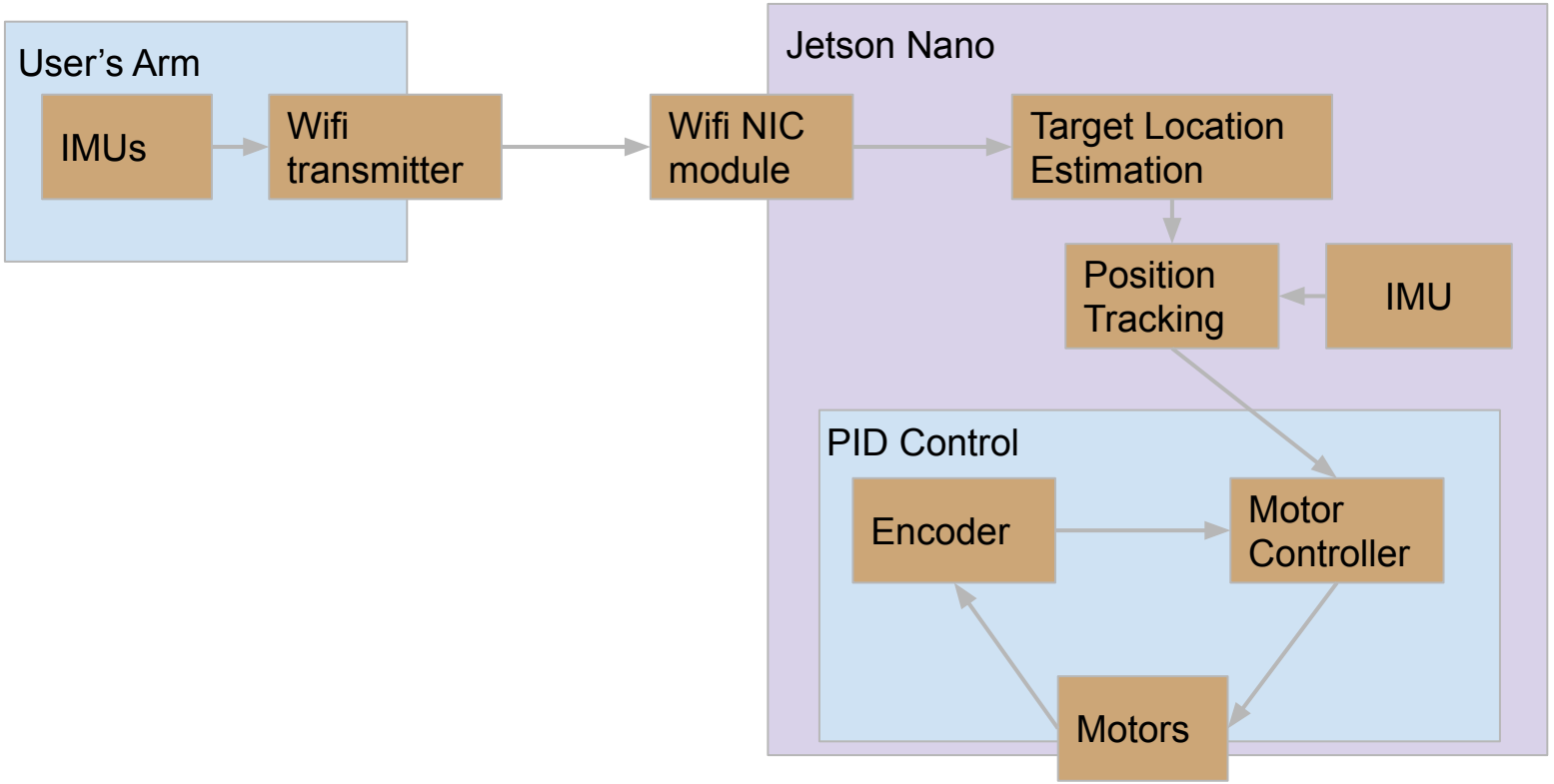
- IMUs communicate via WIFI to an NVIDIA Jetson on dog device
  - WIFI has a smaller latency than Bluetooth (150ms compared to 200ms)
- Once user begins prethrow, device moves up to 1m in throw direction
- IMUs on fingers convey ball release and Jetson computes the arrival
- The vehicle’s rotary encoders, through a PID control system, guide the device to ball and tilt the basket accordingly

Solution Approach (Cont.)

- Once the ball enters the basket, motion sensor at the top of the basket tells the lid on top of the basket to close. Basket then tilts upright.
- The vehicle, combining its IMU data with its starting position, drives back to the user and opens the lid. The throw cycle then repeats



Solution: Architecture Diagram



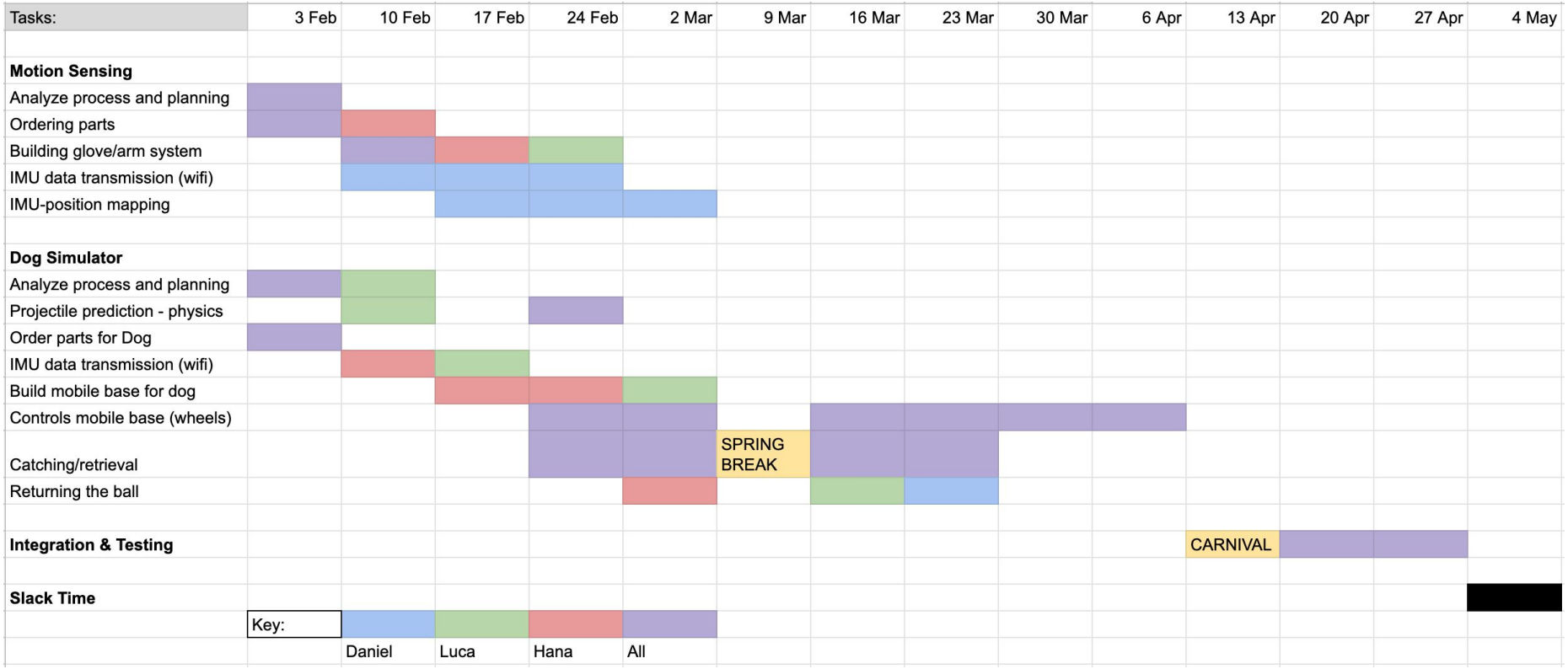
Testing Verification and Metrics

- Execute pre-throw and ensure robot moves 1m away at the expected angle (5% error allowed). Angle measured using large protractor.
- Latency of IMU data transmission from user arm to Jetson Nano.
- Mapping of IMU data to target location
  - Ensure distance between target location and landing location of the ball < 12.5 cm radius
- Ensure the robot travels to target location with enough speed and accuracy to catch the ball.
  - Throw ball in various locations within 1m from the robot
  - Calculate catch success rate and ensure it is at least 50%

Key Challenges

- Connectivity and Latency over Wifi
- Estimating the landing location of the ball using IMU data
- Control system design to reach the target location
- Reactive speed of dog device
  - Reacting to prethrow
  - Tilting to anticipate ball arrival angle
  - Enclosing ball to prevent bouncing out

Schedule


Tasks:
3 Feb
10 Feb
17 Feb
24 Feb
2 Mar
9 Mar
16 Mar
23 Mar
30 Mar
6 Apr
13 Apr
20 Apr
27 Apr
4 May
Motion Sensing
Analyze process and planning
Ordering parts
Building glove/arm system
IMU data transmission (wifi)
IMU-position mapping
Dog Simulator
Analyze process and planning
Projectile prediction - physics
Order parts for Dog
IMU data transmission (wifi)
Build mobile base for dog
Controls mobile base (wheels)
Catching/retrieval
Returning the ball
SPRING BREAK
Integration & Testing
CARNIVAL
Slack Time
Key:
Daniel
Luca
Hana
All