# TEAM B3: FARMFRESH

Ishita Kumar, Ishita Sinha, Kushagra Sharma

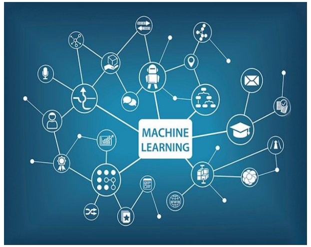
# Introducing FarmFresh!

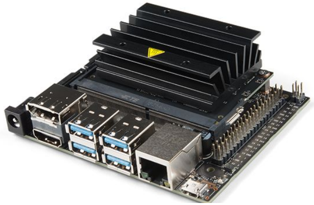
What is FarmFresh?

> An AI tool to sort fruits based on freshness and, most importantly, separate rotten fruit from fresh fruit.
> Meant to be integrated into existing conveyor belt system

ECE Areas

> Software: ML, Computer Vision
> Hardware/Embedded:
Jetson Nano, Raspberry Pi



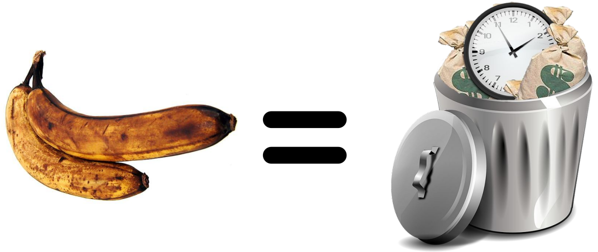


# Problem Area & Existing Solutions

Problem Area

> Millions of $$ wasted yearly packaging and transporting rotten fruit

> Manual labor and time of farmers separating rotten fruit.



Existing Solution

>TOMRA has multiple machine for sorting foods

> Usually very expensive ($ 10,000 - $ 25,000)

> Not feasible on small scale, which is our target market.

Blizzard sorting machine by TOMRA

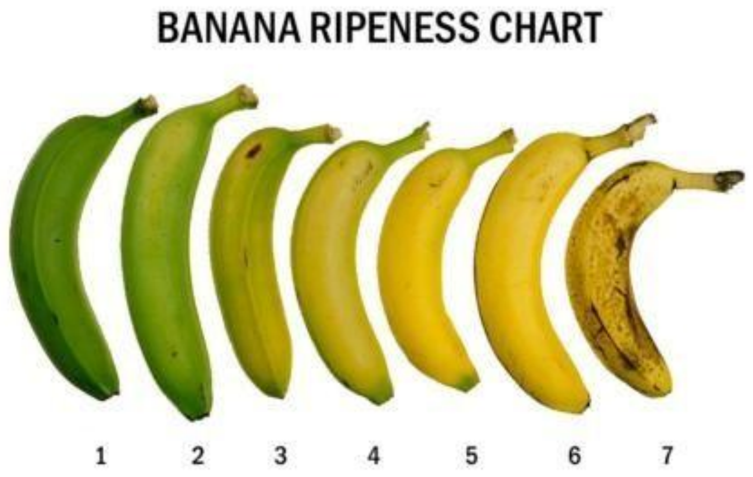
Our Solution

> Cheaper

> Multi-fruit

# User Requirements

- Save time and money by automating fruit sorting based on ripeness
- Want it to work for multiple fruits
- Want to avoid false negatives
  - Aim for ~95% accuracy
- False positives not so bad
  - Aim for ~85% accuracy
- Battery should last working hours
  - 9 am - 5 pm
  - 6600 mAh Li-on battery



# Technical Requirements

- Typical commercial conveyor belt can be configured to move at 5 cm/s.
    - 3 s for execution time -> 15 cm movement
    - We essentially abstract this away as stationary
- ~20 cm banana. Bananas are spaced at least 20 cm ± 5 cm.
    - Take picture every 4 s to guarantee not missing banana.

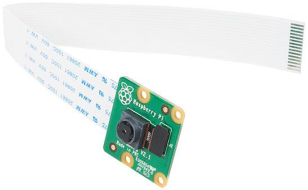
Hytrol Incline Slider-bed Belt Conveyor Model TA - 24"W X 29'L

# Technical Challenges

- Ensuring our algorithm and physical setup will work for multiple fruits: bananas, apples, and oranges
    - Handle variation in fruit lengths and take pictures with right period to avoid missing fruits.
- Developing algorithms for sorting fruits into 3 categories, unripe, ripe, and rotten.
    - Need to ensure good image segmentation for this.
    - Lighting and background
- Ensuring false negatives < 15% and false positives < 5%.
- Coordinating cameras and linear actuators (pistons) through the RPi.
- Building the framework that holds the cameras and the pistons.
- Ensuring all parts of the fruit are captured

# Solution Approach

- Hardware platforms: Raspberry Pi, NVIDIA Jetson Nano 2GB
- 2 Raspberry Pi cameras V2
- 2 linear actuators for the pistons
- Dataset: Google images, manual pictures
- Libraries: Scikit-image, OpenCV
- 6600 mAh Li-on battery

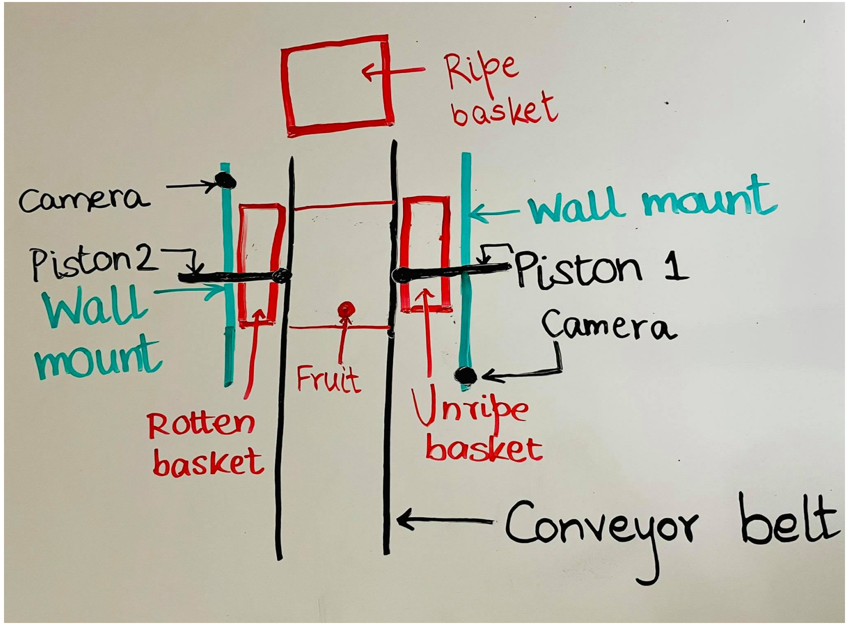


# Solution Approach

Preliminary design:

- 2 wall mounts on either side of the conveyor belt
- 2 cameras, one on each wall mount, diagonally across from each other
- 2 pistons, one in each wall mount
- 3 baskets for collecting the unripe, ripe, and rotten fruits respectively

Meant to be integrated into existing conveyor belt system



# Testing, Verification, and Metrics

| Requirements | Metrics | Verification |
|---|---|---|
| Easy to install | Should work with existing belt infrastructure | Test with a stationary ramp. |
| Meet the conveyor belt speed | Be able to take picture every 4 s, and process data and fire actuators within 3 s. | Simulate the process by putting new fruits quickly. No deadline should be missed. |
| Accuracy | False Negatives < 5%<br>False Positives < 15% | Run a test with 50 fruits. Should meet classification metrics. |
| Battery life | Battery should last 8 hours (typical working day) | Run the setup (camera + actuators) until battery runs out. |
| Fruit spacing | Handle fruits spaced at a distance of 20 cm ± 5 cm. | Test the extremes (25 cm and 15 cm). No deadlines should be missed. |
| No fruit should be missed | No fruit should be missed | Perform a stress test with 50 fruits. |

# Tasks and Division of Labor

**Ishita Kumar**

- Image segmentation
- Object classification
- Rotten fruit classification
- Train and test models
- Raspberry Pi + camera
- Building the physical setup

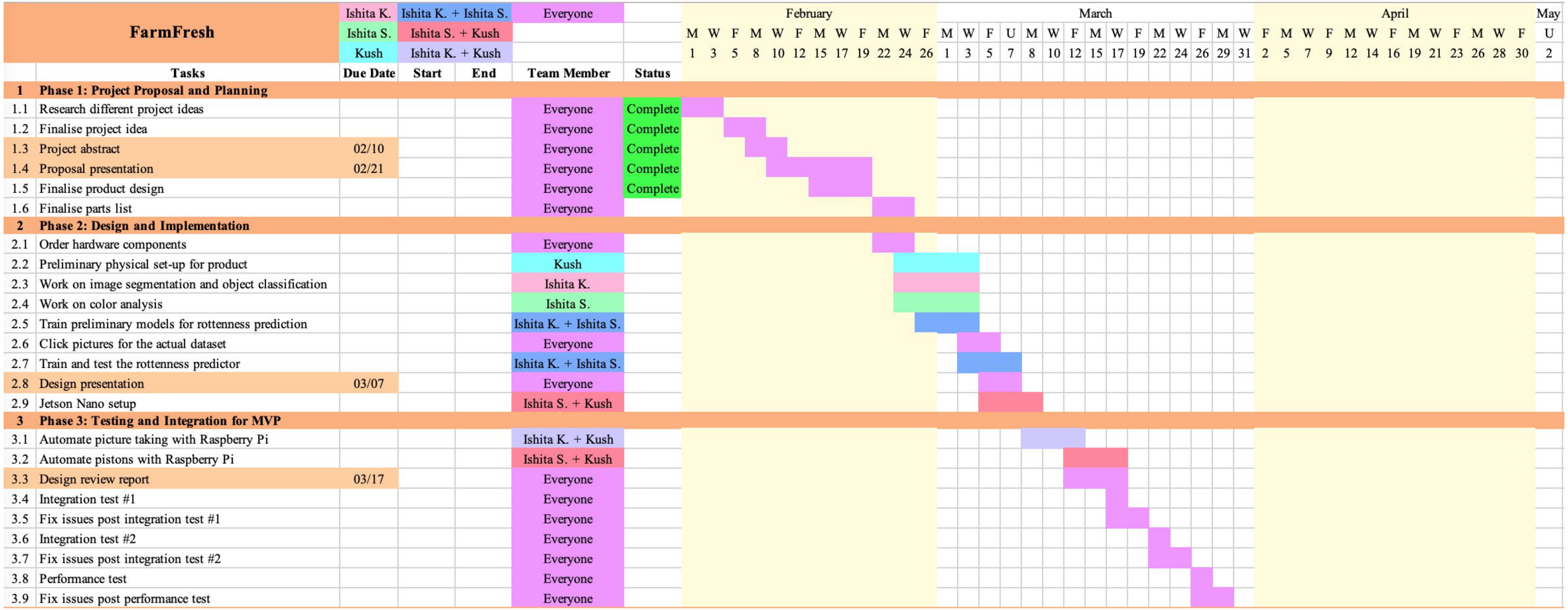
**Ishita Sinha**

- Color analysis by pixels
- Rotten fruit classification
- Train and test models
- Programming Jetson Nano
- Raspberry Pi + piston
- Building the physical setup

**Kushagra Sharma**

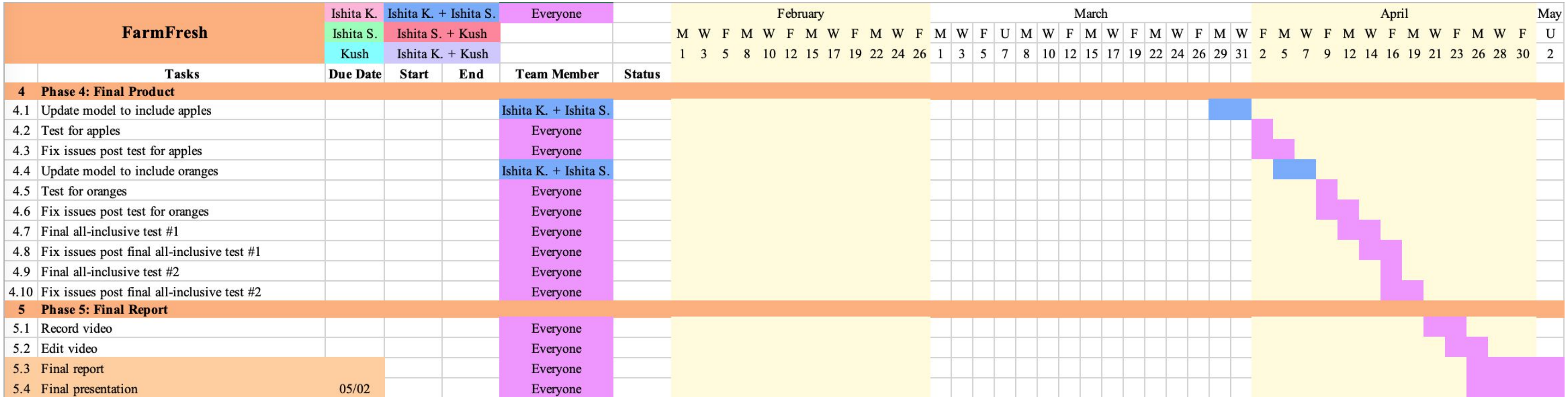
- Programming Jetson Nano
- Raspberry Pi + camera
- Raspberry Pi + piston
- Building the physical setup

# Schedule



| FarmFresh | | Ishita K. | Ishita K. + Ishita S. | | Everyone | | February | | | | | | | | | | | | March | | | | | | | | | | | | | | | April | | | | | | | | | | | | | May |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ishita S. | Ishita S. + Kush | | | | M | W | F | M | W | F | M | W | F | M | W | F | M | W | F | U | M | W | F | M | W | F | M | W | F | M | W | F | M | W | F | M | W | F | M | W | F | M | W | F | U |
| | | Kush | Ishita K. + Kush | | | | 1 | 3 | 5 | 8 | 10 | 12 | 15 | 17 | 19 | 22 | 24 | 26 | 1 | 3 | 5 | 7 | 8 | 10 | 12 | 15 | 17 | 19 | 22 | 24 | 26 | 29 | 31 | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 19 | 21 | 23 | 26 | 28 | 30 | 2 |
| | Tasks | Due Date | Start | End | Team Member | Status | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Phase 1: Project Proposal and Planning | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.1 | Research different project ideas | | | | Everyone | Complete | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.2 | Finalise project idea | | | | Everyone | Complete | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.3 | Project abstract | 02/10 | | | Everyone | Complete | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.4 | Proposal presentation | 02/21 | | | Everyone | Complete | | | | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.5 | Finalise product design | | | | Everyone | Complete | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.6 | Finalise parts list | | | | Everyone | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Phase 2: Design and Implementation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.1 | Order hardware components | | | | Everyone | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.2 | Preliminary physical set-up for product | | | | Kush | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.3 | Work on image segmentation and object classification | | | | Ishita K. | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.4 | Work on color analysis | | | | Ishita S. | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.5 | Train preliminary models for rottenness prediction | | | | Ishita K. + Ishita S. | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.6 | Click pictures for the actual dataset | | | | Everyone | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.7 | Train and test the rottenness predictor | | | | Ishita K. + Ishita S. | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.8 | Design presentation | 03/07 | | | Everyone | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.9 | Jetson Nano setup | | | | Ishita S. + Kush | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Phase 3: Testing and Integration for MVP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.1 | Automate picture taking with Raspberry Pi | | | | Ishita K. + Kush | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | |
| 3.2 | Automate pistons with Raspberry Pi | | | | Ishita S. + Kush | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | |
| 3.3 | Design review report | 03/17 | | | Everyone | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | |
| 3.4 | Integration test #1 | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | |
| 3.5 | Fix issues post integration test #1 | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | |
| 3.6 | Integration test #2 | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | |
| 3.7 | Fix issues post integration test #2 | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | |
| 3.8 | Performance test | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | |
| 3.9 | Fix issues post performance test | | | | Everyone | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | |

# Schedule



| | FarmFresh | Ishita K. | Ishita K. + Ishita S. | | Everyone | |
|---|---|---|---|---|---|---|
| | | Ishita S. | Ishita S. + Kush | | | |
| | | Kush | Ishita K. + Kush | | | |
| | Tasks | Due Date | Start | End | Team Member | Status |
| 4 | **Phase 4: Final Product** | | | | | |
| 4.1 | Update model to include apples | | | | Ishita K. + Ishita S. | |
| 4.2 | Test for apples | | | | Everyone | |
| 4.3 | Fix issues post test for apples | | | | Everyone | |
| 4.4 | Update model to include oranges | | | | Ishita K. + Ishita S. | |
| 4.5 | Test for oranges | | | | Everyone | |
| 4.6 | Fix issues post test for oranges | | | | Everyone | |
| 4.7 | Final all-inclusive test #1 | | | | Everyone | |
| 4.8 | Fix issues post final all-inclusive test #1 | | | | Everyone | |
| 4.9 | Final all-inclusive test #2 | | | | Everyone | |
| 4.10 | Fix issues post final all-inclusive test #2 | | | | Everyone | |
| 5 | **Phase 5: Final Report** | | | | | |
| 5.1 | Record video | | | | Everyone | |
| 5.2 | Edit video | | | | Everyone | |
| 5.3 | Final report | | | | Everyone | |
| 5.4 | Final presentation | 05/02 | | | Everyone | |

| | February | | | | | | | | | | | | March | | | | | | | | | | | | | | | April | | | | | | | | | | | | | May |
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