FENETT 2027

Two Wheel Food Transport Robot Competition

Proposed competition framework and rules

Prepared for the FENETT 2027 organizing committee | 2 November 2026

This proposal defines a student competition in which a two-wheel self-balancing robot transports fruit across normal ground, rocks, sand, and an uphill section. Teams earn points for eligible fruit mass delivered and mission completion time. It provides a basis for assigning organizers, building the course, and preparing published rules.

All course dimensions, payload limits, and timing benchmarks below are proposed values. Confirm them through prototype trials before publishing the final rulebook.

1 Competition mission and participation

Competition name: FENETT 2027 Smart Food Transport Robot Challenge.

Mission: Carry fruit from the starting zone, cross every terrain section in sequence, and stop successfully inside the delivery zone while maintaining automatic balance.

Item	Proposed arrangement
Participants	Undergraduate students; 3–5 students and one academic adviser per team
Robot type	Two parallel driven wheels with active self-balancing
Control category	Remote steering and speed commands permitted; balancing must be automatic
Official attempts	Three runs per team; final score is the average of the best two runs
Mission limit	60 seconds per run, including the final three-second balance hold
Payload	Organizer-supplied fruit; team-selected load up to 2 kg

If participation supports it, offer an autonomous category with a separate ranking. Do not mix remote-controlled and autonomous entries in one race ranking.

The educational focus is payload handling, balance control, traction, and protection of food products. A separate design award can recognize engineering development without changing the measured race score.

2 Course layout and construction

Use a straight course with a 1.50 m obstacle section, plus a 0.60 m starting zone and a 0.60 m delivery zone. Total travel length is approximately 2.70 m and clear lane width is 0.60 m.



Section in travel order	Length	Surface and function
Starting zone	0.60 m	Flat, firm board for loading and preparation
Normal ground	0.35 m	Firm, level surface with a consistent finish
Rock section	0.35 m	Fixed rounded stones, approximately 3–8 mm protrusion, on a removable board
Sand section	0.35 m	Dry sand initially 5–10 mm deep in a recessed tray
Uphill section	0.45 m	Firm ramp initially set at 5 degrees
Delivery zone	0.60 m	Level platform aligned with the top of the ramp
Total	2.70 m	Obstacle section alone totals 1.50 m

Ramp and transitions

A 0.45 m ramp at 5 degrees produces a rise of approximately 39 mm. Keep the delivery platform at this height. This avoids an unintended drop after climbing. Keep module edges flush, with no raised lip around the sand tray.

Repeatable field conditions

- Fix stones in place so their position and height remain consistent between runs.

- Level sand to a marked depth before every attempt. Use one sand type and a consistent dry condition.
- Publish module dimensions, surface specifications, photographs, and the lane boundary convention before the event.
- Provide a separate practice course built to the same specification.
- Inspect and reset the field after every attempt; record any organizer equipment failure.

Space constraint

The proposed 1.50 m dimension applies to the obstacle section. If the entire available footprint is limited to 1.50 m, run separate terrain tests instead. That alternative requires its own published start, finish, and scoring arrangements.

Because the course is short, transitions between surfaces will strongly influence performance. Validate shallow sand and a gentle incline first, then adjust the final specification using pilot results.

3 Robot and fruit requirements

Parameter	Proposed rule
Ground contact	Exactly two supporting wheels during the scored mission
Maximum dimensions	400 mm long × 400 mm wide × 600 mm high, including the loaded carrier
Maximum empty mass	5 kg including battery and carrier
Payload cap	2 kg of fruit, excluding all packaging and carrier components
Controller	Any programmable controller; automatic active balancing required
Carrier	Team-designed tray, basket, or compartment; padding, dividers, and retaining straps permitted
Parking supports	Permitted during setup only; fully retracted before the ready check
External assistance	No guide rails, supporting tethers, towing, or human contact during the mission
Safety provisions	Accessible power isolation and securely fixed battery and load

A robot with two driven wheels and a supporting caster does not qualify for the self-balancing category. Teams may use PID, LQR, fuzzy logic, or other controllers; controller complexity does not earn extra mission points.

Fruit selection and measurement

The organizer supplies one fruit type, such as oranges, with similar size and maturity. Teams select a load up to 2 kg. Weigh actual fruit mass; whole fruits do not need to match fixed weight increments.

- Record fruit mass before loading and document pre-existing visible defects.
- Photograph the loaded carrier before the run.
- After successful delivery, weigh eligible fruit remaining onboard.
- Exclude the tray, padding, dividers, straps, and robot components from scoring mass.

Product loss and damage

Dropped fruit cannot be collected during the mission and earns no mass points. Fruit with a new visible split, cut, or crushing damage also earns no mass points. Officials should compare against the pre-run record.

Do not apply subjective deductions for subtle bruising in the first event. Such damage can be recorded as an optional research measurement because immediate visual assessment may be inconsistent.

4 Mission procedure and failed attempts

Stage	Procedure
1 Setup	Allow two minutes to select, weigh, load, and secure fruit.
2 Ready check	Robot balances without physical assistance for three seconds inside the starting zone.
3 Start	Referee gives the start signal and starts the timer.
4 Travel	Robot crosses normal ground, rocks, sand, and the uphill section in order.
5 Delivery	Entire robot and its load enter the delivery zone.
6 Finish hold	Robot remains inside the delivery zone and self-balances for three consecutive seconds. Timing stops after the hold.
7 Inspection	Officials inspect and weigh eligible delivered fruit, then calculate the run score.

Small balancing corrections are permitted during the final hold. The 60-second mission limit includes this hold. No manual fruit pickup or unloading mechanism is required: teams load before starting, and officials unload after the mission.

Consequences of incidents

Incident	Result
Some fruit falls off	Continue if possible; score eligible delivered fruit only.
Robot falls or a non-wheel part provides support	Attempt ends; zero run score.
A wheel crosses outside the lane boundary	Attempt ends; zero run score.
A team member touches the robot after starting	Attempt ends; zero run score.
No completed final hold within 60 seconds	Zero run score.
No eligible fruit delivered	Zero run score.
Organizer course or equipment failure	Referee may authorize a rerun.

A failed attempt uses one of the three official runs. Teams may repair or retune the robot before their next scheduled run. Reinspect any changed configuration before it competes again.

Referees should record the reason for each unsuccessful run and retain timing and weighing records. Publish the procedure for score queries before the competition begins.

5 Scoring and ranking

Each successful run earns up to 100 points: 70 points for eligible fruit mass and 30 points for completion time. A failed run receives zero points.

$$S = 70 \times \frac{m}{2.0} + 30 \times clip(\frac{60 - t}{55}, 0, 1)$$

S is the run score. m is eligible delivered fruit mass in kilograms, capped at 2.0 kg. t is elapsed time in seconds, including the finish hold. The clip function limits the time factor to the range zero to one.

Five seconds or faster earns all 30 time points. The five-second benchmark is provisional: establish and publish the final benchmark through pilot runs before registration closes.

Example	Fruit mass	Time	Mass points	Time points	Total
Team A	2.00 kg	20 s	70.00	21.82	91.82
Team B	1.50 kg	10 s	52.50	27.27	79.77
Team C	1.00 kg	5 s	35.00	30.00	65.00
Failed run	—	—	—	—	0.00

Final ranking

Calculate the final score as the average of the best two scores from three official attempts. Failed runs count as zero. Retain unrounded values for ranking and display scores to two decimal places.

Resolve equal final scores in this order: higher combined delivered fruit mass across the two counting runs; lower combined time across those runs; higher third-run score; then a playoff if still tied.

Official scoring record

Record team ID, run number, pre-run fruit mass, eligible delivered mass, elapsed time, successful or failed status, failure reason, calculated score, and referee initials. Mark the two counting runs and the final average.

Awards

Recommended awards: Champion, First Runner-up, Second Runner-up, Highest Payload Delivered, and Best Engineering Design. Evaluate the design award separately through a poster and a short engineering explanation.

6 Event operation and preparation

For approximately 12 teams, reserve about four hours plus a buffer for technical delays. Run all teams once before beginning the next official round.

Activity	Duration
Inspection and registration	30 minutes
Briefing and course demonstration	15 minutes
Practice session	45 minutes
Three official rounds	120 minutes
Result verification and awards	30 minutes
Total planned time	240 minutes

Role	Primary responsibility
Competition chair	Coordinate rules, registration, staffing, and final results.
Two referees	Judge starts, lane compliance, balance, completion, and incidents.
Two field technicians	Prepare, inspect, and reset the field and practice course.
Weighing official	Record fruit mass and visible product condition.
Timing and scoring official	Record time, calculate scores, and maintain standings.
Inspection and safety official	Check dimensions, mass, batteries, supports, and power isolation.

Equipment to prepare

Competition and practice courses; a verified digital scale; timer and backup timer; sand levelling tool and depth gauge; ramp angle gauge; organizer fruit supply; inspection tools; scoring records; and a camera for run and payload documentation.

Pilot testing before publication

Build one complete course and test a representative student robot across several payloads. Use the results to confirm sand depth, rock height, ramp angle, maximum payload, achievable completion times, and the reliability of starting and stopping procedures.

Publish the final rulebook, field drawings, practice arrangements, control categories, and scoring benchmarks together. Course difficulty and scoring parameters should be settled before teams finalize their designs.

7 Related competitions and research

The following primary sources support aspects of the concept. They are precedents for agricultural missions, transport scoring, or balancing control; they do not establish that an identical fruit-carrying competition already exists. Web sources were consulted on 2 November 2026.

1 ASABE Robotics Student Design Competition

Agricultural missions have included transport and precision manoeuvring, with objective emphasis on speed and precision. The competition also requires a technical report. It provides an educational model for integrating this challenge into FENETT.

https://asabe.org/robotics

2 Pan African Robotics Competition 2024

The Autonomous Field Navigation simulation task concerns navigating crop rows on rough terrain to reach a goal. It is useful for a future autonomous category, rather than a direct precedent for two-wheel fruit transport.

https://parc-robotics.github.io/documentation-2024/competition-instructions/phase-1/task-1-autonomous-field-navigation/

3 NASA Break the Ice Lunar Challenge 2024

The finals scoring rubric uses measured mass, time, system mass, and energy in excavation and transportation-related performance. It supports objective measurement of useful material movement; its formula should not be copied directly for this short course.

https://breaktheicechallenge.com/break-the-ice-finals-scoring-rubric/

4 Lee et al 2023

Design and Implementation of a Two-Wheeled Inverted Pendulum Robot With a Sliding Mechanism for Off-Road Transportation. IEEE Robotics and Automation Letters, 8(7), 4004–4011. The study addresses slopes, asymmetric payloads, and step climbing, making it relevant to carrier design and centre-of-mass control.

https://doi.org/10.1109/LRA.2023.3279585

5 Kim and Kwon 2022

Robust Stabilization of Underactuated Two-Wheeled Balancing Vehicles on Uncertain Terrains with Nonlinear-Model-Based Disturbance Compensation. Actuators, 11(11), 339. Relevant to disturbances associated with changing slope and ground friction.

https://doi.org/10.3390/act11110339

6 Journal of Computational Design and Engineering 2025

Control of a longitudinally extended two-wheeled inverted pendulum robot with a sliding mechanism. Volume 12(10), 118–132. Combines model predictive control and disturbance estimation for unbalanced loads and slope traversal, including reported traversal of an 8-degree slope.

https://doi.org/10.1093/jcde/qwaf098