2022 ASABE Student Robotics Challenge

Updated, January 2022

The committee endeavors to publicize changes, but please continually check ASABE website and the ASABE Robotics Competition email list for rule changes.

Overview

The ASABE Student Robotics Challenge provides a challenging and fun hands-on learning experience for undergraduate and graduate students to demonstrate their knowledge and skills of robotics in agriculture. The 2022 challenge, which will be held during the ASABE International Meeting in Houston, TX, July 17–20, 2022, will simulate the harvesting of cotton.

Goal: Autonomous robot(s) will harvest "cotton" on an 8' x 8' playing field. The robot(s) will harvest 3 rows with each row containing 11 plants. The cotton plants may vary in height from 7" to 10".

Competition Rules

Two-tiered System

Beginner Division

1. Designed for undergraduate students with limited coursework in programming and microprocessors or who are new to the competition
2. Membership: Undergraduate students only
3. Maximum of two teams per institution
4. Limit of one robot per team
5. Robots must start and end each time trial at specified locations
6. Max robot size of 12”x12”x12” at the start of each time trial or greater than 12”x12”x12” once a trial starts
7. Cotton will be placed at varying heights from the surface of the playing field.
    - Height: 7”- 10” from surface of the playing field
    - Spacing: 2” to 4” between plants
    - Opened cotton bolls: 1 to 2 on each plant
    - Simulated, unopened cotton bolls: 5 in each row
    - Between 0 to 1 unopened boll on any one plant
    - 11 cotton plants per row
8. Cotton boll orientation: face the row

Advanced Division

1. Designed for upperclassmen and graduate students.
2. Membership: Both Graduate and Undergraduate students
3. Max one team per institution
4. Maximum of two robots per team
5. Robots must start and end each time trial at specified locations. Robot(s) can start from any corner on the board. If a team has two robots, they should start from two different corners of the board.
6. Max robot size of 12”x12”x12” at the start of each time trial or greater than 12”x12”x12” once a trial starts
7. Cotton will be placed at a varied height from the surface of the board.
    - Height: 7”- 10” from surface of the playing field
    - Spacing: 2” to 4” between plants
    - Opened cotton bolls: 1 to 3 on each plant
    - Simulated, unopened cotton bolls: 10 in each row
    - Between 0 to 3 unopened bolls on any one plant
    - 11 cotton plants per row
8. The robot will map each unopened boll. These will be displayed on an LCD panel on the robot. The whole playing field needs to be displayed at one time.

9. Upon completion of the harvesting operation, the robot will move to the designated "hopper" area to load the cotton bolls to a hopper truck.
10. Efficiency of the harvest will be done by the weight of cotton fiber harvested.
    - A minimum of 20 opened cotton bolls has to be harvested before this will be done.
    - Husk will be removed from harvested opened bolls to weigh the fiber.
    - Scoring will be by (measured weight divided by the calculated weight) X number of cotton bolls collected. This will be added to the total score.
    - Calculated weight would be the actual weight of cotton bolls X number of ones collected. Actual weight will be determined by an average weight of 40 cotton bolls. This will be set and not change.
    - Measured weight would be the total weight cotton bolls collected. Making sure that any boll with any part of the husk is removed before weighing.

Timing

a. The competition will consist of two or three rounds (will be decided later based on the number of entries) of time trials. Each team will complete one time trial per round.
b. The order in which teams will complete their time trial will be announced prior to each round.
c. Each team will be given a 4-minute heads-up before placing their robot on the board.
d. Time trials will begin at the specified times whether robot(s) are present or not. Judges will NOT wait for teams that are making last-minute changes to start their time trial.
e. Teams will have a total of 10 minutes to prepare their robot on the board, complete each time trial, and score as many points as possible. Touching the robot after it starts navigating the course is considered as intervention.
f. No bonus points will be awarded for time remaining. In the event there is a draw, the time will be used as the tie-breaker.

General Regulations

a. Teams must declare their division (beginner or advanced) at the time of registration (March 1). Teams may elect to change their division until July 1, 2022, after which no division changes will be allowed.
b. A robot may NOT be used in both the "beginner" and "advanced" divisions.
c. An undergraduate student may be a member of both a "beginner" and an "advanced" team.
d. Due to space and resource limitations at the competition, each team must designate up to three (3) team members who are allowed in the competition area for each time trial. Additional team members will be permitted in the setup/work area as space permits.

Scoring

a. Harvesting cotton

1. Fully open cotton bolls
    - Completely removed cotton bolls (this means removing all 4 sections of cotton from each boll): 5 points
    - Partially removed cotton bolls: 2 points
    - No point if any of the carpel (husk) is removed with cotton.
    - Robot must store the cotton on board.
2. Unopened cotton bolls
    - If knocked off/removed: 5-point penalty
3. Moving cotton to storage container (Advance division only)
    - Team may NOT dump until all three rows have been attempted to be harvested. Dumping early will result in a 10-point penalty
    - For each cotton boll moved successfully to the hopper container: 2 points
4. Mapping of unopened bolls.
    - Each correct map of unopened boll: 5 points
    - Each incorrect map of unopened boll: 5-point penalty

b. Autonomy Score (bonus)
    1. Robots will be scored based on their degree of autonomy from human interaction. Each team will begin a time trial with a 10-point autonomy score.
    2. Two (2) points per each interaction will be deducted from the autonomy score
    3. Autonomy score will be calculated using the following formula:

        $$AS = 10 - 2x \quad (x = \text{(number of interactions)})$$

    4. An interaction is any situation in which physical human intervention is initiated to aid a robot once the robot has begun to move on the competition surface. This includes but is not limited to:
        - Moving a robot back to its starting position
        - Pushing a robot to correct its direction of travel
        - Manually articulating a device on the robot
        - Resetting the robot's electronics
        - Removing debris which obstructs robot functions
    5. Robots which are placed on the board, but do not interact with any cotton bolls, will receive an autonomy score of 0 for that round.
    6. Any cotton bolls that the robots interact with as a result of human interaction will receive a score of zero.

Processor Restrictions

Processing power restrictions will be implemented as a cost limit in the 2022 competition to simultaneously level the competition and maximize the teams' flexibility in robot design. Teams can use up to $200 (or equivalent monetary values based on MSRP) for computational devices to be integrated with their robots. Market prices as of the competition period (until July 2022) for the devices will be used by judges for cost evaluation. Devices such as consumer-grade

computers, laptops, NUC-like devices, smartphones, tablets, or gaming devices may not be integrated into robots for the 2022 competition.

Wireless communication is allowed only for transferring detection and counting results from robots to a dedicated server computer. Other wireless communication with the robots is expressly forbidden.

Suggested processors: Arduino, Raspberry Pi. If you wish to use a processor that is not listed, please check with the competition committee.

Rankings and Prize structure

1. Rankings for each team will be determined by adding scores from the two highest-scoring rounds together. The team with the highest combined two-round score will be the winner for that division.
    - In the event that there is a tie, the time will be used as a tiebreaker.
    - In the event that there is still a tie after the time is considered, teams will split the prize for that ranking, and the competition committee will revise the prize structure to fairly compensate all teams.
2. Prizes will be awarded to the top three teams in each division.
3. Prizes will also be awarded to the best poster/video presentation, as determined by the judges.
4. Prizes will be awarded in the following ways:
    - Trophies for top three teams in each division.
    - Ribbons for top three posters, as voted by judges.
    - Prize money for top three teams in each division:

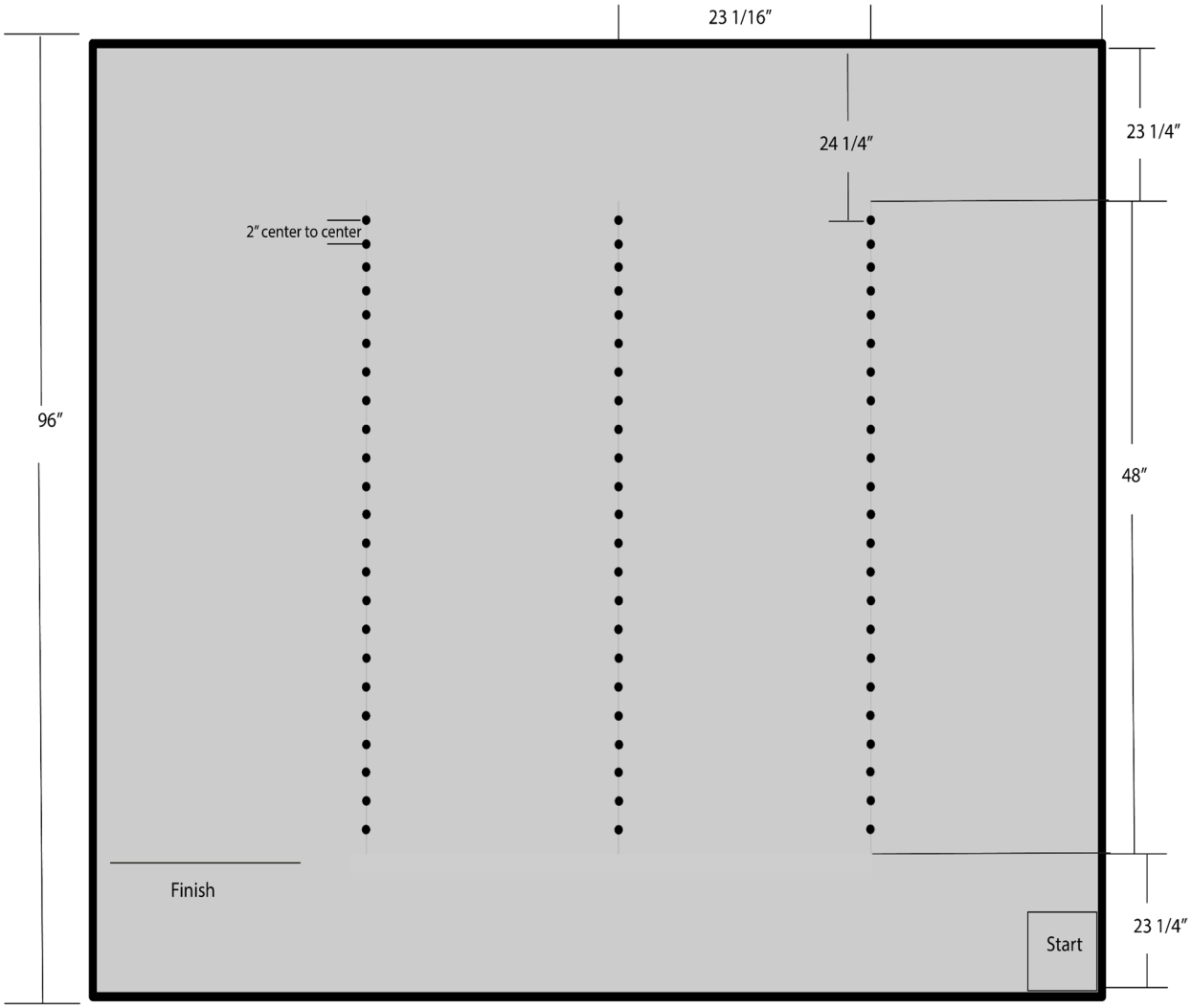
Materials and Components:

Major Components

1. Simulated cotton plants - DomeStar Cotton Stems, Natural Dried Cotton 30PCS Cotton Sprigs Cotton Blooms Floral Stems: https://www.amazon.com/dp/B08Z3FFF7L
2. 23/32-in x 4-ft x 8-ft Pine Sanded Plywood: https://www.lowes.com/pd/Plytanium-23-32-CAT-PS1-09-Square-Structural-Plywood-Pine-Application-as-4-x-8/3010111
3. Jumbo Cotton Bolls - https://www.amazon.com/dp/B07YSN9Y9H
4. White Ceiling Paint: https://www.amazon.com/dp/B004HZGJ72
5. Rust-Oleum Gloss Kona Brown: https://www.amazon.com/dp/B004HZELYA
6. 50Pcs/Pack Colored Ping Pong Balls 40mm 2.4g - https://www.amazon.com//dp/B07JNCVVMF/
7. Flat Washer: https://www.lowes.com/pd/Hillman-24-Count-x-1-2-in-Zinc-Plated-Standard-SAE-Flat-Washer/3035986
8. Magnet: https://www.amazon.com/dp/B06XVPHMJL/

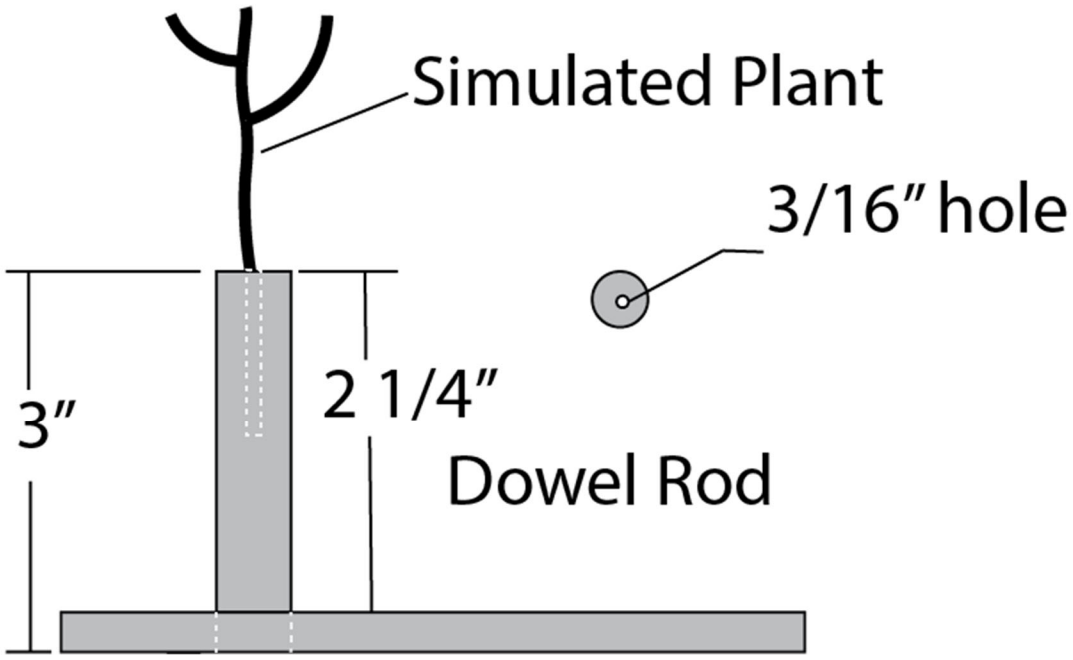
Board Layout

1. The playing surface will be two 4'X8' sheets of plywood joined to form an 8' X 8' area.
2. The surface will be painted white.
3. A 4" high by 23/32" wide board will be put on the edges of the plywood.
4. Each row will be 23 1/16" from the sides and each other.
5. The offset from the end that the robot turns on will be 24 ¼"
6. Each row will have 23 holes drilled at 2" intervals. Cotton plants will be placed in 11 randomly-selected holes per row.



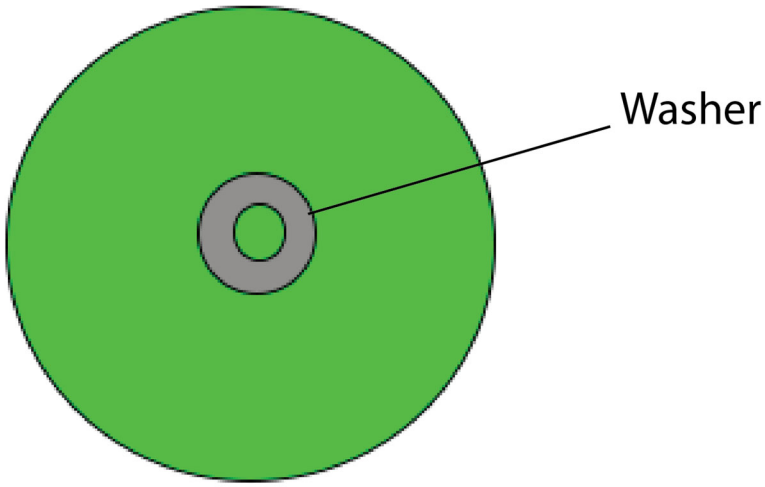
Plant

1. A ½” dowel rod will be use for the base of the plant. The dowel rod will be 3” in length and painted brown.
2. The cotton stem will be inserted into a 3/16” hole drilled in the top of the dowel rod. The hole will be 2 ½” deep
3. The cotton stems will be cut so that the total plant height is between 7” and10”.
4. The cotton husk will have a cotton ball which will take the place of a real cotton boll and will be referred to as a cotton boll in the contest.
5. Attach the boll to the husk by hot glue.
6. The unopened cotton bolls will be a green ping pong.



Unopened Cotton Bolls

1. Use only the green ping pong balls
2. Glue the washer on the ping pong ball
3. Cut one of the bolls off any one of the plants.
4. Glue magnet onto the wire where you have just cut the boll off. Hot glue works the best



Board example

Contact

If you have any questions regarding the competition rules, please summarize and submit to the email: asabe.p127@gmail.com. If you have general comments and feedback to the competition and committee, please reach out to Richard Fox (foxrj@purdue.edu) and Yu Jiang (yj522@cornell.edu).