

**AGRICULTURAL RESEARCH FOUNDATION
INTERIM REPORT
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TITLE: A Prototype Robot for Sorting Seed

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COOPERATORS:

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SUMMARY/ABSTRACT: The primary goal of our team is to increase the efficiency and accuracy of seed laboratory analysts, seed cleaning facilities, and seed companies through automation and robotics. We are developing a tabletop seed handling device that uses a combination of cameras, artificial intelligence techniques, and robotics to classify and separate seed into either pure seed or off-types. Over the past year, our project team developed an early prototype of an automated device for seed distribution, inspection, and sorting (see Figure 1 for a labeled image of the device). In the first step of processing, a user pours a sample of seed into a feed mechanism. The seeds are then distributed/segregated evenly using a hopper before being delivered to a conveyor that passes the seeds under the seed inspection station. The inspection station consists of a microscope and camera. At the inspection station, Deep Learning algorithms are used to classify grass seeds, weed seeds, and impurities (development of the algorithm is not part of this project). Finally, after classification, the seeds continue to move down the conveyor; at the end of the conveyor, a servo-controlled sorting mechanism sorts the types of seeds into collection containers. In addition to the components described above, we also developed a novel auger mechanism for the feed step. By changing the rotational speed of the auger, we found that we can control the rate of seed delivered to the device. We also performed tests to evaluate whether the auger caused any damage to the seeds.

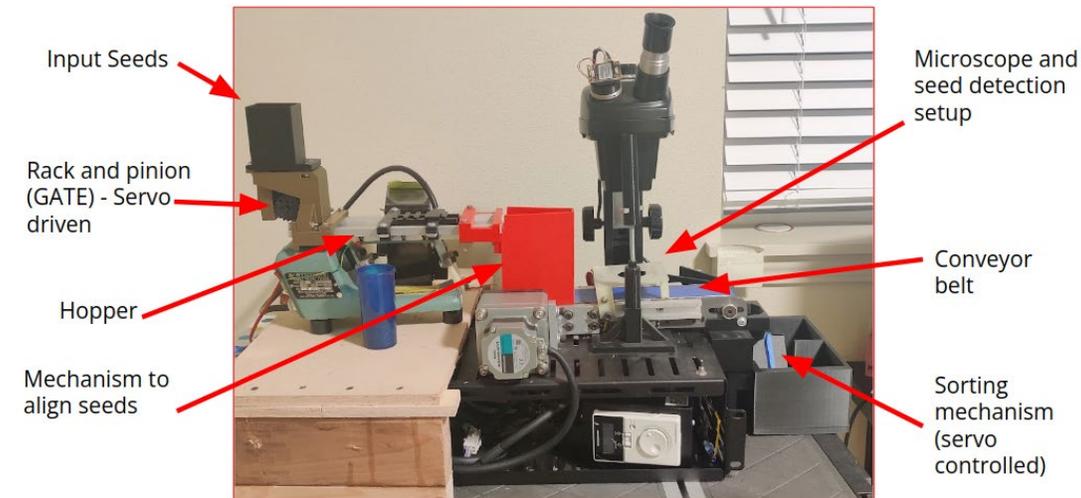


Figure 1. Prototype seed sorting robot.

OBJECTIVES: As described above, the specific research goal of this project is to develop a prototype robotic system that physically separates off-type seeds detected by a Convolutional Neural Network (CNN; development of the CNN is not within the scope of this proposal).

We defined the following three research objectives for this two-year project:

1. Design a conveyance system for transporting individual seeds to the camera's field of view for autonomous inspection.
2. Develop a robotic system that physically removes off-type seeds detected by the Convolutional Neural Network.
3. Integrate all system components (e.g. vision system, CNN, and robotic hardware) in a proof-of-concept demonstration.

PROCEDURES:

- **Feed mechanism:** The seed is delivered to the hopper using a feed mechanism. It's important to control the feed rate to have an optimal distribution of seeds at the inspection station. Our initial design included a simple on/off gate controlled by a servo motor. As this is a binary device, it could not regulate the number of seeds passed when the gate was open. We therefore designed and integrated an auger mechanism (Figure 2), which proved better at controlling the feed rate (according to its rotational speed).

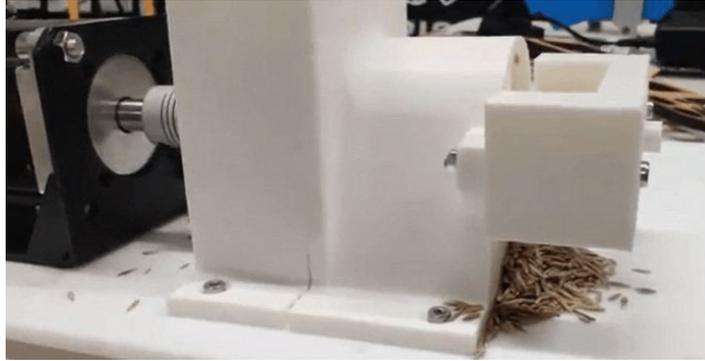


Figure 2. Auger developed for more consistent seed delivery.

- **Hopper mechanism:** The seeds from the feed mechanism are clustered together. The vibratory hopper is used to evenly spread the seeds and align them in lines. This makes it easier to detect individual seeds under the microscope.
- **Conveyor mechanism:** The aligned seeds are then transferred on a blue conveyor belt to the inspection station.
- **Seed quality inspection:** The seed quality detection mechanism consists of a microscope, camera, and Deep Learning algorithms. The seeds are autonomously classified as good or damaged seed/ impurities. Development of the CNN is a parallel effort to this project.
- **Sorting mechanism:** After being classified, the seeds on the conveyor belt reach the sorting mechanism. The sorting mechanism consists of two containers (one for good seeds and the other for damaged seeds/impurities) and a servo-actuated flipper. Based on the seed class, the flipper guides the seed to the corresponding container.

SIGNIFICANT ACCOMPLISHMENTS TO DATE:

- Developed an early prototype device for seed delivery, inspection, and segregation.
- Conducted preliminary tests with the Seed Lab to determine whether the auger damages seeds prior to the inspection and classification.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: None

FUTURE FUNDING POSSIBILITIES: The project team is submitting a proposal to the 2022 Oregon Department of Agriculture Specialty Crop Block Grant program. The submitted proposal expands upon some of the scope included in this research project.