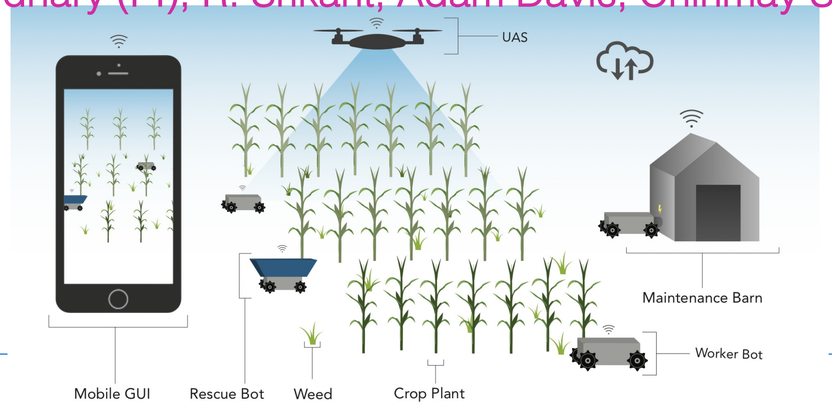
CPS: Robust Deep Learning for Mechanical Weeding Agbots

(USDA # 2018-67007-28379/ NSF#1739874
Aug 2018)

Girish Chowdhary (PI), R. Srikant, Adam Davis, Chinmay Soman, UIUC

Challenge:

Herbicide resistant weeds are proliferating

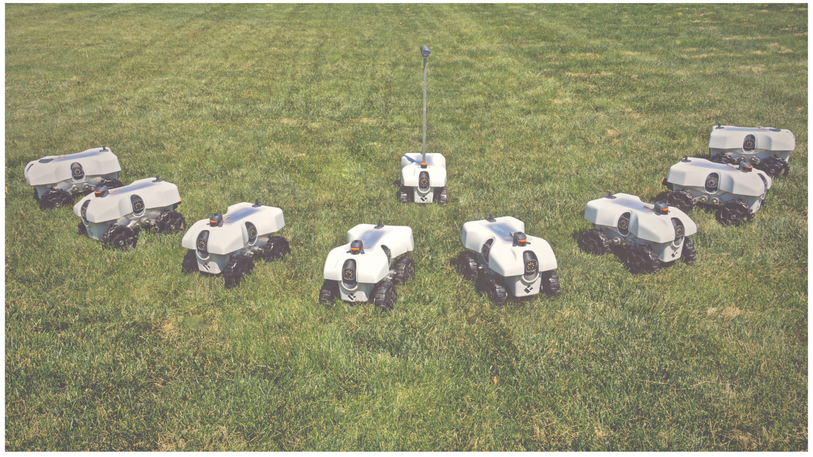


Scientific Impact:

Increasing robustness of deep learning for real world

Solution:

Robust deep learning enables autonomous teams of mechanical weeding robots



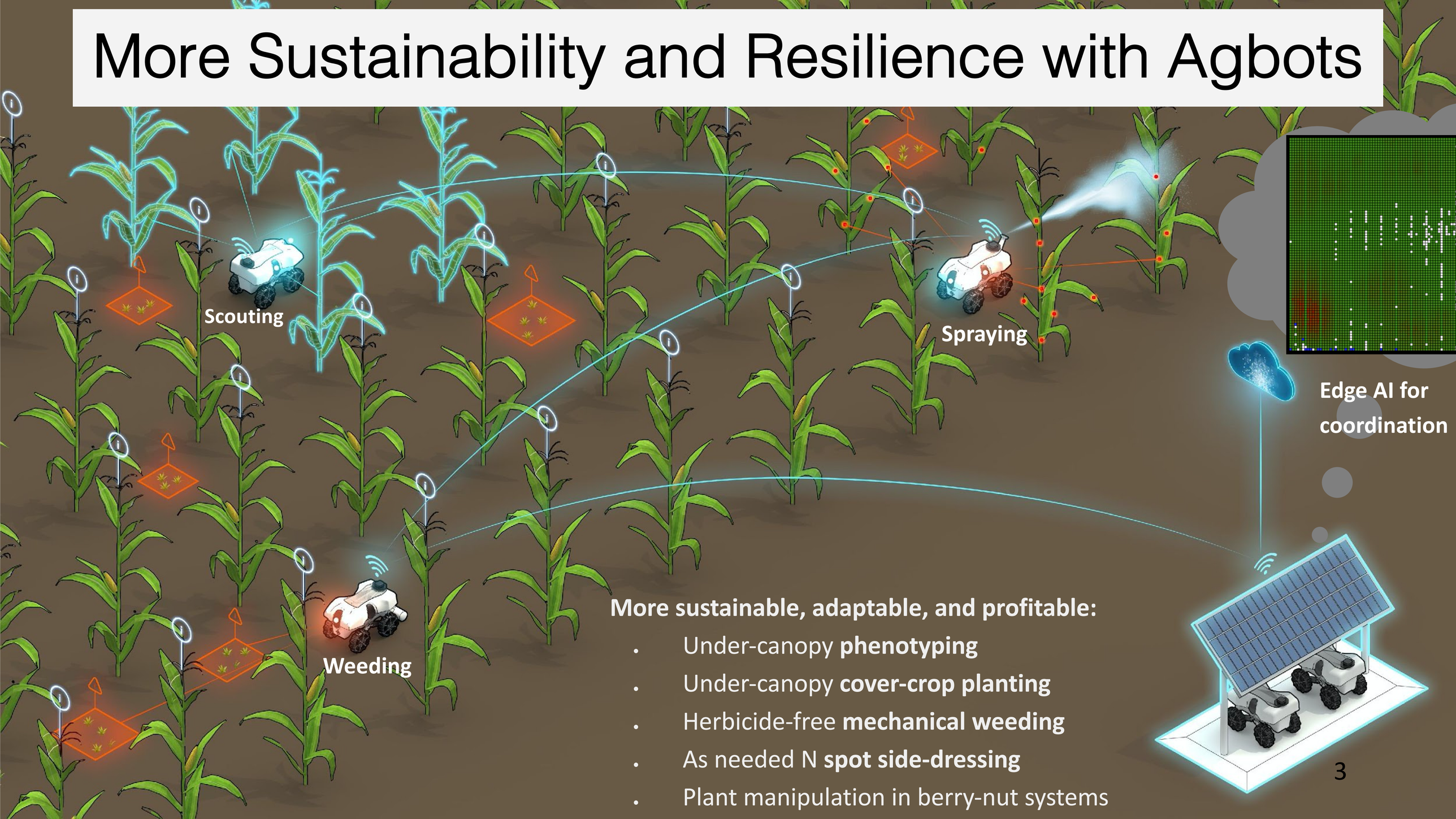
Broader Impact:

- Solution to herbicide resistance
- New options for organic growers
- K-12 outreach bringing students into ag+CPS

girishc@illinois.edu


$1.42/day!

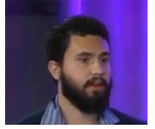
More Sustainability and Resilience with Agbots



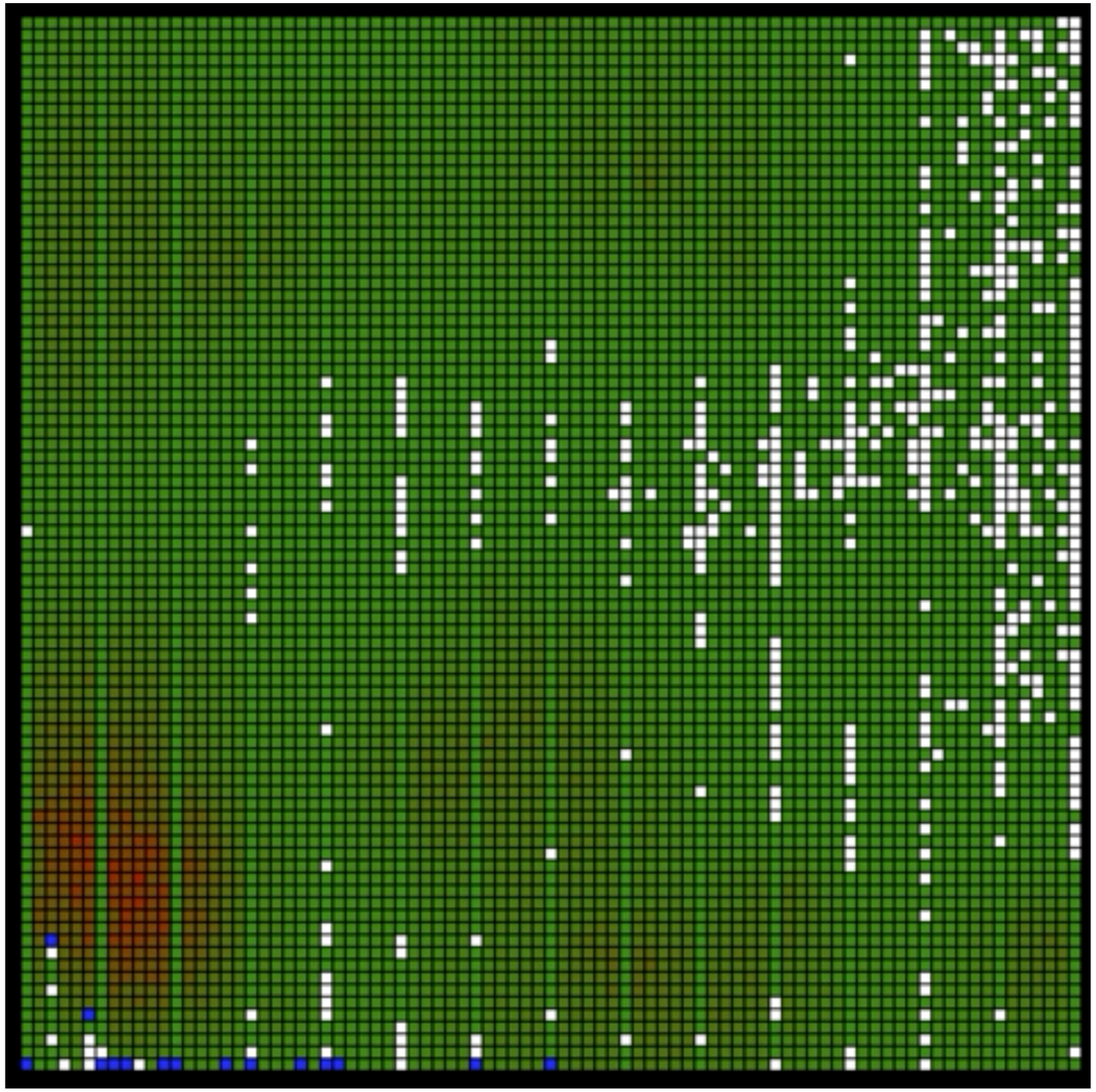
More sustainable, adaptable, and profitable:

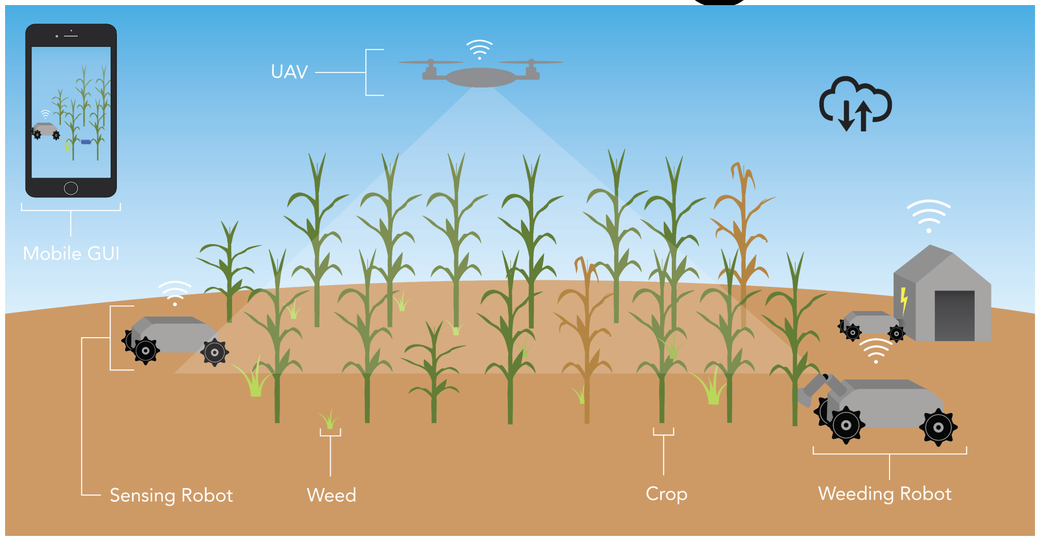
- Under-canopy **phenotyping**
- Under-canopy **cover-crop planting**
- Herbicide-free **mechanical weeding**
- As needed N **spot side-dressing**
- Plant manipulation in berry-nut systems

McAllistar, Whitman, Davis, Chowdhary, Agbots 2.0 Weeding Denser Fields with Fewer Robots,

Coordinated robotic weeding

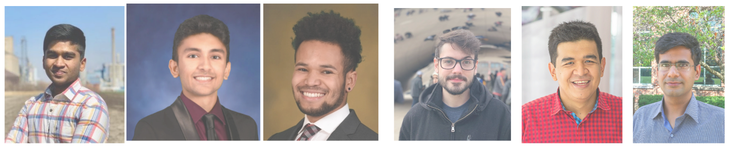




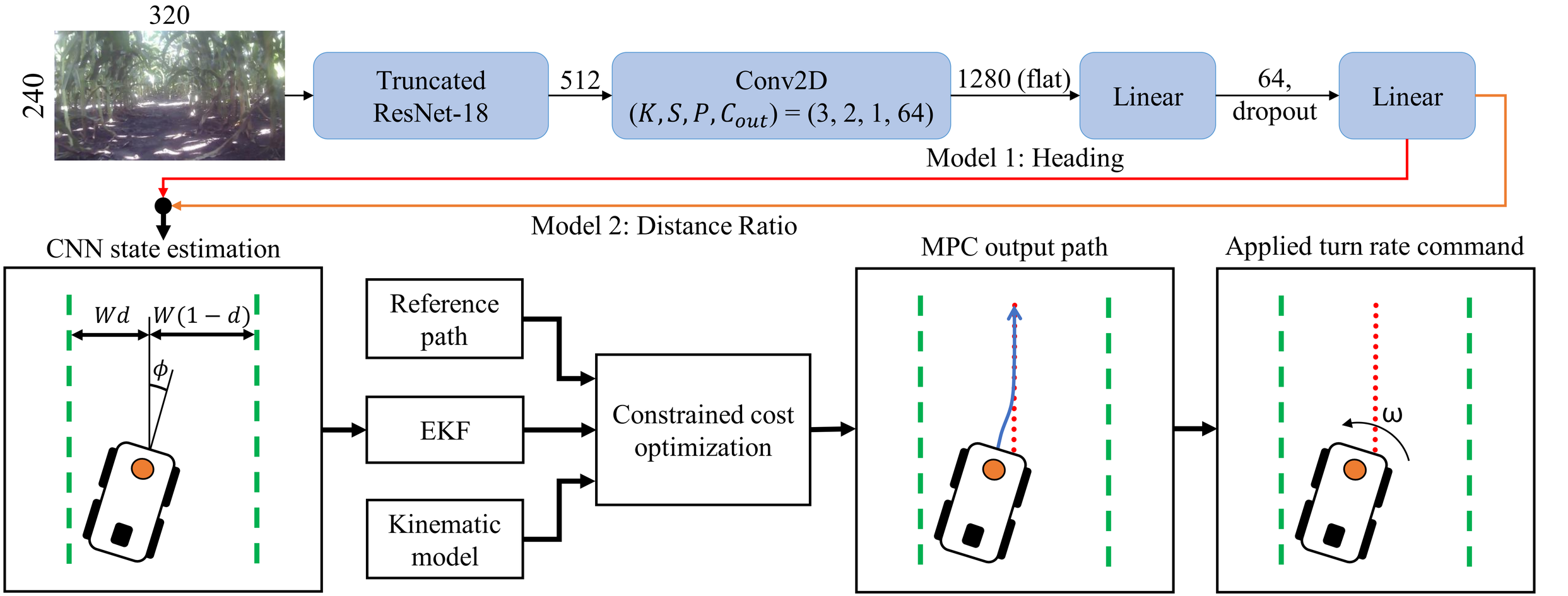
McAllistar et al. IROS 2018, CEA 2019, RSS 2020, TRO 2021

GPS+LIDAR is not enough!

- LIDAR doesn’t work when crops too small
- LIDAR doesn’t work with occlusion
- Solution Vision:
  - Large visual variability
  - Classical vision methods haven’t work
  - No large-scale datasets
  - No real-world visual crop-follow system



CropFollow overview



CropFollow w/IMU – 485 meters/intervention compared to LiDAR w/ IMU – 286 meters/intervention

Early season

Late season

Navigating through a curve

Navigating through occluding leaves

Videos are at 5x speed

Narenthiran, Modi, Gasprino, Baquero, Gupta*, Chowdhary*, RSS 2021

Publications

- Narenthiran A., Modi S., Gasprino M., Ellis C., Velasuez A., Gupta* S., Chowdhary* G., Learned Visual Navigation for Under-Canopy Agricultural Robots, Robotics Science and Systems (RSS 2021), held online due to COVID-19, July 2020. Average acceptance rate 28.6%.
- McAllistar W., Whitman J., Varghese J., Davis A. and Chowdhary G. Agbots 3.0: Adaptive Weed Growth Prediction for Mechanical Weeding Agbots, IEEE Transactions on Robotics, March 2021
- McAllistar W., Whitman J., Axelrod A., Varghese J., Davis A. and Chowdhary G. 2020. Agbots 2.0: Weeding Denser Fields with Fewer Robots, Robotics Science and Systems (RSS 2020), Oregon State University (held online due to COVID-19), OR, July 2020. Average acceptance rate 28.6%.
- Ji Tianchen, Vuppala Sri, Chowdhary G. and Driggs-Campbell K. 2020. Multi-Modal Anomaly Detection for Unstructured and Uncertain Environments, Conference on Robot Learning (CORL 2020), Massachusetts Institute of Technology (held online due to COVID-19), MA, Nov 2020. Average acceptance rate 34%.
- H. Gupta, N. He, and R. Srikant. Optimization and Learning Algorithms for Stochastic and Adversarial Power Control. Proc. WiOpt 2019. (Runner-up for Best Paper Award)
- S. Liang, R. Sun., J. Lee and R. Srikant. Adding one neuron can eliminate all bad local minima. NeurIPS 2018.
- W. McAllistar, D. Osipychev, A. Davis, G. Chowdhary, Agbots: Weeding a field with a team of autonomous robots, Computers and Electronics in Agriculture, 163m 104827, August 2019
- W. McAllistar, D. Osipychev, G. Chowdhary, A. Davis, Multi-agent planning for coordinated robotic weed killing, IEEE IROS 2018