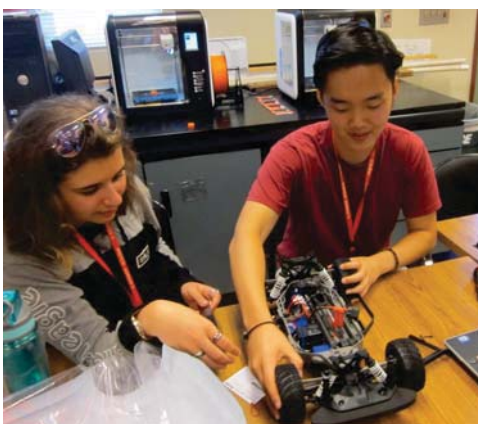


CLUSTER 11: Introduction to Autonomous Vehicles



Cluster 11 is in its first year and the students were very excited to get started. After the safety lecture students learned CAD from Dr. Phan using the Autodesk Inventor program. The cluster learned quickly and were able to complete their first design before lunch. After lunch we formed teams. The students unboxed their RC cars and took measurements to design the mounting plate for the autonomous car. This is the component that all of the parts needed for autonomy will be attached to. The rest of the afternoon was spent designing the mounting plate using CAD. Upon returning to the residence halls students prepared for Cosmolympics.



On Tuesday students attended the Discovery Lecture by Professor Nicole Steinmetz. The topic was nanoengineering of plant viruses as therapeutic agents. Dr. Phan then gave a lecture on 3D CAD. Students worked on finishing their mainplate from Monday and on drawing the camera mount for the autonomous car using 3D CAD. In the afternoon TA Sayan helped the students prepare their CAD files to laser cut the mounting



plates in the Mechanical and Aerospace Engineering Design Studio.

Wednesday morning students finished their 3D CAD files for the camera mount and began printing them. Students also used the laser cutter to cut the mounting plates. Both the camera mount and the mounting plates had to be tested and in some cases redone all part of the engineering process. Some students designed camera mounts that could vary the angle of the camera. This was tricky and difficult to 3D print. Another issue was finding a suitable axle for the variable mounts but the students persisted and succeeded.



Thursday morning began with a presentation on how to use the UCSD libraries for research. The students then completed 3D printing the camera mounts. In the afternoon, we worked on electronics and learning to solder. On Friday students mounted the parts for the autonomous car on the mounting plate and began assembling the cars. In the evening the cluster participated in Cosmolympics.

CLUSTER 11: INTRO TO AUTONOMOUS VEHICLES

The week began with more work on electronics. Students had previously loaded the software needed for the project on their laptops and the Raspberry Pi, the small computer used to control the car. Students also got to see a self-driving wheelchair, another project that Cluster 11 leader Jack Silberman is involved with. We got to meet the UCSD undergraduate students working on the project and they talked about some of the engineering challenges of the project and how they have overcome them. The wheelchair uses computer vision similar to the RC cars Cluster 11 is working on. The wheelchair project students also discussed some of their experiences at UCSD with Cluster 11 students.

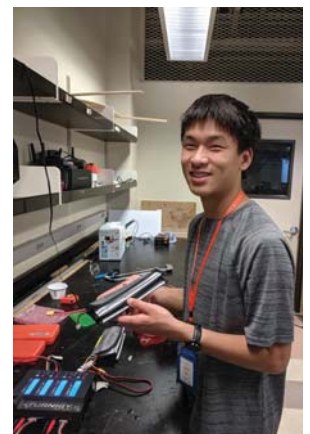
The students continued building the car, connecting all of the electronics needed. The car had to be converted from the default radio controller to be under the control of the Raspberry Pi computer. Students drive the car using a PS3 video game controller that uses Bluetooth to communicate with the Pi. The camera was connected to the Raspberry Pi so that the path driven by the human driver can be recorded by the Pi and then uploaded to be processed by the AI. The data on how to drive the car is then sent by the AI to the Raspberry Pi and the car can drive itself.

Tuesday started with the Discovery lecture by Professor Rob Knight on the human microbiome. After that, students returned to the engineering building to charge batteries and power up their cars for the first time. Some groups were able to drive their cars using the PS3 controllers. They were surprised by how fast the cars are and how difficult it is

to drive them. Students had to adjust the acceleration and steering control to make the car more controllable so that the car could be trained properly. The rest of the afternoon was spent on driving practice.

On Wednesday, the rest of the groups were able to drive their car for the first time. The outdoor track was refurbished with orange tape to designate the center divider. The AI is capable of seeing color so the car will stay to one side of the solid white line and to the other side of the dotted orange line. Students were able to save data of their driving and then let the AI train using this data. In the afternoon the students learned how to connect to the supercomputer center to process their data faster. They practiced training the car by having the AI follow the movements of a person standing in front of the camera or even a metronome on a screen. In this way, the concept could be proven without having all the cars on the track at once.

Thursday's morning lecture was cluster exploration. Here students learn about the kinds of projects that the other clusters work on. After that, more training and letting the AI drive the cars rounded out the week.



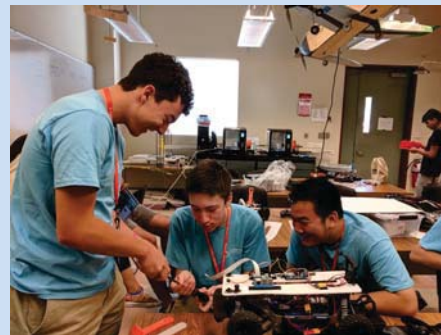
CLUSTER 11 : Autonomous Vehicles



Students asked questions of Mark Murray, the head of electrical engineering for Brain. The cluster learned some of the details of how Brain's vehicles work and how they are different

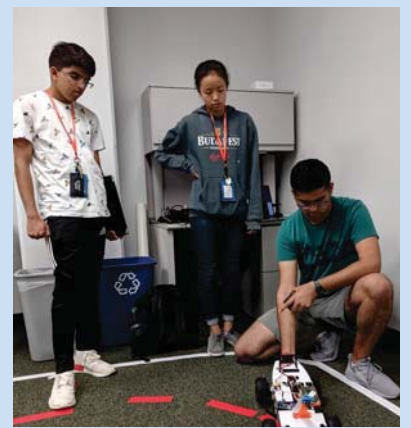
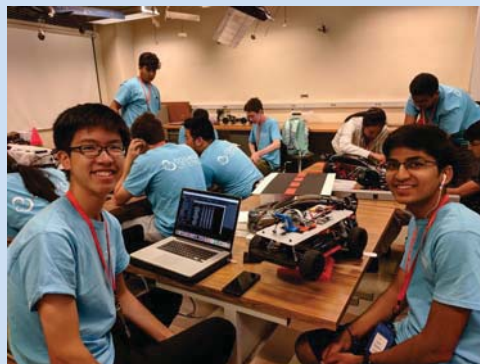
Week 3 of Cluster 11 began with students training the cars to drive on an indoor track. Indoors is easier because of consistent lighting. The data was uploaded to the supercomputer center and the cars could drive themselves. Once this goal was achieved by all groups, outdoor driving commenced. We also standardized on a single camera mount design so that each group's car had the same view of the road. This allowed all the groups to share each other's data and train the cars together.

from the RC cars we are working on. They also learned about the STEM job market. All in all it was an amazing field trip to a very special company with incredible people.



On Wednesday, the day was spent training the cars for outdoor tracks. Thursday morning began with Cluster Explorations where we heard from Clusters 4, 5, 7, 8, and 9 about the work going on there. We continued training the cars on the outdoor track and improving the performance. The rest of the week was spent refining the outdoor training and planning the additional behavior of the car, which is the Cluster 11 final project.

Tuesday began with the Discovery lecture by Professor Veerabhadran Ramanathan on climate change. More car training completed the morning. Students tried training the car to drive around cones placed on the outdoor track. In the afternoon was the field trip to Brain Corp, a local company that specializes in AI. Students got to see autonomous floor cleaning robots. Some students had the opportunity to drive the vehicles and train them. After the demonstration stu-



CLUSTER 11: Introduction to Autonomous Vehicles

Week 4 began with a lecture on Open CV from Dr. Phan. Students then began hard coding a line following program to see the difference between using a neural net and traditional coding. In most cases the neural net worked better but the drawback is that it requires a great deal of training. Various groups got the cars to follow other cars, follow people with tape attached to their shoes, and drive around courses made of cones.

Tuesday morning was the Discovery lecture by Professor Molly Roberts on the topic of online censorship. After that students worked on their final projects. In the afternoon students were taught Tensorflow by Dr. de Oliveira of Clusters 7 and 9. There was also more time for the final projects. Topics include following other cars, following bouncing balls, stopping at stop signs, following people and adaptive cruise control to avoid rear ending other cars.

Wednesday afternoon was a lecture on the technologies employed in full size autonomous vehicles. Thursday morning we visited the robosub competition and saw teams from around the world competing.

On Friday students presented their work to Clusters 1 and 10 and also heard from those clusters on their work in computer science and robotics. Late Friday afternoon was practice for the final ceremony. On Saturday families had the opportunity to see the cars and ask questions of the students and the cluster staff.

