Spring 2023 Volume 33

Monkey Business

News of The Funky Monkeys, Lynbrook High School Robotics, FIRST® Team 846

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Editor-in-Chief: Khadija Raza

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The Importance of Prototyping

Taking a look back at gripper design...

Monesh Ponduri (jr.)

The first few days of build season were gone in a flash. Putting together project requirements for the gripper seemed simple, but we were stumped when we realized we'd have to build something that met those requirements. Our first thought was to try everything: all the ideas, however outlandish or impractical as they seemed, had to be prototyped. But with our limited time and resources, it was clear to us that we had to have some structure to our brainstorming process. When we turned to our team mentors for assistance, they took some of our ideas and worked with us to refine and test them for conceptual viability.

A lot of different designs could be viable hypothetically, but it was only application that mattered; we had to find a way to channel our abstract ideas into tangible objects that we could test for viability. Immediately, we got to work implementing one of the most reasonable options into a working prototype. With limited resources and a focus on teaching the underclassmen, we were able to construct a functioning model. The main mechanism of this prototype was a brake to restrict and harness some of the drive motor's power to move other parts of the design. This feature allowed using only one motor to drive the entire system. We found a few problems after the prototype was constructed, mostly to do with the build quality of our prototype. We also noticed that the wear on the brakes would be a serious problem for the intense usage expected over the span of a competition. This could not be foreseen in CAD and these situations really highlighted the importance of building a prototype before a final product.

*see **The Importance of Prototyping**, page 2*

Fuzzy Feelings

Khadija Raza (jr.)

When we evaluated why our team did demos, there were the obvious reasons. It was a way to give back to our community and share the same opportunities we had to others. It was not only to promote FIRST and our team, but increase interest and inspire others to venture into the wonderful world of STEM. There was also, however, the undeniable validation we received at these demos that motivated us to continue showcasing our robot.

> *"It meant being able to see kids approach a robot hesitantly and leave proud and satisfied"*

"Fuzzy feelings" as I had dubbed it, were not something unique to demos. Competitions were incredibly gratifying experiences and everyone on the team certainly felt proud watching our robot race across the field. Our dedicated efforts were realized in the matches won, rankings, and interactions with other teams as they appreciated all the impressive works of engineering. Competitions, posing the true test of a team's skill, were the ideal environment to seek such recognition.

But somewhere in the rigorous competition (no matter how fun or enlightening) and very high stakes, some part of those fuzzy feelings were left incomplete - something that we could only experience in these special demos. There was something inherently different about watching a child who had never heard of FIRST's eyes light up with curiosity after seeing our robot from an experienced veteran admiring a certain feature of our robot. Furthermore, while competition was a culmination of all our technical work across the season, demos were the amalgamation of our non-technical and technical work from the entire year. Our two demos at Blue Hills Elementary and Foothill College towards the end of the season this year exemplified this.

Our first demo took place in an intimate evening gathering at Blue Hills Elementary, meant to promote STEAM to the young students. And while there was a relatively small audience there, it meant we were able to have a meaningful conversation with everyone as they were drawn to the large and attractive booth we had set up with our 2022 robot. It meant nearly every child there got the chance to drive and operate it, buzzing with excitement as they controlled a machine taller than them. It meant being able to see kids approach a robot hesitantly and leave proud and satisfied once we led them through replacing a battery.

The demo at Foothill College was no different in instilling pride in our team. With a projected attendance of 1500 at the all-day event, the day took off to a surpris-

Two children are led through replacing the robot battery at Foothill College

*see **Fuzzy Feelings**, page 4*

The Importance of Prototyping, Continued...

To address these problems, we formed a design using one way bearings and quickly built a prototype. This prototype worked better than the last and gave us the confirmation we needed to greenlight the production of a final version. We began modeling the new gripper out on CAD, machined out the parts, and assembled them. We were all proud of our work when it came time to show off our creation, but something was wrong when we mounted it on the robot. We had failed to account for the acceleration that it would be facing, and the clearances for some of the moving parts were too small to handle the violent shaking. This fatal error meant we had to redesign the whole subsystem.

Despite being very dejected by this setback, I decided to trust the process and started brainstorming for a new design. One of the most glaring problems with the previous gripper was its inability to maintain grip. We went through every single possible material that we had in the shop to see if we could find something grippy enough, eventually settling on some orange polyurethane belt. Another vital lesson we learned from the earlier design was the importance of contact area on the game pieces we were holding, so the flexible nature of the polyurethane belt addressed that problem as well. We threw together another prototype using the parts from our old design and this one worked even better than anything we had made before. We were absolutely sure that this was the one that we would be using on our robot.

Although the sudden discovery of a much simpler design made through taking inspiration from other teams made all our previous prototypes defunct, the lessons that we had learned from the prototypes greatly enhanced my knowledge of not only the physics and math behind designing parts like this, but also the design process and the many moving parts of a well functioning team.

Students test the wooden prototype of the gripper.

The Regional Experience

FRC Regional: A robotics competition with up to 60 teams

The team poses with our alliance partner, Team 5857 Walnut Valley Robotics, after the Los Angeles Regional.

Los Angeles Regional

Yuvraj Gill (soph.)

The air was thick with tension and the sound of whirring robots. We had finally arrived at the Los Angeles Regional, an event that we had been working towards for the last month and a half. Hosted by Da Vinci Schools in El Segundo, the competition was packed with teams from all over the world. To my surprise, the air was not an overly competitive one, with every team only focusing on winning. Rather, I saw teams helping one another, smiling in every interaction, and congratulating each other after every match. I came to learn about the term "gracious professionalism", which encouraged competition, not for the sake of beating one's opponents, but rather to cultivate through mutual growth. And although we cheered hard for our team while we competed, once the competition was all over, we congratulated each other and applauded each team at the very end.

*see **Los Angeles Regional**, page 4*

Silicon Valley Regional

Arnav Kametala (soph.)

I was thrilled to attend my first FRC Regional and after our electrifying performance at the Los Angeles Regional, I was pumped to see how our robot, Kone Kong, would perform at the Silicon Valley Regional, an event with many top teams competing.

The event was already in full blast when we arrived at San Jose State University in the morning, and the atmosphere was buzzing with excitement. Hundreds of students from around the world had gathered to showcase their robots, and the stadium was filled with the sound of whirring motors and chatter. We quickly met with the other members of the team and set out to pit-scout each and every robot there. We carefully observed the robots and engaged in conversations with other members from other teams. We absorbed the unique design choices, mechanisms, and clever

*see **Silicon Valley Regional**, page 4*

The For*see*able Future

Vyaas Baskar (soph.)

Computer vision in FRC and robotics, in general, is becoming increasingly important. A computer can react much faster than a human can, especially when that human has to focus on the field and is under the time pressure of the game. Additionally, drivers from some of the top teams have put in hundreds of hours of driver practice on a full field - something that we often don't have the bandwidth for. A quality vision software can achieve alignment faster than even those experienced drivers. High-scoring teams have used computer vision as a critical part of their software.

This year, we used computer vision to align to the nodes on the grid. We used the retro-reflective tape on the poles as a guide. Retro-reflective tape reflects light back the direction it was shined from, making it easily distinguishable to the vision software. The robot can then adjust its position with the knowledge of the distance and angle to the tape. This saved crucial seconds during our matches this year. The addition of April Tags further increased the potential for computer vision this year. Tracking April Tags can be much more accurate than

*see **The Forseeable Future**, page 3*

Looking Up

Touring aerospace facilities

Phoebe Tang (soph.)
Lakshya Kalra (alum.)

Tang: After the thrilling Los Angeles Regional, we got the amazing opportunity to explore the University of Southern California thanks to one of our alumna, Anna Shaposhnik, who was more than happy to show us around.

Walking into the campus the first time, I saw that it was way bigger than I imagined. The coolest part, however, was getting the chance to look throughout their rocket lab. The rocket team at USC is the first undergraduate club to reach the Karman Line (space) with a solid propellant rocket!

Coming into the building, we immediately saw a bunch of rockets which were recovered from previous launches towering over us. Some were in good condition and others had seen better days, but it showed an iterative design process where the improvements were clearly visible across the rockets on display. They were working on their rocket, "Fireball," a lower altitude 6 inch diameter rocket designed to be a technological stepping stone to their next spaceshot attempt. They are focused on making improvements to the leading edges of the fin, vehicle thermal protection system, recovery system, avionics system, and designing it to reach a 40kft altitude.

"The tour showed us what was possible with our engineering mindset..."

SpaceX and USC provide the club with valuable resources like carbon fiber for the rocket's body and funding respectively. Although carbon fiber can get expensive fast, it would definitely be cool to use it on our robot as it is significantly lighter and stronger than aluminum, which makes up the majority of our robot build. The team also makes their own propellant at the ExQuadrum facility near the desert. They also use a design tool called Siemens NX which is similar to the CAD (computer-aided design) software we use on our team, Autodesk Inventor. They design and assemble their own printed circuit boards for their avionics unit, known as the HAMSTER, which helps to track and recover the rocket through a variety of onboard sensors. Growing up building model rockets as a child that only went up at 500 to 1000 feet, it was fascinating to see rockets on a bigger and more complicated scale. Looking at the many iterations of the rockets over the years, one of my takeaways was to learn from past experiences to improve for next time, and that the FIRST Robotics Competition program is a stepping stone to bigger, fascinating, and more complicated projects in the world and beyond.

USC Rocket Propulsion Lab's (USCRPL) past rockets on display.

Lakshya: We also got to visit the largest satellite development center in the world, Boeing's El Segundo Space Center thanks to an alumna that worked there. As soon as we entered, our three amazing tour guides had already introduced us to the concept of gyroscopic stability and showed how it affected satellite design. As we entered the massive hangar, we saw the ongoing construction of an impressive satellite. It was part of the O3B (Other 3 Billion), one of a series of 11 satellites with a goal of bringing satellite connectivity to the "other 3 billion" people who don't have access to it.

Before actually entering where the satellites are stored, they had us put on a full lab gear to ensure we didn't contaminate anything that will eventually end up in space.

Throughout the tour they focused on how they test satellites on the ground to ensure a successful trip to space and how they simulated a zero gravity environment. For the massive wings, they are able to mimic a Zero-g space environment by attaching strings across the wings and providing an upward force to counteract gravity. They even had an anechoic chamber (a large room where the walls and ceilings are covered in special foam spikes that absorb any reflections of sound or electromagnetic radiation) to test their equipment in a similar void as space.

The BOEing engineers even talked about their iterative process where they learn from their past and innovate for the future. In their circuitry, they mentioned separating each mechanism into separate circuits in a gridlike fashion to reduce single points of failure. They took this and iterated to have a parallel style with breakpoints and redundancies to ensure the safety of the most important mechanisms. In this process, they aren't able to put backup circuitry on every mechanism so they rank connections based on what is most critical to the satellites core functionality and ensure those before working on anything else. This is something the team can take inspiration from as well: we are often pushed for time trying to accomplish everything so a more structured evaluation of what the most critical mechanisms are that need the most testing would be helpful.

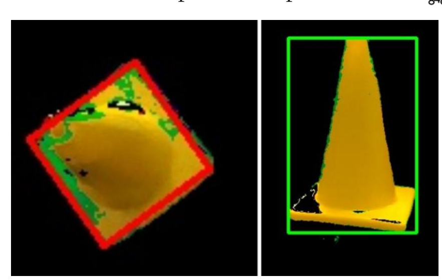
I loved learning about the satellites and the whole tour was enriching and exciting. The tour showed us what is possible with our engineering mindset and what all of us can do when we apply what we learned in robotics.

***The Forseeable Future**, Continued...*

tracking retro-reflective tape, and there is a lower chance of false recognition of a target. The increased size and number of features to track on the April tag make it more accurate and reliable. As April Tags can all have different values (like QR codes), the robot can know which April Tag it is at, and reset its position relative to that.

Other uses of vision in FRC include detecting and tracking game pieces on the field and tracking common error points on the robot. This year, I worked on a piece of software to detect the location, orientation, and type of game pieces on the field. This would have been very helpful for a consistent several-game piece auto routine, but for lack of time, our team resorted to (mostly) hardcoding our autonomous routines. In the offseason, we used this software to automate shelf pickup. Another use of vision would be to track error points on the robot. On our robot, common error points were when the game piece got stuck at the edge of the intake and at the vertical rollers of our conveyor system. Using vision to detect if the game piece was in an orientation it should not have been, or if it had not passed the conveyor would have allowed us to eject the game piece before it became an issue.

It is possible to play the FRC game without the use of any computer vision with basic commands linked to key presses on the remotes of the operator and driver. However, with vision, the execution of complex tasks can be better timed and more reliable. If our team works to implement more computer vision solutions on our robot, we can improve our performance.



Cones framed by bounding boxes.

Fuzzy Feel*ings, Continued...*

ingly slow start. But as noon approached, we suddenly found ourselves inundated with a stream of attendees. There was something so gratifying about telling people about our team and seeing their amazed and appreciative reactions that it was hard to complain about the relentless flow of people into our station. I had the pleasure of learning how to drive the robot for the first time that day and in my time managing the drivers' station, I saw the excitement and interest on people's faces as they were invited to control the robot as well. Answering people's questions as they marveled over the scope of our team and FIRST Robotics was something I didn't see at competitions and not only left me feeling proud but reminded me of how valuable the opportunity to participate in such a high-performing robotics program was.

At the end of the day, I'm glad our team chooses to partake in demos like these every year. Watching people leave our booth, inspired and interested about STEM, because of something we made makes for a very rewarding experience and is a true testament to FIRST ideals.

Los Angeles Regiona*l, Continued...*

During the competition, I learned how to scout robots, both in the pits and during matches, and I learned important information on several teams. Along with this, I made new connections with several members from different teams across the nation, learned new perspectives about building robots and gained fresh insight on how to compete with a professional mindset.

> *"... teaching me important values along the way."*

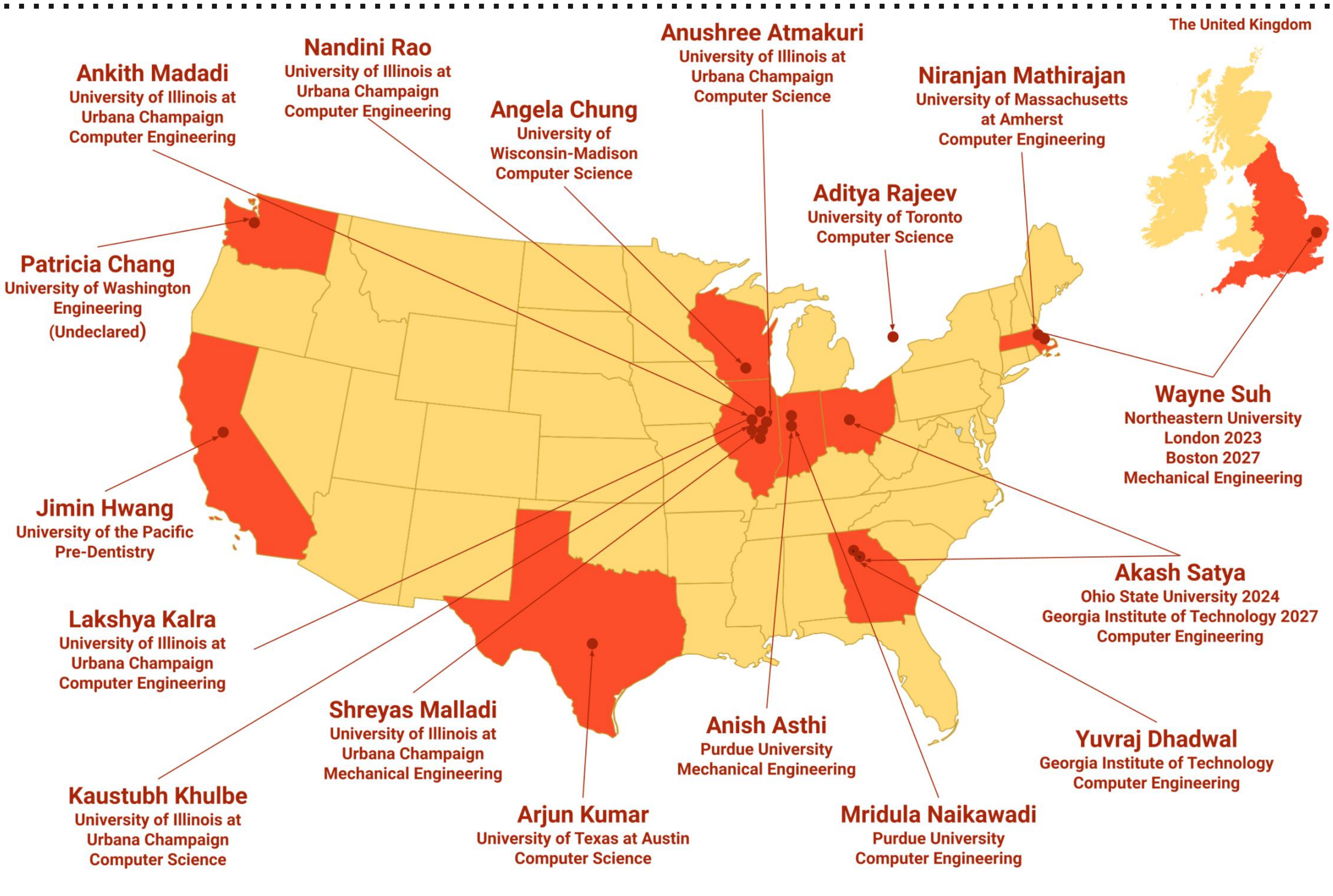
Throughout the build season, I witnessed firsthand how the power of teamwork can succeed in the end. I saw that through the hours building prototypes and brainstorming on whiteboards, a team that is motivated to succeed will prevail in the end. At the Los Angeles Regional, I saw our team compete for my very first time and in the end, win the Quality Award and finish as semi-finalists. As a freshman member of The Funky Monkeys, this year has been extremely valuable to me, exposing me to the world of robotics and teaching me important values along the way.

Silicon Valley Regional*, Continued...*

solutions they implemented to solve the same problems we faced.

On the second day of the regional, the real fun began. The qualification matches started and I saw for the first time an FRC match. We watched in awe as the robots competed, intaking cones and cubes and placing them into the nodes. We used a newly designed app created by our team to scout and track the performance of the other teams, noting down their strengths and weaknesses. Then the time we were all waiting for, our first qual match. Kone Kong was being placed down on the field by the drive team and we cheered loudly from the bleachers as we saw our robot move across the field with such robustness through the giant screen, scoring points left and right. It was exhilarating to see our countless hours and hard work pay off.

The Silicon Valley Regional was undoubtedly an unforgettable experience. We left inspired and determined, already looking forward to the offseason to improve Kone Kong. It was a privilege to be a part of such a remarkable event, surrounded by brilliant minds that share our passion for robotics.



Graphic by Khadija Raza