Ogni Goswami

June 18, 2015-August 10, 2015

Lab Records

Location: UC Berkeley Etcheverry Hall Mechanical Dynamic Systems Laboratory

Professor: Dr. Masayoshi Tomizuka

Mechanical Systems Control Laboratory

June 18th- This was the very first day I went to the lab. I was accompanied by my father and we arrived at UC Berkeley at 11 AM and went to Professor Tomizuka’s office for an introduction. He spoke with us for a few minutes and then and went to his lab for a brief tour. Professor Tomizuka showed us around the lab and introduced us to his various students including Dr. Cong Wang and Kevin. He explained and showed us many of the projects such as a vibration-canceling silicon wafer handling robot, three Fanuc industrial robots, a gyroscope, a quadrotor, and a heart-rate adapting electric bicycle. Then the professor took us to another room which was the “older room” from which the items were being transferred to a new room beside the lab. After that we returned to the lab and the professor graciously allowed me to use the desk of a student who was going to be away for several weeks.  Then we thanked the professor and left the building.

June 22nd- This was my first full day at the lab. Dr. Cong Wang described some projects he was personally working on and gave me some information about himself and then he showed me a few things Professor Tomizuka did not cover during the last visit, such as Cong’s own office. Cong took me to visit ProfessorH. Kazerooni’s Berkeley Robotics & Human Engineering Lab. One of his students gave us a tour of the lab, where we saw many exoskeletons for various applications and body parts. Next Cong and I discussed a plan of my activities during my stay. Then Cong explained a recent incident which occurred in the lab to me where he was almost blinded when an extremely powerful industrial robot’s arm swung around and hit him in the head. He suggested that it may have been prevented through one of two methods: a blast of air to push him out of the arm’s trajectory, or an airbag to encapsulate the arm when it was evident that an impact was inevitable. I agreed that it was an interesting and timely project as I recalled that a man had recently been killed by a robot accident at a Volkswagen plant. Then Cong gave me a few research papers on this topic. He also suggested that I learn SimMechanics on MatLab programs for simulation work. I spent the rest of the day reading the research papers, researching online about topics in the field, and watching MatLab tutorials. I also contacted Dr. Wenlong Zhang, another member of the lab who was working on the electric bicycle project, which greatly intrigued me.

June 23rd- Cong lent me a popular undergaduates textbook named Control Systems Engineering by Norman S. Nise. I read a few additional papers which Cong gave me (including ones he wrote himself), and some papers written by Wenlong’s about his electric bicycle project. Wenlong was out of town for the week so I was communicating with him over email. I also researched online about subjects mentioned in the paper which I wasn’t familiar with.

June 24th- This was the first day I was able to use MatLab. I watched several tutorials for MatLab to learn the basics and started using it. I was able to create the model of a motor that is winding a spring. I generated a graph of the motor’s rpm and torque (interchangeably) output of a motor winding a spring to its entirety.

June 25th- Today I uploaded the CAD model of a robotic arm which I found online and converted it into a SimMechanics model. I was then able to characterize its motion based on various forces I applied on it, such as shifting the centers of gravity of various links of the robot. Cong also showed me the SimMechanics model of a Fanuc robot arm which a previous student had made.

June 26th- Today I received my first lecture from Cong, regarding Finite Element Analysis and Multibody Simulations. I learned that he had been previously employed in the safety division of Toyota where he often worked with airbags, crash test dummies, and similar devices. He explained how generally systems were modeled using multibody simulations and when engineers wanted to concentrate on a specific part of the simulation (say the head of the person getting struck by the industrial robot) they would have to use more precise Finite Element Analysis. In multbody simulations, objects were often characterized as ‘rigid bodies’ while in finite element analysis, even the fluctuations of the surface of the model (such as indentations) were carefully modeled. Then, when the engineer wanted a proof-of-concept, they would carry out the real experiment. This would usually be avoided as it required a lot of calculations among other preparations.

Wenlong (who had been attending the ACC conference in Chicago) sent me an email after consulting a German visiting scholar whom he collaborated with an answer to a question I had asked him regarding negative torque on his electric bicycle project. He also suggested that I learn the LabVIEW software.

June 29th- Up until this day I had been discussing predominantly with Cong, but I also occasionally emailed Wenlong. However this day, after another short lesson from Cong, I came to the conclusion that working on this project would be simply out of my grasp, mainly due to my lack of understanding of calculus. Cong also explained how even many of the second or third year college students who took the course in order to learn how to create even multibody simulations failed it, so I understood that it was definitely beyond my reach. At this time I really wanted to work with Cong because of his openness to helping me and his cooperative character, but unfortunately I understood that I wouldn’t be able to help him on this project and had to find something else to do. However I didn’t feel bad for long as I realized that I would still be able to assist Wenlong with his electric bicycle project. I spent the rest of the day learning LabVIEW from a YouTube playlist which Wenlong had suggested to me. I also attempted to use the LabVIEW software but unfortunately the password to the computer which had it installed had been forgotten.

July 1st- I saw Wenlong after a long time this day and we discussed what would be a feasible portion of his project I would be able to (mainly individually) complete during my stay at the lab. I started with suggesting the idea of modifying his bicycle to provide negative torque while traveling downhill in order to allow the rider to maintain his constant heart rate (the objective of his project). This negative torque could also be used to recharge the battery using the rider’s pedaling. However we settled that this would require advanced modifications to the motor driver or the purchase of a new one (which wasn’t feasible). Then Wenlong mentioned that while riding the bike, the rider still had to carry the laptop to run the LabVIEW program. This added unnecessary bulk and complexity to the design, so he suggested that we could upload his LabVIEW program onto the myRIO platform (a platform from NI), which was much smaller, so that carrying the laptop wouldn’t be necessary. I agreed to the idea and when I asked Cong if I could borrow a copy of LabVIEW to install onto my laptop, he coincidentally also lent me a myRIO platform. I spent the rest of the day watching LabVIEW tutorials and finishing its installation.

July 6th- This was my first day using the myRIO platform. Since LabVIEW had finished installing, I was able to test the accelerometer, lights, and button on the myRIO with simple programs which I assembled. I also continued to learn LabVIEW through tutorials this day. After learning the basics of it I felt I had to begin tackling the issue of how to use the myRIO for this project. The first hurdle was the heart rate monitor, of which the data was output through a Bluetooth dongle. For the majority of the day I researched on how to use the USB port as a data input on the myRIO or if I could use Bluetooth at all, as installing its driver was the main issue. I also spoke with Wenlong for a brief moment and he lent me the heart rate monitor strap and gave me a copy of the algorithm which he had previously used in the project to analyze. Cong also dropped by the lab and gave me a demo of the full-sized Fanuc arm robot.

July 7th- The night before, Wenlong sent me a cut-down version of his algorithm to only monitor the heart rate of the user. He wanted me to see how the computer analyzed the incoming data and how to use the heart rate sensor. After spending a few hours with the program, I was unable to make the heart rate monitor work so I gave up and spent the rest of the day working with LabVIEW and researching on how to make the myRIO platform work successfully with this project. Cong dropped by the lab at one point with two officials from a Japanese university and he gave them a demo (which I was allowed to watch) of a system where he was able to control a robotic arm using an infrared pen and sensor.

July 8th- This day I concluded that the USB port would not be able to handle the Bluetooth data input of the heart rate monitor. However, I thought of an alternative where I utilized the Wi-Fi capabilities of the myRIO and used a separate computer to stream the Bluetooth data to the myRIO to then execute. However, since the computer would, again, sacrifice portability, I decided to use the Raspberry Pi platform (a credit-card sized fully functioning computer) in order to stream the Bluetooth data over Wi-Fi to the myRIO. I presented the idea to Wenlong and spent the rest of the day figuring out how to make the Raspberry Pi to carry out this function.

July 10th- This day I was finally able to get the heart rate monitor working after a lot of tinkering with the hardware and software aspects. I also created a plan for the next three weeks of my stay at the lab in order to complete my project.

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| Task | Comments | Duration |
| Connect Raspberry Pi to HR Monitor | 1. Plug the dongle into a USB port on your Pi and boot it up. 2. At the command line type sudo apt-get install --no-install-recommends bluetooth. 3. Once the software is installed, type sudo service bluetooth status. 4. You should see bluetooth is running. If not, reboot and try again. 5. Type hcitool scan. Any Bluetooth discoverable devices in the area will appear on screen; you are now ready to use Bluetooth on the Raspberry Pi. | 1 Day Maximum |
| Raspberry Pi converts HR input into bpm value | LabVIEW cannot run on RPI, so find out how to get bpm | 1 Week Maximum |
| Raspberry Pi BPM Data Transfer to myRIO | Soldering required between analog/digital pins or breadboard? | 1 Day |
| myRIO executes labVIEW code independently | Research Required | 1 Week Maximum |
| input of myRIO connects to torque sensor | How would it be connected? | Unknown |
| output of myRIO connects to hub motor | How would it be connected? | Unknown |

July 13th- This day I was finally able to make the myRIO function independently of the computer. I made a small program which switches on one of the LEDs on the device when I pressed a button and it worked. This drastically cut down on the amount of time I expected this project to take (by a whole week). I also saw Professor Tomizuka for the last time today before he left for a business trip for the next four weeks, so I thanked him and told him I would send him a report of my project and time at the lab when I finished. I spent the rest of the day researching about how I would stream the heart rate data through the Raspberry Pi to the myRIO.

July 14th- This day I spent uninstalling LabVIEW 2014 due to some issues and began installing LabVIEW 2013. I spoke with Cong about his work in New Jersey for about 30 minutes in the morning. I also researched about and slightly modified the myRIO to RPI connection concept. From this I realized that these were the two remaining obstacles were:

1. Convert the incoming BT data from the HR sensor into bpm locally on the RPI (by using a short python program?)

2. Modify the LabVIEW program to reference the RPI or USB B port as an input instead of a generic computer.

I spent the rest of the day tinkering with the RPI and researching on ways to accomplish those goals.

July 15th- This day I spent completing the installation of LabVIEW Fall 2013. I also began working with the RPI by first installing Rasbian OS onto it. Then I installed a Bluetooth dongle onto it and was able to successfully use a wireless keyboard. I spent the rest of the day trying to get the Wi-Fi on it to work in order to update some drivers and other software. I briefly spoke with Cong in the morning about the RPI as it was one of his first times seeing one.

July 16th- This day I was finally able to get the Wi-Fi to work on the RPI and was able to access some websites and download some necessary programs. I also tinkered with the BT connection. I figured out that the connection I had made the day before between my keyboard and the RPI was false hope as it was limited to only that. Therefore I installed the lab’s Asus BT dongle today. I wasn’t able to make any connection or transfer data yet, but I got proof that it was working as it was able to see my phone searching for a signal.

July 20th- Wenlong returned after travels and I spoke with him about our plan in order to complete the project by the end of the week when he would be leaving. I also was able to successfully connect the iPhone to the RPI, but I realized that I couldn’t transfer any data due to iOS’ stringent restrictions. I spent the rest of the day researching on what to do.

July 21st- This day I was finally able to connect the HR sensor to the RPI over Bluetooth, but I spent the majority of the day figuring out how to display the data which was being sent to it. A professor from Hong Kong also dropped by and spoke with us for a short while.

July 22nd- This day I was finally able to view the incoming Hexadecimal data and Wenlong and I interpreted it and figured out how exactly the LabVIEW program was functioning. I spent the rest of the day figuring out how to output the hex data through a serial port.

July 23rd- This day I made some python code to stream the serial port data through the RPI to the myRIO. However there are still a lot of errors in the code so I have yet to execute it successfully for the first time. I also need to assign the myRIO a serial port.

July 24th- This was Wenlong’s last working day in the lab so I tried to complete as much work as I could and I stayed until about 5. This day, I completed the majority of the python algorithm and assigned a placeholder output serial port for the myRIO until I figure out how to assign it one. It seems like the only remaining error in the code is that arrays cannot be written to serial ports, so I will have to convert it to a string. I wrote a line to convert it, but I will test on Monday if it works.

July 27th- This day I was able to perfect the python code as I had eliminated all the remaining bugs in the algorithm. This day I also decided that an USB connection would not be possible, so I have to use pins.

July 28th- This day I was able to run the heart rate monitor code independently of a computer on the myRIO successfully after I made a few edits.

July 29th- This day I started working on the lab report I would eventually present to the professor. I also used to jumper wires to connect the corresponding ports between the myRIO and RPI.

July 30th- This day was spent reinstalling LabVIEW as it had been erased, and tinkering with the myRIO to RPI connection. I also finished the abstract for the lab report I would be presenting to the professor.

August 4th- This day I was able to route the myRIO’s computations to be displayed on the screen of my laptop-as proof that the myRIO *was* doing something. I also was able to run a “loopback test” which showed me that the UART pins on the myRIO *were* working and also supplied me some sample code to show me how to manipulate its serial ports.

August 5th- This day I was finally able to complete the project. I was able to see my heart rate on the screen of my computer after it was analyzed by the myRIO. I needed some modifications to the python code, specifically converting the string to hexadecimal. I also wrote a little bit of my report this day.

August 6th- This day I mainly focused on writing the report. I made drastic edits to its organization and took and added many pictures. I also redid the flowchart using pictures of the devices instead of just their names. I also figured out that the Raspberry Pi would only need a battery while booting up. After that it would draw the power through a 5 volt jumper cable on the myRIO.

August 7th- I spent this day writing my report and I ran a practice demo once to make sure it was working. I also scheduled a meeting on Monday at 10:30 to present what I worked on.

August 10th- Today I gave the professor a demonstration of what I have been working on. I began like a story starting with how the ebike caught my eye on the first day. Then I demoed my work and then I discussed future works with him and my father. We then discussed what I gained from this experience and presented him a Lindt Chocolate box for him and the lab to enjoy. After that the professor showed my father the new room and we discussed more about the ebike and Ford’s recent announcement of one. After that we shook hands, he left, and I packed up. On the way out I handed Cong a card and an Indian gift of some scriptures on palm leaves. After walking a short distance, I realized I had forgotten my Bluetooth receiver for my keyboard, so I returned to the lab, picked it up, and waved Cong and the interns goodbye and left.

THE END