Lecture 09: Experimentation III

I welcome you all to the experiment number 3, path and gait planning of a system. So, experiment number 3, path and gait planning of hexapod robot. So typically, if you could look to this hexapod robot, which has been made by Wincross, which is having one motor, two, three. So basically, it is having six legs with each leg having three motors and all are revolute joints. So all in all, it has a switch which can be pressed to make it on or off conditions. As well as all in all, it has a three degree of freedom or mobility.

So if you open it and see, what exactly is in this behind. So it has a LED, which actually flashes when it is in blue color, it flashes that it is in configurations with a mobile app through which it can be controlled. Also it has a camera if you could look closely. So with the camera, it can detect the obstacles, it can see everything.

Also it has the ultrasonic sensor and the infrared sensors to detect the obstacles also, which help in navigations through different terrains. So, after that, we would be dealing with some of the tasks for the hexafod to understand the navigation and the path planning of hexafod. So, as we have seen a basic brief introduction about this hexapod, so I would like to show you this interface of the mobile application through which we are actually controlling this hexapod. So first task that we are going to see here would be the variations of the height of this hexafod. It is straight away move to it.

So you can see it can adjust at different heights as well as it can raise itself to a particular height also. Apart from that, it can rotate its height in which the camera is already in built. So it is a great application, it will be great for the applications area such as first operations, cleaning the pipes and those stuffs. It can reach to any level with the three degree of freedom mobility as well as it can rotate its heads. Moreover, it can change its height based upon the need and the necessity and perform its application accurately, okay. So the next task would be to move the hexapod backward and forward.

I would request to the listeners to focus on the legs, how they are responding to various conditions and how they are maintaining its stability. Now this is hexapod is trying to move in forward direction, maintaining its stability. Now also in this context, I would like to introduce one terminology, that have already been stated by Professor Pratihar in the lecture, that is, the duty factor. Now in this conditions, you could see, what happens when it is navigating at some time, this leg is not in contact with the ground.

So how many legs are in contact with the ground divided by total number of legs that is called as duty factor and this is very, very important while maintaining the balance. So the first task that we have tried to move the hexapod in forward and in backward directions has been successfully performed. So let us move to the task 3. In task 3, our aims would be to rotate this hexapod at the same point. So it would take a turn at the same location.

Let us see how it is done. Now again you can see it is in accordance with each and every motor with the 6 legs and turning at the same point. Next task would be to move the hexafod to a curved path. Let us see how it behaves to these kinds of responses. Now you can see it is not moving in left or right or forward, it is moving in a curved path diagonally.

It is not making a straight path rather than it is moving in diagonal direction. It can move like this. Now see again it is taking a diagonal path, not a straight path rather than a diagonal path. So the next task is climbing on a staircase. These kinds of tasks are majorly applied in case of search operations, finding, navigations.

So let us find, how this hexapod is responding to these kinds of conditions. Now once its edge detects some obstacle, so it will try to navigate and perform the staircase operation. Well I would like to highlight here that this is inbuilt. We are not controlling anything and this is automated. So next task would be to let us play around with this hexapod and make it dance, make it use its entire motors and see how much effective it can balance itself and do the gait motions.

So first it is waving its hand and then like this. Now you can see as I have told about the duty factor, it can maintain its balance on the four legs. So 4 by 6 is your duty factor in this case. Simultaneously it can move its head also. So you can see it is moving its head and giving some good moves.

Now again duty factor is 3 by 6. Now it can perform these kind of operations with various speeds. It can perform in a medium speed, in a low speed and gradually it can increase its speed like a rabbit. So, I hope you have enjoyed this entire task performed by the hexapod and in its own word, hexapod is telling by tomorrow.

Thank you. Hello everyone. So this is the information again. So in continuation with the previous task performed in our hexapod robot, we are going to add the more task into it and that we are going to explain. So, basically first task what we are going to do is navigating through unknown terrains. So when we are navigating the robot through unknown terrains, it needs different, its CG should be at different levels.

So for example, if the CG of the robot is very low, in that case it can move on the flat terrains but when we are going for unknown terrains, so its CG should not be very low otherwise it will stretch or it will collide with the objects coming around and all these things. So it is better recommended for learning from those learning from terrains to keep the CG of the robot a little bit higher. So when we are keeping CG of the robot at very low level, so in that case stability will be more but in that case stability will be more and also it will take steps faster. So it will move, it will navigate faster through the terrains. When we are keeping the CG level at high, so in that case step length will be less and in that case, stability will be a little bit less but it will be a level of navigating.

So these are the things we are going to explore in this next task. So let us explore. So, I am going to connect the hexapod and then we are going to see what different levels of CG this hexapod can navigate. Okay, so now we are going to see three different levels of height. So now we are going to see motion of the robot in different levels of motion.

So, at first we will start at the very low CG level. So, now the CG of the robot is at very low level and this is the navigation. So you can observe it properly like in this mode, it is taking more and bigger steps and it will move navigating faster and in this case CG is low. So the robot is more stable in this case. So the next mode is I am going to raise the CG.

So this can be used when we have non-uniform terrains. So different level of high can be adjusted. When you have small obstacles or small varying terrains, there are many aspects. You can easily navigate to those terrains. So as you can see here in this mode, the step lengths are less.

So different depths are followed. So it is not as fast as previous case. And it is trying to maintain the stability with the constraint, whatever constraint we have given. At moderate level, we want to see, this is the moderate level.

So this is the navigation. So, a little bit more movement, a little bit faster. So, next task is we are going to navigate the robot using three different gait motions. So, it has three different gait motions in which it will follow different patterns of gaits and the robot will move. So based on the six legs, some legs will follow some pattern and some legs will follow different patterns.

So first is normal. So the upper motion you have already seen. So I am going to marching. So in the marching, it will lift its legs more. I am going to marching.

This is the marching movement. So as you can see, it is marching. So at a time, three of its legs are following same pattern and other three are following the other different patterns. So it is a combination of three. So this mode is now same.

Now I am going to carry mode. So robot, you will be seeing that these two front legs and back side, one center leg will follow the same pattern. And this front center leg and these two extreme back side legs will follow the same pattern. So these will be combination of patterns. This robot is going to follow this.

So this is the tail. As you can see here, these two legs and back side center leg is following same pattern. These center top, center front and back side two legs are following the same pattern. So this is the carry mode. In this mode, CG of the robot is kept very low as it is crawling on the floor. So in this task, we have seen three different patterns.

That is, first is normal mode, second is caving. So it will be caving through the current.

And third is marching. So in caving mode, the CG of the robot will be at the very low level. In the normal mode, the CG of the robot will be at its trunk level.

So it will be normal. And in that marching mode, the CG of the leg will be above the CG level. Leg will move above the CG level. Now the next task is we are going to negotiate the robot through different inclination levels. So robot will be travelling on inclined surfaces and we are going to explore how much angle it could go. So we will, small increments we are going to move the robot one by one.

So let's start with the 5 degree. We are giving the 5 degree inclination and we are navigating the robot. Let us see how robot behaves and how it follows the gait pattern in that mode. So now, as we have seen that the slope of this particular setup is 5 degree and we will try to move the robot and we will see how it reacts. As you can see, since the slope is very less, the robot is easily navigating through in-line terrain.

Now this is the ascending. Now we are going to show this is the descending. So now robot is descending. It is automatically adjusting its gait cycle according to the slope and it is trying to navigate. Now see, here that we have maintained the 10 degree slope here.

Now the inclination is of 10 degree. Now let's see this is the ascending in 10 degree. So now I am going to rotate the head and we are going to come descending. So this was descending, ascending and descending. Now let's see the backward ascending, whether robot is a good robot or not. So its head is at front but it is moving backward.

Now we are going to backward descending. Now we have raised the inclination level to 20 degree. Now it is 20 degree. So we are going to see how robot is navigating through. So as you can see that robot is finding it very hard to navigate through 20 degree slope. So we can say this is the extreme limit that a robot can travel because of the friction is not allowing sufficient resistive forces and this free body is not able to balance itself.

So we can say that this is the maximum capability of the head robot. Now we are going to see 25 degree, whether robot is able to move in 25 degree slope. So as you can see it is slipping, it is not able to navigate. So we can say that the more it gets inclination, the more unstable its motion is. So different inclination level, different energy consumption will be there.

So the more the inclination level, the robot will consume more energy and it will drain, the battery will drain faster. So less inclination level, less battery draining and more inclination level, more battery will be draining because it has to move against the gravity and it will have more torque will be required to move the robot for each motors. Now we are going to demonstrate one experiment using our head support. Now we will try to see whether the head support can cross a ditch. Now, this ditch crossing depends on the width of the ditch as well as the stride of that particular head support.

Now with a particular stride value, it can negotiate reach of certain width only. So what we are going to do, we are going to change the stride of the head support and we are going to change the width and we are trying to find out with a particular value of stride how much width of the ditch it can negotiate. We are going to start with the ditch crossing module of the head support with the minimum start that is the maximum centre of gravity of this particular head support. Now we are going to do this experiment on ditch crossing with the minimum CG and the maximum stride rate. Now we are going to do the ditch crossing.