Lecture 06: Experimentation II

  Hello everyone, my name is Pradeep Nahak. I am a research scholar of department of mechanical engineering IIT Kharagpur. Currently, I am working under the supervision of Professor Dilip Kumar Pratihar and Professor Alok Kanti Deb. Today, I welcome you all for the experiment two of this course which is control of tracked mobile manipulator. In this lecture, I will be giving a short introduction about tracked mobile manipulator and then I will make you familiar about the components of tracked mobile manipulator. Then, later on, I will perform few tasks with the help of this tracked mobile manipulator.

  Now, moving towards the introduction, as we have seen in experiment on a serial manipulator with fixed base can perform various tasks, but it cannot move from one place to another place and to overcome these limitations, tracked vehicle have been developed by the researchers. So, that it can move one place to another place, but in this lecture we are going to talk about tracked vehicle. So, the question is coming to our mind, what is tracked mobile manipulator? A tracked mobile manipulator is nothing, but it is the combination of a serial manipulator and a tracked vehicle. Tracked vehicle provides better traction as compared to wheeled one because they have larger contact area.

  So, that it can navigate in rough terrain as well as in smooth terrain and a serial manipulator equipped with gripper and specialized tools can perform various tasks. However, the control system of this tracked mobile manipulator is very sophisticated which employs a combination of sensors actuators, servo motors and advanced algorithm to coordinate seamless movement and precise manipulation. This tracked mobile manipulator can be controlled either autonomously with its own on board system or semi autonomously with the help of human being and self controlled robot. That choice depends on the particular application and environment, where this tracked mobile manipulator is going to be operated. Now, moving to the application of this tracked mobile manipulator, it can be used in various factors such as remote inspection, defense and security.

  In agriculture also, it is used for this decision farming in mining and exploration as well as in rescue operations it can be used. In agriculture many other operations can be performed such as fruit picking, fruit health monitoring, plant health monitoring and watering to the soil. The mobility of this tracked vehicle navigate in the field and the serial manipulator can perform delicate task in agriculture. As you all can see a tracked mobile manipulator is beside me, which is an indigenous product. This tracked vehicle is rear powered vehicle with a serial manipulator having 5 degrees of freedom.

  This tracked vehicle generally made for agriculture applications such as fruit picking, plant health monitoring, fruit maturity prediction and watering to the soil. Various other operations can be performed with the help of this tracked mobile manipulator. Now, we will see different components of this tracked mobile manipulator. This is a tracked vehicle which contains 4 wheels and 2 belt drives. This is a serial manipulator with having 5

degrees of freedom and a gripper.

This is a camera which is used for capturing the images. This is the control unit which can be used to operate this tracked mobile manipulator. This one is the Zigbee module which can provide connection between control unit and tracked vehicle. This one is the tank which is used for either for watering purpose or pesticide spraying. This one is the CPE, outdoor wireless CPE customer premised equipment, which is used to transfer image data from transmitter to receiver.

This one is the battery pack box which contains 30,000 milli-ampere hour battery. Now, we are going to perform different tasks with this tracked mobile manipulator. Task 1, navigation of tracked mobile manipulator in forward direction, in backward direction and turning of its motion. Now, we are moving forward. Task 2, navigation of tracked mobile manipulator in forward direction.

Task 3, navigation of tracked mobile manipulator in forward direction. Task 4, navigation of tracked mobile manipulator in forward direction. Now, we have seen that this tracked mobile manipulator is moving with constant velocity of 0.2 meter per second. We have programmed in such a manner that it can move very slowly so that it cannot damage plant available in the field.

Now, moving backward. Now, I will take left turn. Now, I will take right turn. Now, I will take a turn with the stationary position. Now, from this task.

We can conclude that this tracked mobile manipulator can move forward, move backward and then can take left turn and right turn in agricultural field so that it can perform various tasks with the help of serial manipulator. Task 2, control of different joints of serial manipulator. As we can see that a serial manipulator with 5 degrees of freedom is mounted on the tracked vehicle. This has first twisting joint, second revolute joint, third revolute joint, one more twisting joint, one more revolute joint and at the end a gripper is mounted in the end effector. So, now we will perform one by one.

The joint one is going to move clockwise direction. Now it is going to move in anti-clockwise direction. Another operation can be performed with this. Now moving to joint 2 which is a revolute joint, it will move down. Now joint 2 can move up.

Now we will move to joint 3 which is a revolute joint. In this also, it can move up and down. So now we are moving joint 3 up. This is the maximum limit which we have programmed. Now, we are moving down.

Now moving to joint 4 which is a twisting joint, it can move clockwise and anti-clockwise direction. So moving clockwise direction. Now moving anti-clockwise direction of joint 4. Similarly, joint 5 has a revolute joint which can move up and down direction. Now at the

end we can see a gripper is attached to this, which can open and close so that it can hold a fruit or vegetable anything.

So we can see I am giving command to the controller. It can open the gripper. This is the maximum limit which can we can open the gripper. Now we can close this gripper. Now in all the operations you can see that these joints are moving very slowly.

Similarly, we have programmed in such a manner so that it cannot damage any plant. Task 3, disease detection of plant leaves through camera captured images and their analysis and classification. So now we are going to perform a task in which camera is going to capture images of the leaves with this spot where we can see a plant is mounted on this. So after capturing the plant, capturing the image, it is transferred to the desktop wirelessly and the image analysis carried out on a graphical programming software that is LabVIEW. We have developed a application so that it can classify the disease present on the leaves by creating design of interest.

Now we are going to perform this task wirelessly, in which right now, I am moving this vehicle forward for capturing the plant leaves. Now we can see that the plant is near to the vehicle. So we have to operate our track serial manipulator in such a manner so that plant leaves can be captured by the camera. Now we can see the leaf is completely coming to the frame. Now we can see that leaves are completely coming to the frame and we can create a design of interest.

Now we have created and we can found that it is shown here disease detected as nutrient deficiency disease and it is also displaying that we can spray pesticide B, which is included in the tank too and this yellow switch we have to press from the control panel and we have developed this application in such a manner, so that we can save any images of the leaves and for further future we can directly train the model and classify. Task 4, spraying of appropriate pesticide on the disease leaves. Now in this after detecting disease present in the plant we are going to spray appropriate pesticide on the leaves so that it can recover from the disease. Now moving forward. Now we can see that diseased leaf is identified now, we have to spray pesticide 3.

Now moving forward. Now we are going to spray pesticide C on the leaf. Now we can visualize that the pesticide C can be sprayed on the disease leaf. Now further moving. Now with these two, the second part and we have found that the disease present in the plant is also present here. So, we are going to spray pesticide B, because the disease present in this plant is nutrient deficient disease.

So, spray pesticide 2 on the plant. Now the operation is completed. In this way we have performed disease classification and identification and after that we have sprayed appropriate pesticide on the plant. As we have seen we have performed various tasks with this tracked mobile manipulator. The application of this tracked mobile manipulator is not

limited, various other applications also possible with in the agricultural fields like fruit picking, maturity prediction of the fruit and watering to the soil.

  These various types of activities can be possible in the agricultural fields and versatility of this machine can show that this tracked vehicle can move in the field and the serial manipulator can perform other tasks. So, this tracked mobile manipulator holds promise and it can be used further for the advancement in the robotic system. With this, I would like to conclude this experiment, too. Thank you.