CE 6308 / CS 6396 / EEDG 6308

Real-Time Systems

Assignment 1

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Objective

The objective of this project is to move the Ego vehicle through the arena given and make it cross the bridge safely.

Requirements

- Problem 1 – We were asked to modify the Pre-Debug task to accelerate the Ego Vehicle when 'W' key is pressed.
- Problem 2 – To automate the movement of Ego Vehicle and to make it cross the bridge safely

Designated Sensors and Actuators

- **Sensors:** DeviceRegsitry.pixels, DeviceRegistry.compass, DeviceRegistry.speedometer, DeviceRegistry.microphone
- **Actuators:** DeviceRegistry.speedControl, DeviceRegistry.brakeControl, DeviceRegistry.steeringControl, DeviceRegistry.transmitterControl

Implementation

For the implementation of this project, we created the 5 tasks given below using the sensors, actuators and state of the Ego Vehicle.

Task List

```
protected TaskInterface[] tasks = new TaskInterface[]
{
        new Debug_Task(),
        new InitialDirectionControl(),
        new ReachDestinationControlTask(),
        new TurnLeft(),
        new TurnRight(),
        new AlarmControl()
};
```

Sensors Used

```
devices.pixels
devices.compass
devices.microphone
```

The **`device`** is an instance of **`DeviceRegistry`**.

Actuators Used

```
devices.speedControl
devices.steeringControl
devices.transmitterControl
```

To store the current state of the vehicle, we are using Ego Vehicle's memory and we created the states as listed below.

```
devices.memory
```

```
STATE_INIT_DIRECTION_CONTROL = 0;
STATE_VEHICAL_DIRECTION_DONE = 1;
STATE_READY_FOR_STRAIGHT_MOVE = 2;
STATE_CHECK_FOR_GRASS = 3;
STATE_GRASS_DETACTED = 4;
STATE_READY_FOR_LEFT_MOVE = 5;
STATE_LEFT_MOVE_DONE = 6;
STATE_READY_TO_MOVE_TOWARDS_BRIDGE = 7;
STATE_GRASS_DETACTED_NEAR_BRIDGE = 8;
STATE_READY_FOR_RIGHT_MOVE = 9;
STATE_RIGHT_MOVE_DONE = 10;
STATE_BOAT_ALARM_DETACTED = 11;
STATE_TX_CONTROL_AND_READY_MOVE_TOWARDS_DEST = 12;
STATE_MOVE_TOWARDS_DEST = 13;
STATE_DESTINATION_STOP = 14;
```

Task 0: `Debug_Task()`

This task is made to move the Ego Vehicle manually and getting used to the AVL environment. We are moving the vehicle forward using the 'W' key.

```
public class Debug_Task : TaskInterface
  {
    public void Execute(DeviceRegistry devices) {
        if (Input.GetKey("w"))
        {
           /** Problem 1: AVL Environment **/

            devices.speedControl[0] = 1f;
            devices.speedControl[1] = 10f;

        }
```

Task 1: `InitialDirectionControl()`

Using this task, the vehicle will take its initial position by aligning itself towards the north direction.

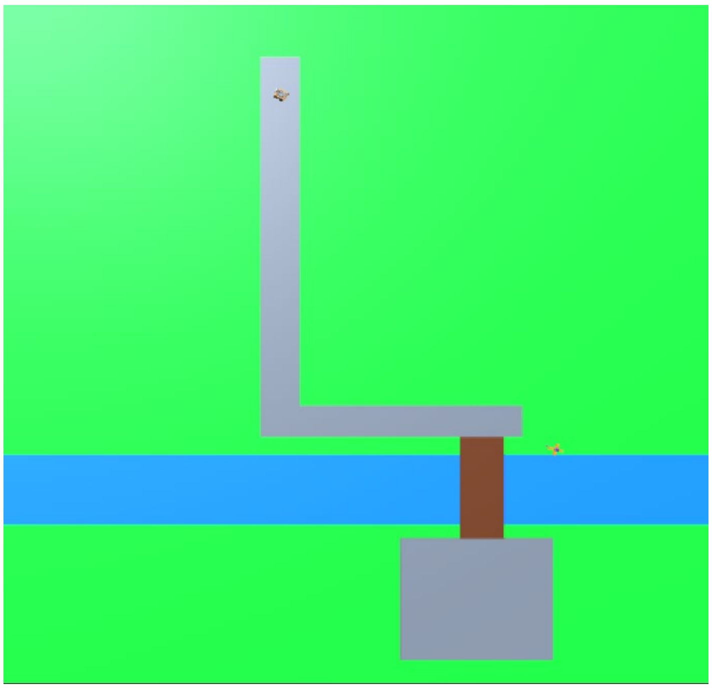
Here, we are allowing a direction correction window of 1 degree (-0.5 to +0.5) for the vehicle to align itself towards the north direction. It will take a left or right turn according to value of **`compass`**. The state of vehicle is `STATE_INIT_DIRECTION_CONTROL`.

```
if (devices.compass[0] > Constants.COMPASS_POS_OFFSET_NEAR_NORTH)
{
    // Left
    devices.steeringControl[0] = Constants.STEERING_CONTROL_IDX0;
    devices.steeringControl[1] = Constants.COMPASS_NEG_OFFSET_NEAR_NORTH;
}
else if (devices.compass[0] < Constants.COMPASS_NEG_OFFSET_NEAR_NORTH)
{
    // Right
    devices.steeringControl[0] = Constants.STEERING_CONTROL_IDX0;
    devices.steeringControl[1] = Constants.COMPASS_POS_OFFSET_NEAR_NORTH;
}
```

```
else
{
    devices.steeringControl[0] = Constants.STEERING_CONTROL_NORMAL;
}

if((devices.compass[0] > Constants.COMPASS_NEG_OFFSET_NEAR_NORTH) &&
   (devices.compass[0] < Constants.COMPASS_POS_OFFSET_NEAR_NORTH))
{
     devices.memory[0] = Constants.STATE_VEHICAL_DIRECTION_DONE;
}
```

<u>**Dependencies**</u>**:**
`DeviceRegistry.compass`,
`Device.memory`



As soon as the vehicle aligns to North direction it's state changes to `STATE_VEHICAL_DIRECTION_DONE.`

The next state is `STATE_READY_FOR_STRAIGHT_MOVE` where the vehicle is now ready to move forward on the straight path.

```
if((devices.compass[0] > Constants.COMPASS_NEG_OFFSET_NEAR_NORTH) &&

   (devices.compass[0] < Constants.COMPASS_POS_OFFSET_NEAR_NORTH) &&
   (Constants.STATE_VEHICAL_DIRECTION_DONE == devices.memory[0]))
{
        devices.steeringControl[0] = Constants.STEERING_CONTROL_IDX0;
        devices.steeringControl[1] = Constants.STEERING_CONTROL_NORMAL;
        devices.memory[0] = Constants.STATE_READY_FOR_STRAIGHT_MOVE;
}
```

Task 2: `ReachDestinationControlTask()`

Responsibilities of this task is to direct the Ego Vehicle towards the goal.

After setting the direction, the vehicle will accelerate towards the goal with the speed of `SPEED_2F`.

```
if (Constants.CURRENT_STATE == devices.memory[0])
{
    devices.speedControl[0] = Constants.STEERING_CONTROL_IDX0;
    devices.speedControl[1] = Constants.SPEED_2F;
    devices.memory[0] = Constants.NEXT_STATE;
}
```

`ReachDestinationControlTask` will execute every time a state is changed. For example, when we change from state `STATE_READY_FOR_STRAIGHT_MOVE` to `STATE_READY_FOR_LEFT_MOVE` the control goes back to **`ReachDestinationControlTask.`**

Dependencies:
`DeviceRegistry.speedControl`,
`DeviceRegistry.memory`
`DeviceRegistry.transmitterControl`

Task 3: `TurnLeft()`

Using this task, the vehicle will take a 90 Degree Left turn, with a direction correction window of 2 degree (+89 to +91). Initially its status is `STATE_READY_FOR_LEFT_MOVE` and after the left turn is completed, the state changes to `STATE_LEFT_MOVE_DONE`. When the state is `STATE_LEFT_MOVE_DONE`, the control goes back to **`ReachDestinationControlTask`** and the vehicle starts moving forward.

Dependencies:
`DeviceRegistry.compass,`
`DeviceRegistry.steeringControl,`
`DeviceRegistry.memory`

```
if (Constants.STATE_GRASS_DETACTED == devices.memory[0])
{
    devices.steeringControl[0] = Constants.STEERING_CONTROL_IDX0;
    devices.steeringControl[1] = Constants.STEERING_CONTROL_FAST_LEFT;

    if((devices.compass[0] > Constants.COMPASS_NEG_91_DEGREE) &&
      (devices.compass[0] < Constants.COMPASS_NEG_89_DEGREE))
    {
        devices.memory[0] = Constants.STATE_READY_FOR_LEFT_MOVE;
    }
}
```

Task 4: `TurnRight()`

The vehicle will take 90 Degree Right turn, allowing a direction correction of 2 degree (-1 to +1). Here, the state of ego vehicle changes from `STATE_READY_FOR_RIGHT_MOVE` to `STATE_RIGHT_MOVE_DONE`, while sending the control back to **`ReachDestinationControlTask`** for transmission of alarm signal by the ego vehicle for crossing the bridge and for moving forward when the boat arrival alarm is not detected.

```
if (Constants.STATE_GRASS_DETACTED_NEAR_BRIDGE == devices.memory[0])
{

    devices.steeringControl[0] = Constants.STEERING_CONTROL_IDX0;
    devices.steeringControl[1] = Constants.STEERING_CONTROL_SLOW_RIGHT;

    if(devices.compass[0] > Constants.COMPASS_NEG_1_DEGREE &&
      devices.compass[0] < Constants.COMPASS_POS_1_DEGREE)
    {
        devices.memory[0] = Constants.STATE_READY_FOR_RIGHT_MOVE;
    }
}
```

Dependencies:
`DeviceRegistry.compass,`
`DeviceRegistry.steeringControl,`
`DeviceRegistry.memory`

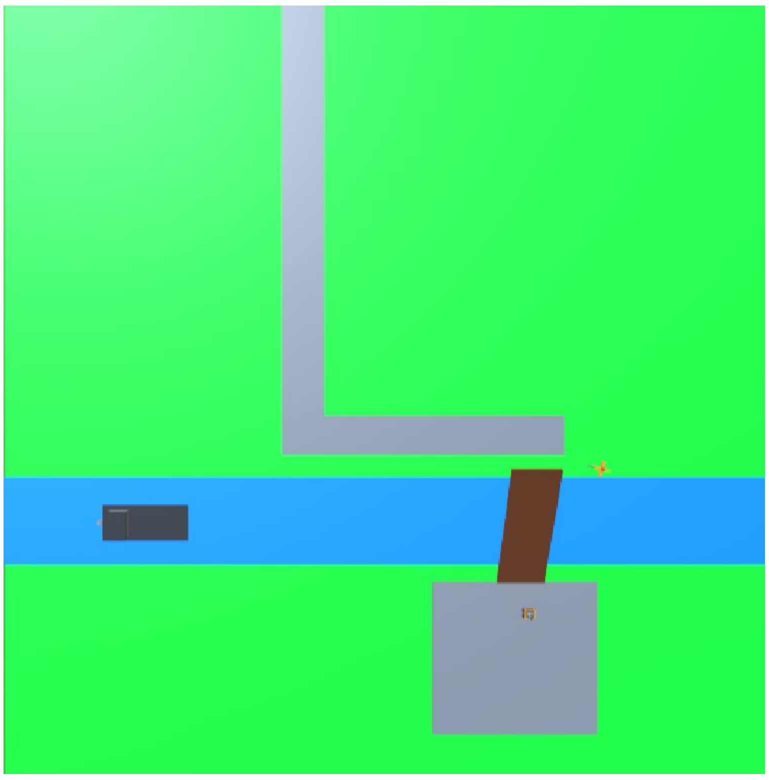
Task 5: `AlarmControl()`

The vehicle will listen to the boat arrival alarm using `devices.microphone` . If the alarm is **ON**, then the ego vehicle will wait and if it is **OFF**, the ego vehicle will cross the bridge by transmitting an alarm. The state of the ego vehicle will initially be `STATE_BOAT_ALARM_DETACTED` if the boat arrival alarm is ON. As soon as the boat alarm goes OFF, it will change to `STATE_TX_CONTROL_AND_READY_MOVE_TOWARDS_DEST`.

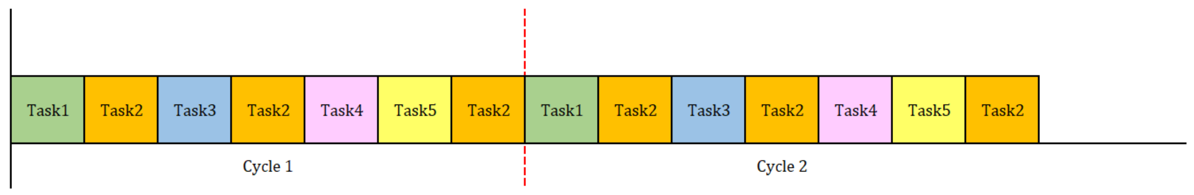
```
if (Constants.STATE_RIGHT_MOVE_DONE == devices.memory[0])
{
    if (Constants.BOAT_ALARM_DETACTED == devices.microphone[0])
    {
        devices.memory[0] = Constants.STATE_BOAT_ALARM_DETACTED;
    }
}

if (Constants.STATE_BOAT_ALARM_DETACTED == devices.memory[0])
{
    if (Constants.NO_ALARM_DETACTED == devices.microphone[0])
    {
devices.memory[0] = Constants.STATE_TX_CONTROL_AND_READY_MOVE_TOWARDS_DEST;
    }
}
```

Dependencies:
`DeviceRegistry.compass,`
`DeviceRegistry.steeringControl,`
`DeviceRegistry.memory`



Task Graph for 2 Cycles of Simulation



Task 1	InitialDirectionControl( )
Task 2	ReachDestinationControlTask( )
Task 3	TurnLeft( )
Task 4	TurnRight( )
Task 5	AlarmControl( )

Cycle 1

Task 1: InitialDirectionControl ( )

The system initially sets the position of EGO vehicle to North by checking the surroundings.

Task 2: ReachDestinationControlTask( )

EGO vehicle moves forward

Task 3: TurnLeft( )

EGO vehicle resets the direction to stay on the correct path

Task 2: ReachDestinationControlTask( )

EGO vehicle moves forward

Task 4: TurnRight( )

The EGO vehicle move forward till it reaches a dead end or a left turn

Task 5: AlarmControl( )

The EGO vehicle shifts the position to the left turn

Task 2: ReachDestinationControlTask( )

EGO vehicle moves forward

Cycle 2 is same as Cycle 1