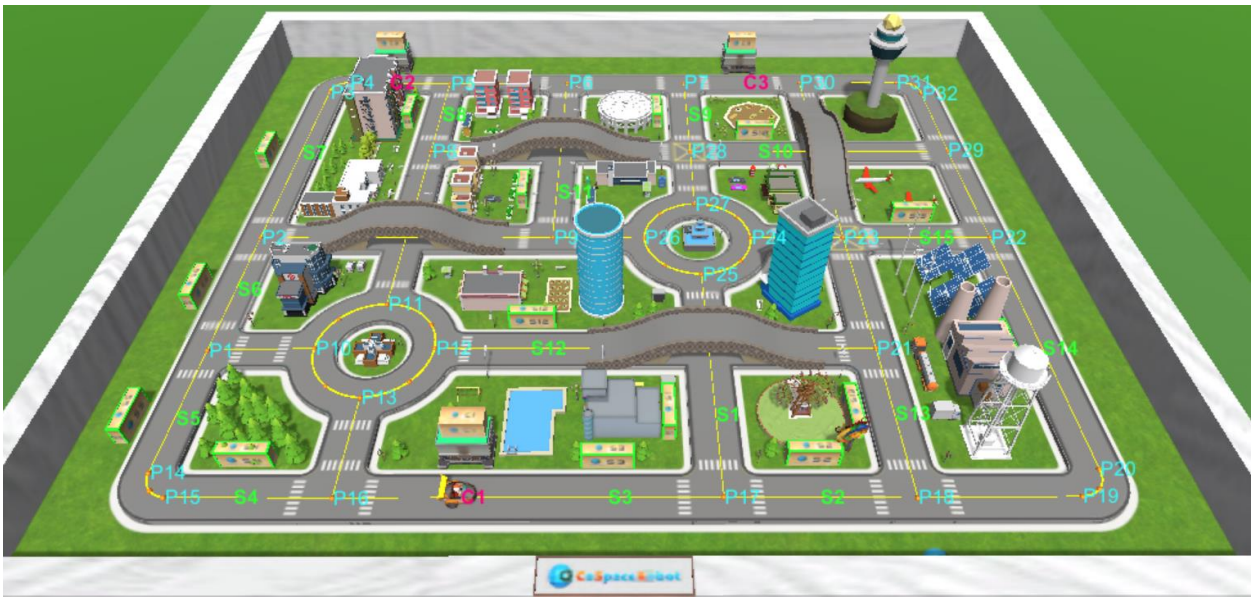
RCAP CoSpace Autonomous Delivery

University Category (Task 2)

The RCAP CoSpace Autonomous Delivery (ADL) Challenge is blending the mobile robots and supply chain management. In the last mile delivery and smart city scenarios, teams are required to program a robot to deliver parcels in an autonomous and fast way.

Specifically, in CoSpace Autonomous Delivery Challenge, University Category, the robot is limited to a maximum carrying capacity of 6 packages and must go back to a distribution centre to resupply. The robot needs to deliver as many packages as possible before the game ends, when all items are delivered or the play time exceeds 6 minutes. To efficiently complete the task, the robot should prioritise packages based on their deadlines and scores, and be able to swiftly navigate around the map.



Above is the default map layout of Autonomous Delivery. For map element descriptions, please refer to CHAPTER 2 in the RCAP CoSpace Autonomous Delivery (ADL) rules.

1) C = Distribution Centre
2) S = Collection Station
3) P = Navigation Points

1. Task Description

In Task2, the robot has to successfully deliver packages to Collection Stations, but with more restrictions now.

Fulfilment Requirements

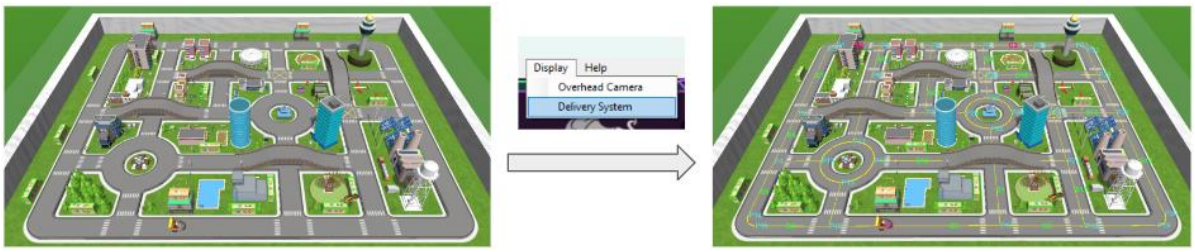
1) Successful delivery of all packages.
   OR
2) Timer reaches 6 minutes.

Additional Information

1) Robot can only carry 6 packages at any one time.
2) Robot must go back to Distribution Centre to restock.
3) Each package has a specific Collection Station to be delivered to.
4) Each package has a deadline to be met, if not their score will decrease.
5) To deliver the package successfully, the LED must be blinking, and the robot must stay still for at least 2 seconds. And leave the Collection Stations (S) automatically after it.
6) To load the package successfully, the LED must be blinking, and the robot must stay still for at least 2 seconds. And leave the Distribution Centre (C) automatically after it.

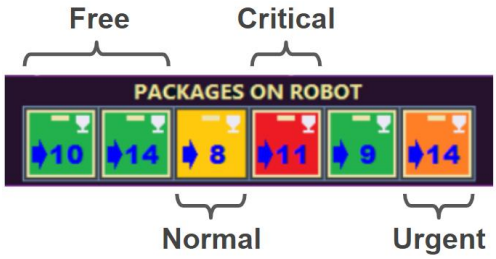
2. Delivery System

By enabling the Delivery System from the top menu: Display > Delivery System. The Distribution Centres (C1, C2…), Collection Stations (S1, S2, S3…) and Navigation Points (P1, P2…), along with the centreline of the road will be displayed on the VIRTUAL_WORLD.



3. Package attributes

In Task 2, packages have different scores(value) and have deadlines that they must be delivered by. If not, their value will decrease from the original score to a minimum of 10 points.

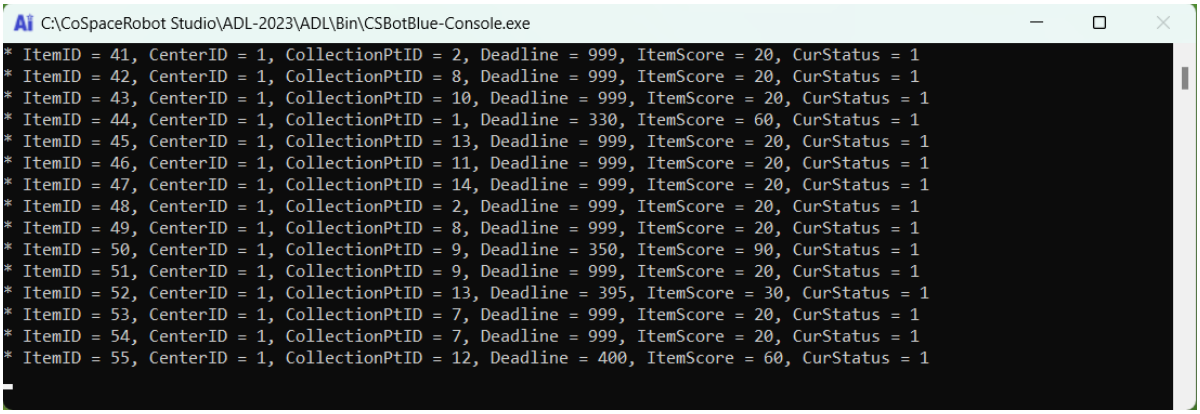


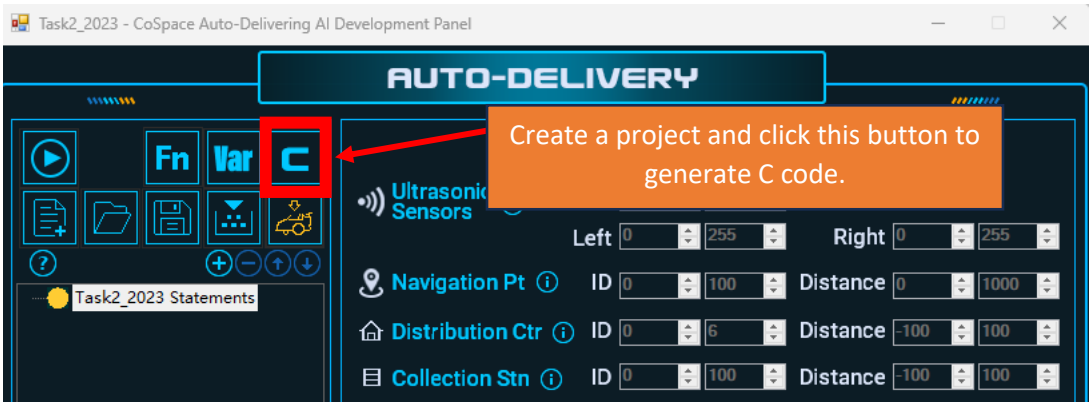
Each packages have unique attributes.

- **ItemID**: ID of the delivery package.
- **StationID**: ID of the collection station where the package is to be delivered.
- **Score**: Points gained for successfully delivering the package.
- **Deadline**: Deadline for delivering the package, which is timed from the start of the game. 999 means no deadline.
- There are four types of package Urgency Levels.
    - **Critical:** Score 90 points, if exceed the deadline, every additional second deducts 3 points until 10 points.
    - **Urgent:** Score 60 points, if exceed the deadline, every additional second deducts 2 points until 10 points.
    - **Normal:** Score 30 points, if exceed the deadline, every additional second deducts 1 point until 10 points.
    - **Free:** Score 20 points, no delivery time restriction.
- **CurStatus:** In the system, Once an Item (Package) arrives at one Distribution Centre, this item is added to '**DeliveryItemList'** and the CurStatus is "at Center". After this package is loaded successfully, the CurStatus changes into "on Car". Finally this item is delivered, the CurStatus changes into "at Station"
    - 1 - at Center;
    - 2 - on Car;
    - 3 - at Station;

4. Printing Items Lists

For each challenge, the delivery packages generated, and their order of collection will be the same every round. Thus, we can print out the full list of items that is generated for delivery with their corresponding attributes, and we can utilise it to plan and improve our strategy.





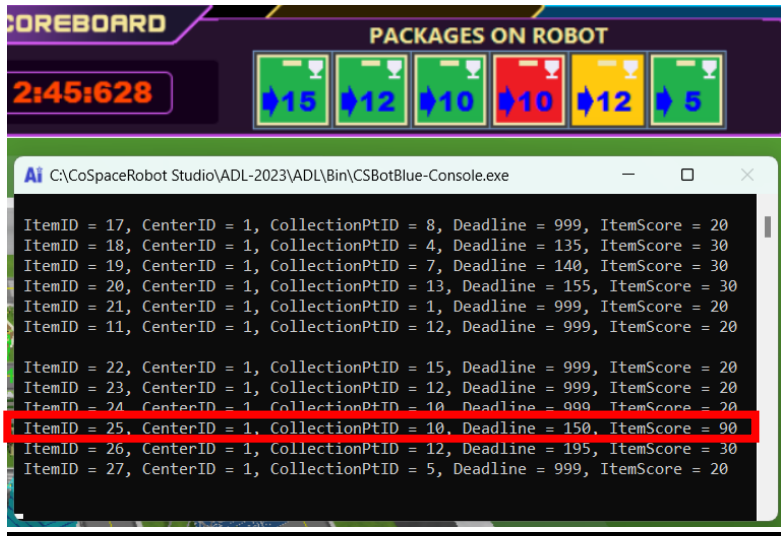
To print the full list of items, add the following highlighted code in and above the default '**AddDeliveryItem'** function in the default c code.

Whenever a new item is added to the '**DeliveryItemList'** by the application in ascending order according to the ItemID, which is also the order of collection, the code will print the new item's information in the console.

When you run the program there will be a high chance of the robot going off course, this is largely due to the program constantly checking for new items, causing the robot to be less responsive. In such cases, continue letting the game run till the 6 minutes mark, where the full list of all the possibly generated delivery items will still be printed out.

```
int listed[100];
DLL_EXPORT void AddDeliveryItem(int ItemID, int CenterID, int StationID, int ItemScore, int Deadline, int
CurStatus)
{
    if (ItemID < 0 || ItemID>99) {
        printf("ItemID Error! ID = %d", ItemID);
        return;
    }
    DeliveryItemList[ItemID].ItemID = ItemID;
    DeliveryItemList[ItemID].CenterID = CenterID;
    DeliveryItemList[ItemID].CollectionPtID = StationID;
    DeliveryItemList[ItemID].ItemScore = ItemScore;
    DeliveryItemList[ItemID].Deadline = Deadline;
    DeliveryItemList[ItemID].CurStatus = CurStatus;

    if (listed[ItemID] != TRUE)
    {
        printf("* ItemID = %d, CenterID = %d, CollectionPtID = %d, Deadline = %d, ItemScore = %d,
CurStatus = %d\n",ItemID,CenterID,StationID,Deadline,ItemScore,CurStatus);
        listed[ItemID] = TRUE;
    }
}
```



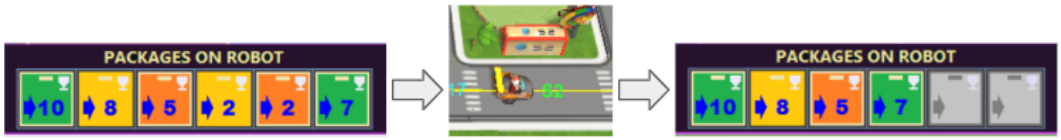
The ADL package panel only displays the ‘CollectionPtID’ of packages loaded on the robot. However, information such as their ‘DeadLine’ and ‘ItemsScore’ can give us better insights on how the AI is currently selecting the paths based on the loaded packages’ attributes, which will help us improve the algorithms.

The ‘DeadLine’ is calculated from the start of the game. For example, item25 in the picture above means that only if the robot delivers item25 to Collection point 10 before the 150th second of the game time, it can get 90 points. If it cannot be delivered in time, every additional second deducts 3 points until 10 points.

5. Delivering Packages

To deliver a package successfully, the robot must carry at least one package with a StationID that corresponds with the Collection Station, stay still and blink its LED for at least 2 seconds, and leave the station after it. Successfully delivered packages will be removed from the packages on the robot, leaving empty spaces to load more.

Teams are not required to make deliveries in the order shown on the scoreboard.



6. Collecting Packages

To load packages successfully, the robot must stay still and blink its LED for at least 2 seconds at a Distribution Centre and leave the centre after it. Upon a successful collection, empty slots in packages on the robot will be filled up and made available to be delivered.

7. Ranking

After the competition, teams are ranked based on the following tiers.

	Situation	Rank
Tier 1	Teams have different scores at the end of the game.	Teams with higher scores will be ranked higher.
Tier 2	Teams scored the same points by delivering.	Teams that consume less time will be ranked higher.