Slide 1

ROBOTICS COURSE PREVIEW
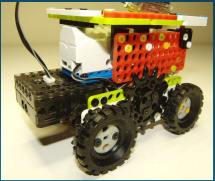
Chi N. Thai

CNT Robotics, LLC

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Slide 2

ROBOTIS DREAM II – School Set

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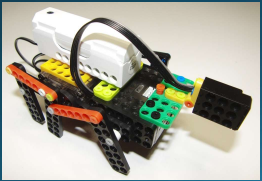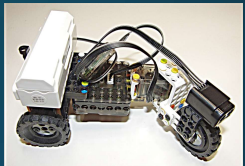
Slide 3

TOPICS – Day 1

- Overview of selected robotics design concepts such as mechanical components (plates, brackets, linkages and fasteners), mechanical gear-reduction system for electric motors and conversion of rotational circular motion to a "hopping", "walking" or "crawling" motion.

ROBOTIS Rivet System

- Rivet components: Sleeve and Stem

  Locked position

- Two sizes:
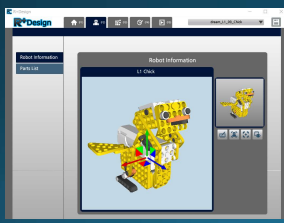 - Long (grey only)
  - Short (multi-color)
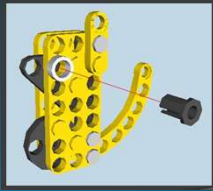
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Slide 4

ROBOTIS DREAM II – Level 1

- Mechanical Engineering concepts.
- Using R+Design Software Tool.

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Slide 5

ROBOTIS Rivet System

- Rivet components: Sleeve and Stem.

  Locked position

- Two sizes:
  - Long (grey only)
  - Short (multi-color)

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Slide 6

4-WHEEL DRIVE DUMP TRUCK
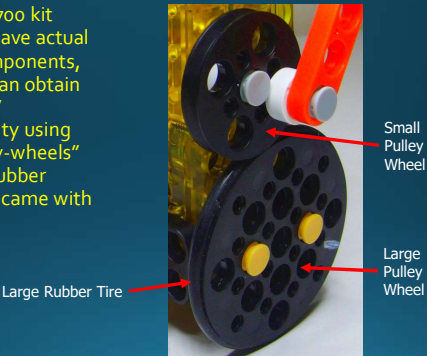
- Gears and Gear Ratio.
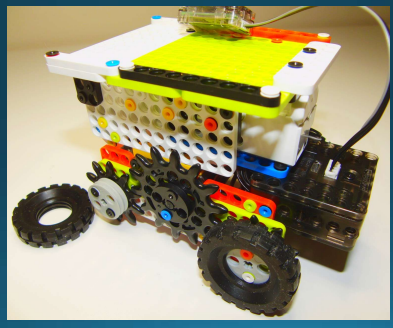
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Gear-like Functionality

- The PLAY700 kit does not have actual GEAR components, but ones can obtain "gear-like" functionality using the "pulley-wheels" and the "rubber tires" that came with the kit.
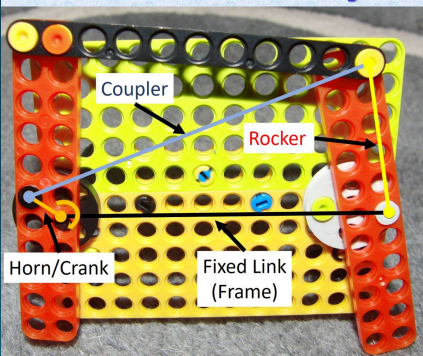
Small Pulley Wheel

Large Pulley Wheel

Large Rubber Tire

Generic 4-bar linkage

Coupler

Rocker

Horn/Crank

Fixed Link (Frame)

(DREAM)

Scorpion Legs

(PLAY700)

ROBOT's FRONT

Common Crank (Motor's Horn)

Parallelogram Linkage

Rocker 1

Rocker 2
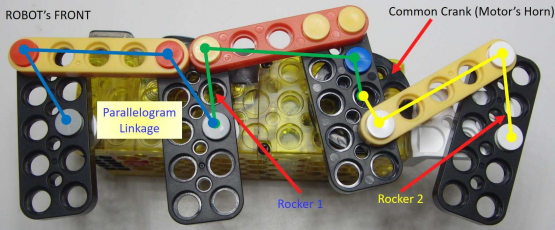
4-Bar Linkage on P700 Caterpillar

Caterpillar (modified)

Entire Edge Used

1 Rivet Used

Fixed Link (Robot's Frame)

Common/Complex Rocker (3-D)

Crank

Idler
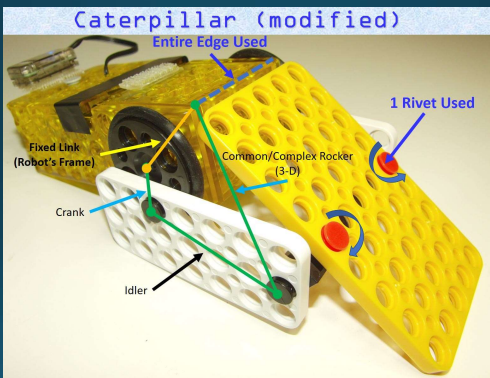
After 3 PM – Start Building AVOIDER

NIR Sensors

Controller
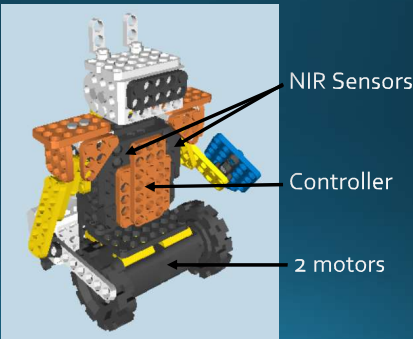
2 motors

TOPICS – Day 2

- Getting into DREAM II **Level 2** (12 programmable robots):
  - Hardware.
  - Software.

- Hands-on training with **AVOIDER**:
  - Programming Motors, built-in NIR Sensors & Sound Generator.
  - **Autonomous Behaviors:**
    - Spinning Top (1 NIR Sensor).
    - Avoider (2 NIR Sensors).
    - Avoider's "Emergent Behavior".
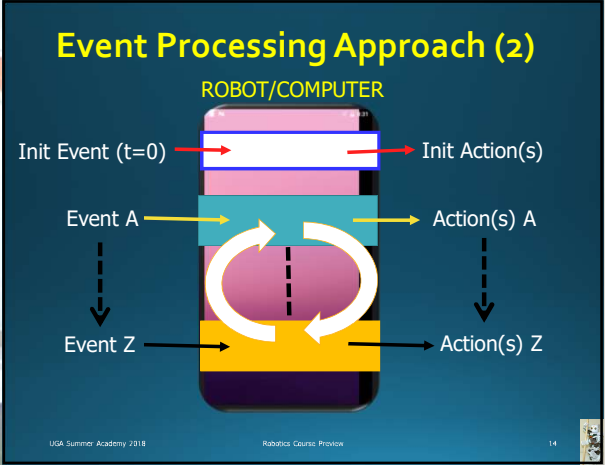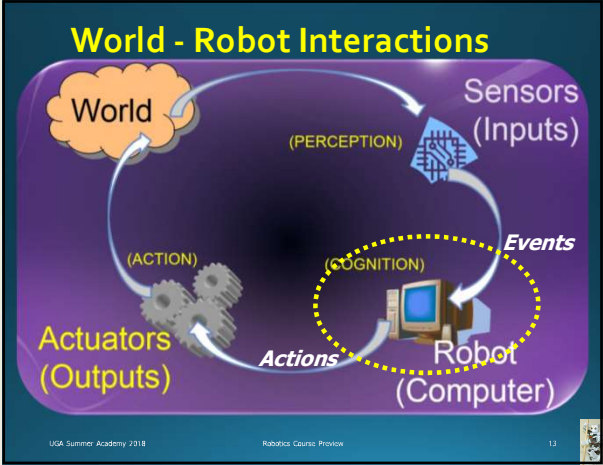   - Follower (2 NIR Sensors).

World - Robot Interactions

Event Processing Approach (2)

ROBOT/COMPUTER

Init Event (t=0) → → Init Action(s)

Event A → → Action(s) A
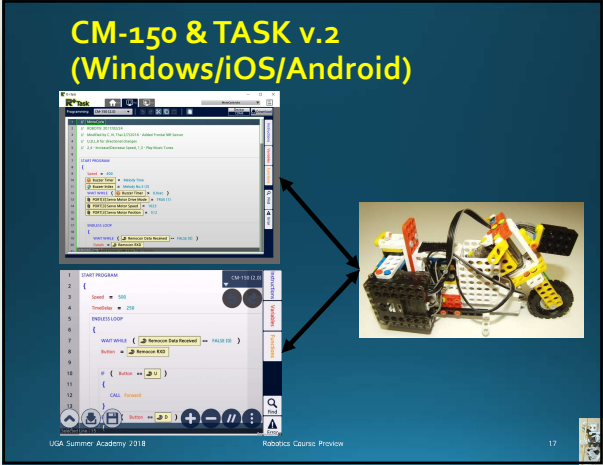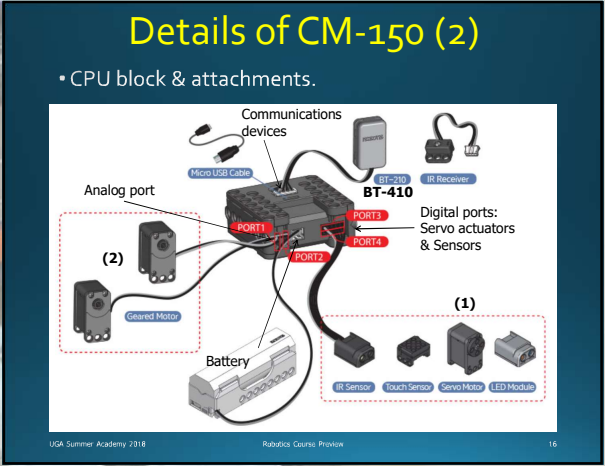
Event Z → → Action(s) Z
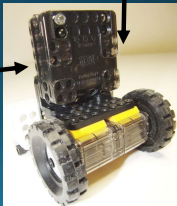
Reactive Control/Behavior (1)

Given Condition (Event) >> Appropriate Robot Action

Condition/Event	Action
Car on top of Track	Car Goes Forward
Car left of Track	Car Turns Right
Car right of Track	Car Turns Left
Paper Cup detected	Pick Up, Dispose of Paper Cup & Rotate Left until Original Direction

1 and Only 1 Condition (Event) can happens at any 1 time.
Multiple Conditions (Events) can happen at any 1 time.

Details of CM-150 (2)

• CPU block & attachments.

CM-150 & TASK v.2 (Windows/iOS/Android)

R+TASK Practice on Spinning Top

• Print & Println. (Assignment & Sequence of Actions)
• How to read/print NIR Sensors. (Endless Loop)
• How to use Hi-Res Timer. (Wait While Loop)
• How to turn on/off Geared Motors. (Wait While Loop)
• Use NIR Sensor Values for Motor Speed Control. (Combining Conditional & While Loop structures)
• Program Modularization with Functions:
  • Maneuvers-1.tskx
  • Maneuvers-2.tskx
  • Maneuvers-3.tskx
  • Maneuvers-4.tskx

"Avoider" Refinement (2)

Re-Analysis of Condition/Action Table:
  Find DEFAULT BEHAVIOR (Going Forward).
  Find ESSENTIAL BEHAVIORS (Backs Right and Backs Left).

Condition/Event	Action
No Object in Front	Bot Goes Forward ←
Object on Left	Bot Backs Right
Object on Right	Bot Backs Left
~~Object in Front~~	~~Backward + LeftBack~~

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"Emergent" Code Behaviors

Try various AVOIDER versions to see how Robot behaves in dealing with a Hallway.

Why would certain codes work or not work?

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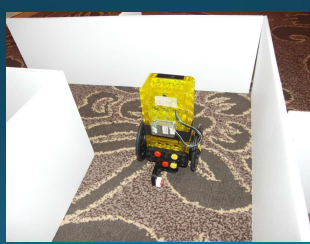
Sound Claps Applications

- Using Sound Claps to start (1 clap) & stop Robot (2 claps).
- 1 clap to Turn Right and 2 claps to Turn Left.
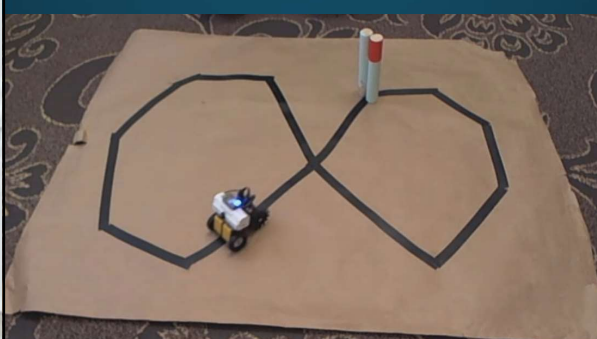- Video Demo of "Seal" Robot.

Seal with Servo Head

Servo Motor

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Autonomous Behavior (3)

- Technique 3 is a variation of Technique 2 and it uses "parallel" LOOP WHILEs instead of "parallel" IFs. It combines "Data Acquisition" tasks in its Conditional Statements, thus it uses the least number of statements, as compared to the other two Techniques.
- Example programs using Technique 3 are "Avoider-4b.tskx" and "Follower-1.tskx".
- "Follower-2.tskx" is a hybrid solution combining Techniques 3 and 1.

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Topics – Day 3

- Modify Avoider into Simple CarBot.
- Advanced Autonomous Behavior:
  - Line Follower / Line Avoider.
  - Line Follower + Obstacle Avoider.
- Remote Control:
  - "Remocon" Packet.
  - RC with 1 Button.
  - RC with Multiple Buttons.
  - PC and Mobile Interfaces.
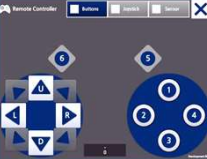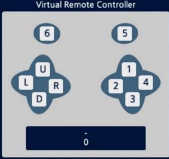- Mixing Remote Control & Autonomous Behavior:
  - Smart Avoider.

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Navigating Arbitrary Black Track

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"Remocon" Packet
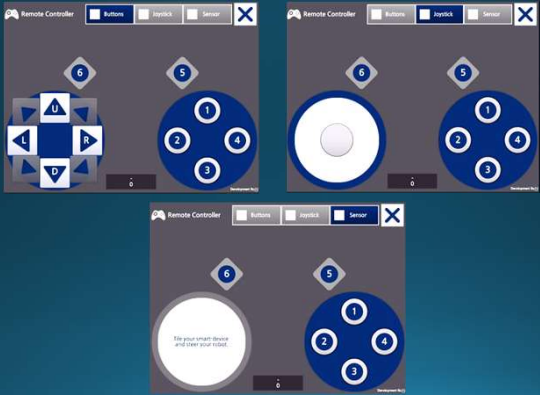
RC-100 10-bit Message

Bit Position	9	8	7	6	5	4	3	2	1	0
Button	6	5	4	3	2	1	R	L	D	U
Example Data	0	0	0	1	0	0	1	0	0	1

When Button(s) released a "0" is sent ONCE

Application to Mobile Virtual RC

"RC-MultiDirectionsSpeeds-Mobile.tskx" (3)

```
ELSE IF  (   Direction  ==  D+R  )
{
     CALL  Backward
     CALL  Delay
     CALL  Le
     CALL  Delay
}
ELSE IF  (   Direction  ==  D+L  )
{
     CALL  Backward
     CALL  Delay
     CALL  Righ
     CALL  Delay
}
```

```
IF  (   Button1  ==  1  )
{
     Speed  =  400
}
IF  (   Button3  ==  3  )
{
     Speed  =  800
}
Direction  =  0
Button1  =  0
Button3  =  0
```
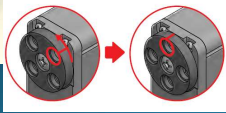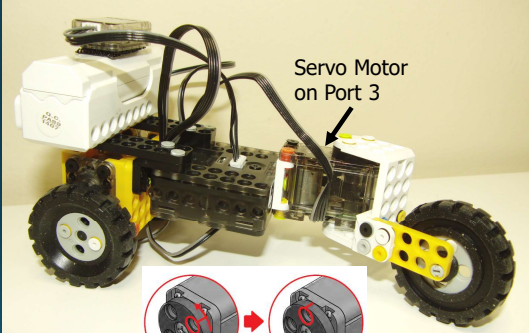
Smart Avoider (RC + Autonomous)

Build "TriCycle" for Day 4
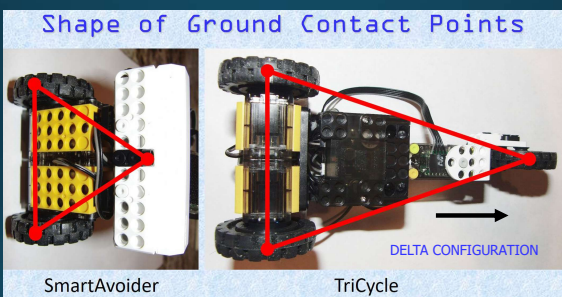
Servo Motor on Port 3

Topics – Day 4

• Differences between Geared Motors and Servo Motors.
• Applications to **TriCycle, 4W-Drive Dump Truck.**
• Students start designing their own robot to compete on Day 5.

Position Control of Servo Motor

0 degree
Pos. 512

+90 degree
Pos. 819

-90 degree
Pos. 205

+150 degree
Max. Pos. 1023

-150 degree
Min. Pos. 0
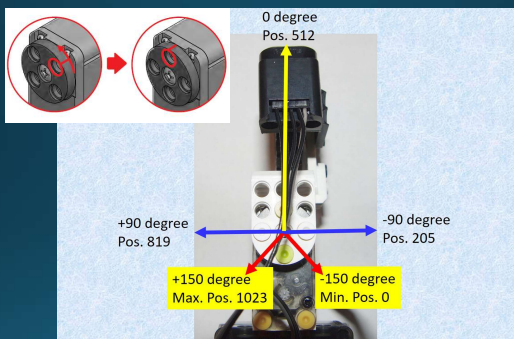
TriCycle's Ground Contact Geometry

Shape of Ground Contact Points

DELTA CONFIGURATION

SmartAvoider   TriCycle

"RC-TriCycle.tskx" (4)


```
ELSE IF ( Direction == D+R )
{
    PORT[3]:Servo Motor Position = PORT[3]:Servo Motor Position - 25
    SpeedDif = SpeedDif + 3
    SpeedL = Speed + SpeedDif
    SpeedR = Speed - SpeedDif
    CALL CheckSpeeds
    CALL Backward
    CALL Delay
}
ELSE IF ( Direction == D+L )
    PORT[3]:Servo Motor Position = PORT[3]:Servo Motor Position + 25
    SpeedDif = SpeedDif + 3
    SpeedL = Speed - SpeedDif
    SpeedR = Speed + SpeedDif
    CALL CheckSpeeds
    CALL Backward
    CALL Delay
```

"RC-TriCycle_LR_Pulse.tskx" (4)


```
ELSE IF ( LR_Direction == R )
{
    LR_Direction = Remocon RXD & L+R
    LOOP WHILE ( LR_Direction == R )
    {
        LR_Direction = Remocon RXD & L+R
    }
    Buzzer Timer = 0.2sec
    Buzzer Index = Sol (10)
    PORT[3]:Servo Motor Position = PORT[3]:Servo Motor Position - 15
    SpeedDif = SpeedDif + 10
    SpeedL = Speed + SpeedDif
    SpeedR = Speed - SpeedDif
    CALL CheckSpeeds
    CALL Right
}
```

Build 4W-Drive Dump Truck

Servo Motor on Port 3

NIR Sensor on Port 4
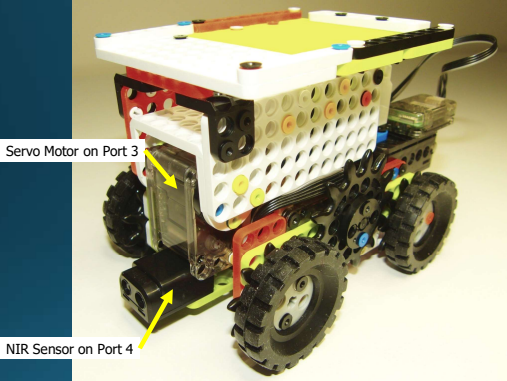
"4W_Drive_DumpTruck.tskx" (6)


```
ELSE IF ( Remocon RXD == 1 )
    PORT[3]:Servo Motor Position = 850
ELSE IF ( Remocon RXD == 3 )
    PORT[3]:Servo Motor Position = 512
```

"1" to fully raise platform
"3" to fully lower platform

```
ELSE IF ( Remocon RXD == 5 )
{
    IF ( ServoPosition < 850 )
    {
        ServoPosition = ServoPosition + 50
        PORT[3]:Servo Motor Position = ServoPosition
        CALL Delay
    }
}
ELSE IF ( Remocon RXD == 6 )
{
    IF ( ServoPosition > 512 )
    {
        ServoPosition = ServoPosition - 50
        PORT[3]:Servo Motor Position = ServoPosition
        CALL Delay
    }
}
```

"5" for incremental raising of platform
"6" for incremental lowering of platform

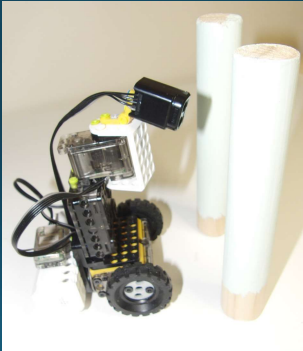## Design & Build Battle Bot

Topics – Day 5

- Students continue with designing & building their own robot to compete on Afternoon of Day 5.
- Concurrent Demonstrations:
  - SCRATCH 2 + DREAM robots.
  - Seal with Servo Head.
  - MotoCycle.
  - Bull with Color Sensor.
  - Racoon with PIR Sensor.
  - Dowel Scanner.
  - Probe Car.
  - Interfacing DREAM robots with Smart Devices.
  - ROBOTIS MINI.
  - ROBOTIS SMART.

Dowel Scanner

SCRATCH 2 + DREAM robot
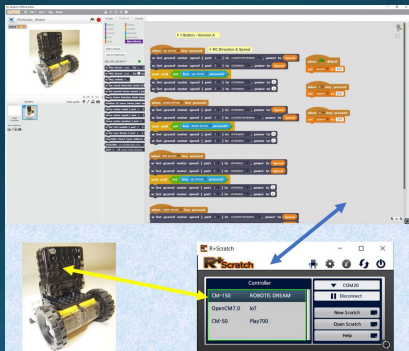
Interfacing DREAM/PLAY700 robots with Smartphones
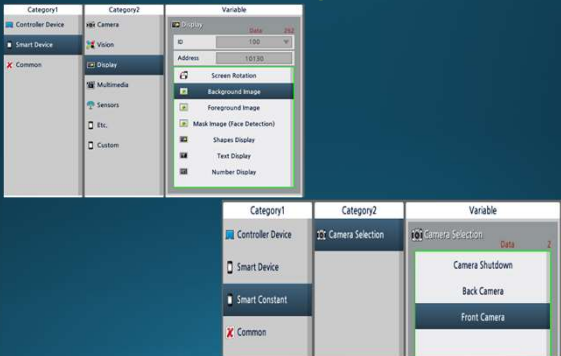
Battle Royale (Day 5 - afternoon)

Student-Created Goals:
Push opponent out of Arena
Flip opponent or immobilize it

- One-on-One Contest
- Every-Bot-In Contest
  - (Last Bot "standing" wins)