.2IO75 (2022-4) DBL Embedded Systems

Sorting Robot

Group 11

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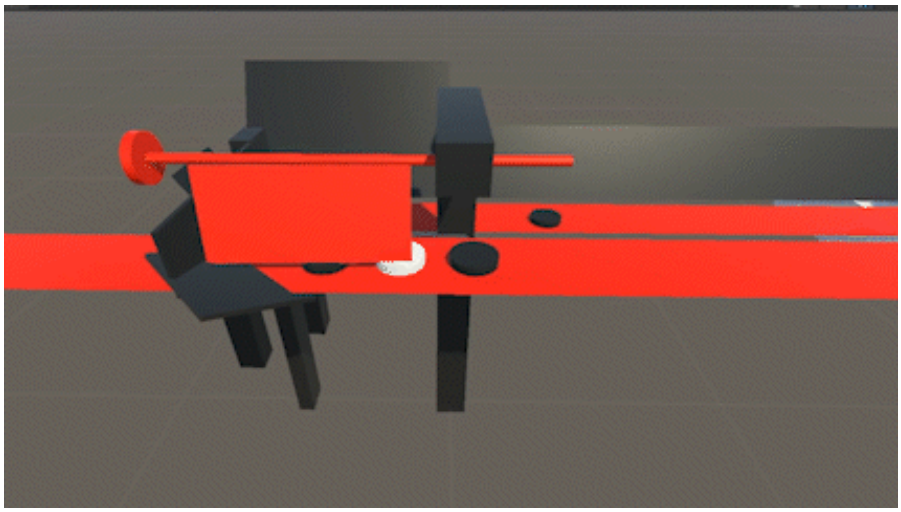
Goal

Build a sorting robot that is able to pick disks from the factory floor and sort them for colour, putting white disks in one bucket and putting black disks in another bucket.

Idea

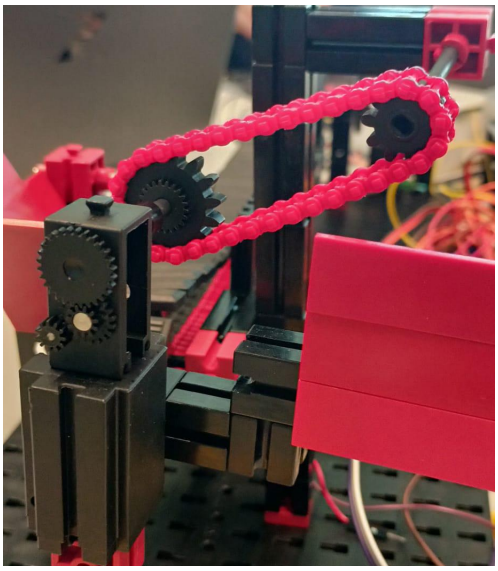
Provided: A factory floor with black and white disks being moved around.



1. Disks on the factory floor are stopped by a plastic wall
2. A rotating shovel pushes disks off the factory floor onto a ramp
3. Disks slide onto a conveyor belt
4. Disks pass under a bar that prevents them from stacking on top of each other
5. A colour recognition sensor checks the colour of a passing disk and forwards that information to a servo motor
6. The servo motor pushes white disks into a bucket; Black disks remain on the conveyor belt and fall into another bucket

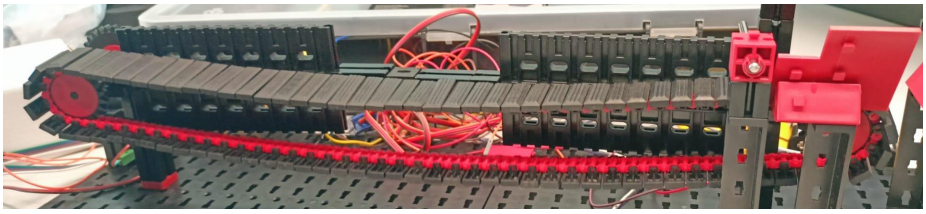
Components

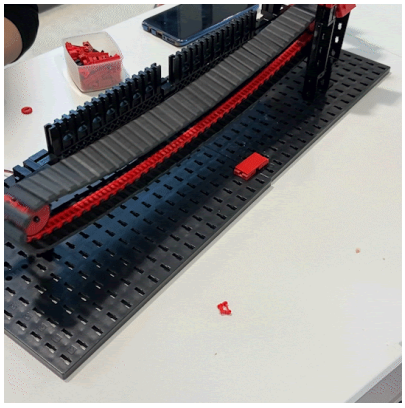
Shovel



A chain connects two cogs, one of which is powered by a motor. The other cog rotates a stick with an attached shovel, which pushes disks off the factory floor onto a ramp. The disks slide onto a conveyor belt.

Conveyor belt

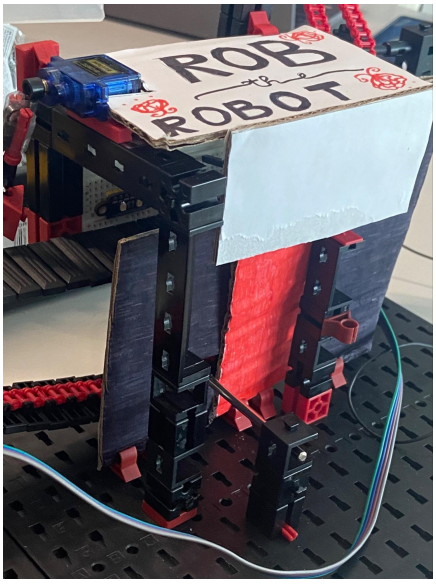




The design includes a conveyor belt powered by a single motor. It is the main component of the robot and is responsible for moving the disks from one location to another.

For stability, a long chain with plates attached to it is used. The belt moves on two wheels on both ends, one of which is powered by a motor. Different sized blocks are used to make the belt the desired height and to provide additional support. Disks are kept from falling off the belt by flat plastic pieces. There is a bar at the beginning of the belt, at one disk's height. The bar's position allows only one disk to slip under it at a time, preventing the disks from stacking on top of each other.

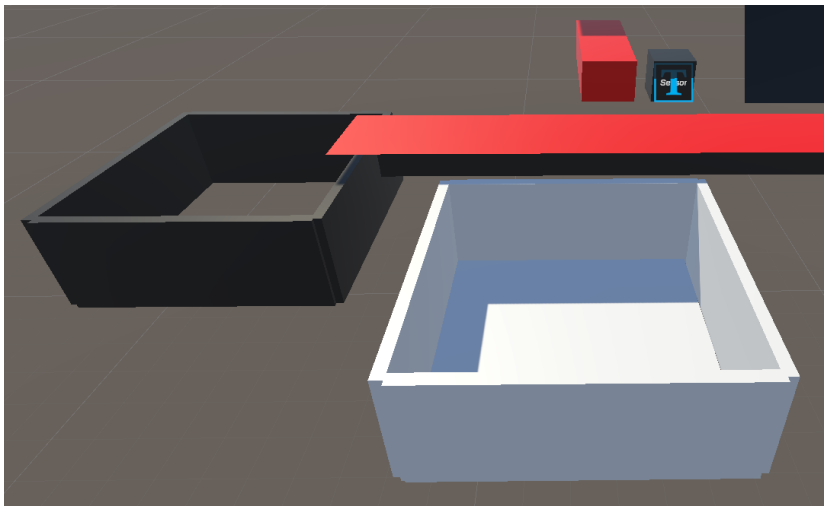
Preventative measures



A sponge has been installed at the beginning of the conveyor belt and serves a purpose of regulating the spacing between the disks. Moreover, a wire has been suspended slightly above the level of the conveyor belt to effectively prevent a possibility of multiple disks being stacked atop one another.

Walls made of cardboard are placed on the sides to both prevent the disks from falling off the construction and create an optimal lighting setting for the colour sensor.

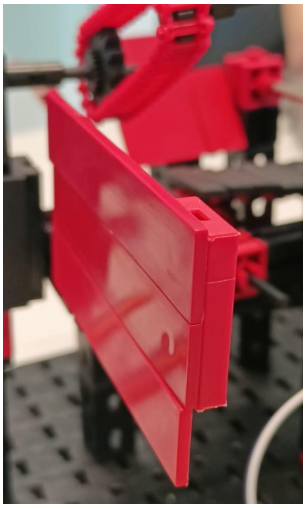
Pushing block

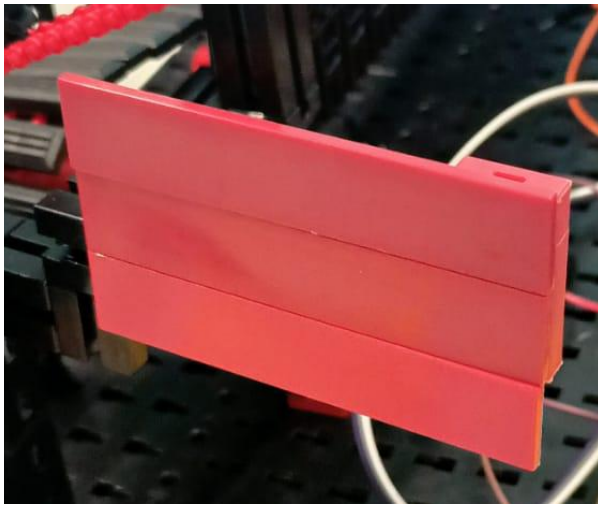


When the optical sensor detects a white disk, it sends a signal to the servo motor, which rotates a stick with a block attached, causing the disk to fall off the belt. The disk is thrown into a bucket. If the sensor detects a black disk, the disk remains on the belt and falls into the other bucket.

Wall

The wall prevents disks from leaving the shovel's reach. This ensures that all disks fall onto the belt and get sorted.





Electronics

As the disks move on the conveyor belt, they pass the colour recognition sensor (TCS34725). If the sensor detects that the luminosity of the passing disk is below 250, a signal is sent through Arduino (UNO R3) to the servo motor (TS90M) to start the pushing mechanism. If the disk's luminosity is above 600, a signal is sent to the servo motor to reset itself and let the disk pass. If the sensor detects luminosity between 250 and 600 or that the sensor is covered, it reports an error "Colour Unknown" and stops the conveyor belt.

Two Fischertechnik motors are used - one to rotate the shovel and the other to spin the conveyor belt. Their motion is regulated in C++ code through Arduino. The speed of the motors is adjusted with the use of gears.

All motors and sensors are powered by AA batteries.

By pairing an Android application and Bluetooth module (HC-02, RF transceiver) connected to Arduino, the user can change the behaviour of the motors and sensors between the following algorithms:

- Sort white and black disks
    - White disks land in bucket A; Black disks land in bucket B
    - White disks land in bucket B; Black disks land in bucket A

Moreover, the application shows how many disks are in each of the buckets.

All code is written in C++.

Use-cases:
The robot is expected to take the disks off of the main conveyor belt using the fischertechnik shovel connected to the fischertechnik motor and this will bring the disks onto the conveyor belt that we built. Now the disks will move a lot slower towards the colour sensor which will detect the colour and report back to the servo motor. The servo motor will push either the white or black disks into a container and allow the other colour to go into a separate container. The choice of whether the servo motor will push the white or black disks will depend on the user input which will be taken at the start through an app that has been developed. The way it works is that the user enters their choice by selecting a button labelled white or black and with that choice, the bluetooth module will send a signal to the servo motor telling it which colour it should react to when receiving the signals from the colour sensor. This will result in a bucket of one colour of disks and then another with the other colour.

Usage constraints:
The robot will give an error if the colour sensor is blocked because in this case it will only detect the colour #000000 meaning that it will constantly think there is a black disk present. The second error detected will be that an unknown colour is detected (not white or black), since the intent is to sort between only black and white disks. The third error is that the app buttons are

being clicked too fast. This is because the colour sensor and servo motor cannot react this quickly to the changes happening. The fourth and final error will be reported if the colour sensor is not found. If the arduino cannot detect it then it cannot receive signals which renders it useless. The colour sensor, motors and bluetooth module are connected to 4 AA batteries producing a 6v power supply. This is another limitation under which the robot must function as more or less voltage supplied could cause the robot to stop working. There are other limitations involved such as the robot getting wet but this is not something we take into consideration as the demo location is in Atlas and this is not possible.

Safety properties:
The robot should not pose a threat to any of the humans around as long as it receives the intended power supply.