SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Highly Commended

Programming, Apps & Robotics

Year 3 - 4

Ethan Xiao

Concordia College - St John's Campus

CONCORDIA
COLLEGE

OLIPHANT SCIENCE AWARDS PROJECT REPORT

Category: Programming, Apps & Robotics
Project Title: Smart Robotics for Real World Challenges: A Safe Crossing to School
Student Name: Ethan Xiao

Introduction

One day when I went to school, I passed some people using signs to tell when people could cross the road. It was a very hot day, and I could see the sweat on their faces. They looked exhausted. When I saw them, I knew I had to change it. My project is to use robots instead of people to show signs for people to be able to cross the road.

The benefits are that on extreme weather days, people won't have to be out there, and since robots don't have feelings, they can do it. There is usually one teacher and three students; the teacher can get ready for his or her class, and the students can get ready for the day.

Observation and Interview

Normally, there is one teacher and three students. On bad weather days, there is only one teacher. There is usually one person with the whistle who directs the lollipop kids to either block the cars or block the people crossing.

Near my house, there is a railway crossing. When there is a train crossing, there are red lights and bars stopping cars. It inspires me; I could use a similar system: bars replace lollipop signs, motors replace the students' hands that hold the signs, and a sensor replaces the teacher's eyes. In addition, there are lights and a warning sound to stop the cars. Finally, we also need a control unit/hub to replace the teacher who blows the whistle to send the signal to control the team. We have all of the hardware in the LEGO Mindstorms set.

Before I do the programming, I need to understand how the lollipop guards do their job. For example, when they blow the whistle, when they move the signs, and how long it takes for the cars to go across. So, I interviewed a few teachers to understand their team's procedure.

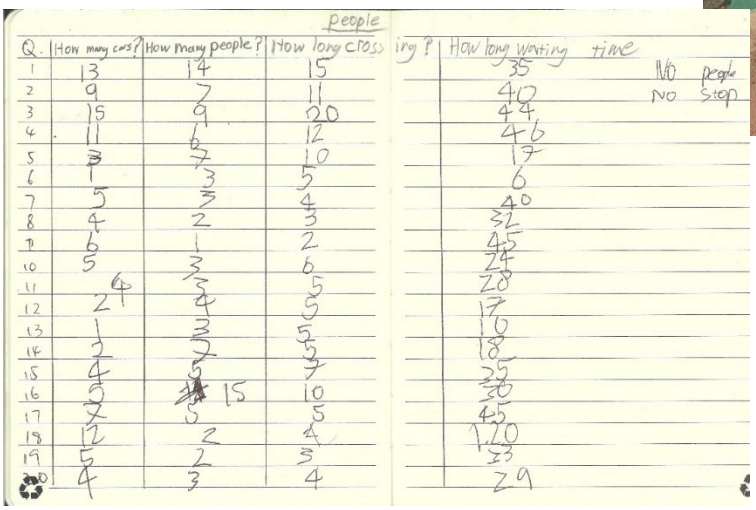
Interestingly, all the teachers I interviewed told me to create this robot so that one day they don't have to do this. The demand is real!

Data Collection and Analysis

I have done 2 data collection rounds: one in the morning and one after school. I have collected 20 groups of data.

Including the questions below:

- How many cars?
- How many people?
- How long is the crossing time?
- How long is the waiting time?

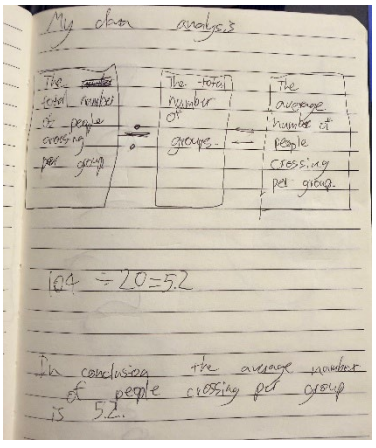


Q.	How many cars?	How many people?	How long cross	How long waiting time
1	13	14	15	35
2	9	7	11	40
3	15	9	20	44
4	11	6	12	46
5	3	7	10	17
6	1	3	5	6
7	5	3	4	40
8	4	2	3	32
9	6	1	2	45
10	5	3	6	24
11	2	4	5	28
12	1	4	5	17
13	3	3	5	10
14	4	3	7	18
15	3	5	7	25
16	3	15	10	30
17	2	5	5	45
18	12	2	4	120
19	5	2	5	33
20	4	3	4	29

No people No stop

The data I collected reflect the real traffic conditions during busy times in front of my school gate.

What My Data Proved (with AI support)



During the data collection, I found that when there are no people waiting, the cars can keep on driving without the lollipop guards stopping them. Larger groups of people take a longer time to get across. But this is not enough for my program, so I have to put my data into an AI to see if there is any logic in it.

AI gave me 3 secrets from my data:

- **The "Crowd Accordion":** It means a lot of people crossing at one time takes longer than normal, supported by (group no. 1, 3 and 16).
- **The "Freezing Penguin":** Which means when there are only a few people waiting, it

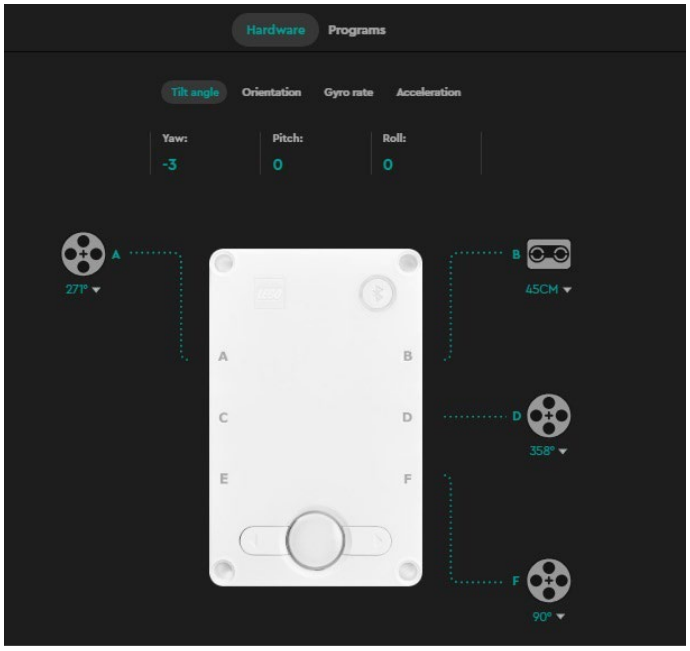
takes a long time for them to be able to cross. Scientific research shows that after 30 seconds; the human brain starts to get impatient. [1] Supported by (group 9 and 18). Data group no. 9 and 18 are also collected towards the end of the data collection after the peak time.

- **The Golden Number (Scientific Control Group):** My research shows that waiting for 5 kids to cross in 7 seconds is the perfect amount, and number 15 is my Golden Point, also supported by (group no. 6, 8, 10, 12, 14 and 19).

System and Hardware

To build the system, I need to connect the motors and a distance sensor to the hub. The core components include:

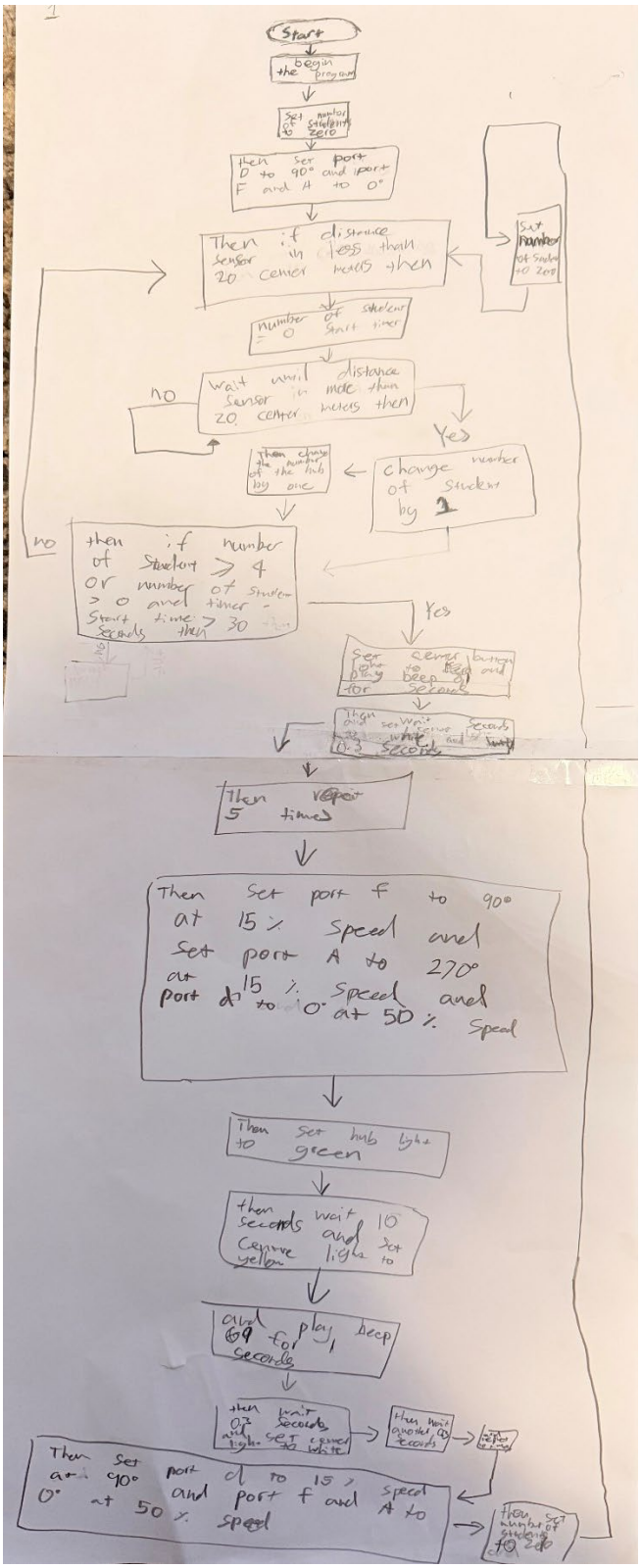
- Mindstorms Hub
- Distance Sensor
- Motor x3



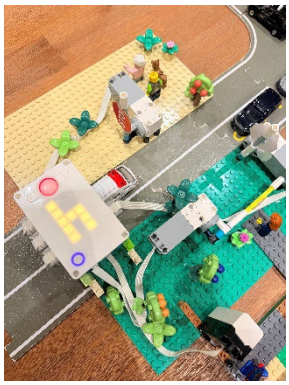
Port connection:

- **Port A & F:** Motor for bars stopping cars
- **Port B:** Distance sensor to count how many people crossing
- **Port D:** Motor for the bars to blocking people

Flowchart


Start
begin the program
Set number of students to zero
then set port D to 90° and port F and A to 0°
Then if distance sensor is less than 20 center meters then
Set number of students to zero
number of student = 0 start timer
Wait until distance sensor is more than 20 center meters then
no
Yes
Then change the number of the hub by one
change number of student by 1
no
then if number of student ≥ 4 or number of student > 0 and timer - start time > 30 seconds then
Yes
Set center button to play beep 2 for seconds
Then wait seconds
Then repeat 5 times
Then Set port F to 90° at 15 % Speed and Set port A to 270° at port D to 15 % Speed and 0° at 50 % Speed
Then Set hub light to green
then wait 10 seconds and Set remove yellow light to
and play beep for seconds
then wait seconds
Then wait another 10 seconds
Then Set port D to 15 % Speed at 90° and port F and A to 0° at 50 % speed
Then set number of students to zero

Instructions on Using the Entry



1. Connect the distance sensor and motors to the hub as shown above.
2. Load the program to the hub.
3. Hold the big button in between the 2 arrows until the light appears.
4. After the starting sound, press the arrow to select the correct program.
5. Then press the button. The hub will start by showing "5" (representing 5 people).
6. **Test Scenario 1 (Rush Hour):** Use a LEGO minifigure to walk past the sensor 5 times. It will display a red light and make a beeping noise. Then, the car poles will go down and the pole blocking the people will go up. The people will have 17 seconds to cross. After that, the car poles will go up and the poles blocking the people will go down. Due to the limitations of the hardware, we have to use the light on the hub to model the crossing for both cars and people.
7. **Test Scenario 2 ("Freezing Penguin"):** Let one LEGO minifigure go past the distance sensor once so that on the hub it will show 1, then wait for thirty seconds without touching anything. Then, the light and warning noise will start, and the same action of the poles from Scenario 1 will happen.
8. **Test Scenario 3 (No One Waiting):** There will be no one waiting. So, keep the LEGO minifigure away from the distance sensor; the car poles will remain open and the poles blocking the people will remain down.

Scientific purpose

When I first start my project, I didn't think of the scientific purpose that much. I was more focusing on solving the problems. And while I fix the problem with my dad, we have discovered the following scientific purpose.

1. Robot instead of human: my project explored whether an automated system could replace human and reduce human error and provide more stable, safe traffic environment.
2. Queueing theory: from the data analysis we have found that the perfect number of people in a group crossing the road each time is 5 people. Big groups take too long to cross, and it can be unsafe. My robot lets only 5 people go at a time, so everyone

crosses fast and safely. I have also found that human brain start gets impatient after 30 seconds, so I set the waiting time as 30 seconds in my 2nd scenario. [2]

3. Fail safe system: when I start the project, I have designed the pedestrian bar to stay up and only go down when people trigger the sensor. Then I asked the question “what about if a young kid run to the road really fast and when the bar go down it may hit the kid or the kid run really fast onto the road before the bar go down. So I have changed the pedestrian bar to stay down from the start. And my dad said this is called “normal close” in the engineering world.

Future applications

- Temporary road work traffic control
- Festive and events: I notice at Adelaide show every year there are extra staffs at the traffic light to help big groups of people crossing the road. They could use my program to assist. I just need to adjust the number factors in my program to suit the larger group.

Improvement

We can replace the distance sensor by using AI camera which it can detect human and provide more accurate data.

I can also include more motors in my program to add additional pedestrian bars on the other side of the road.

Acknowledgment

Dad – a big thank you to my dad who helped me with the Word Blocks coding troubleshoot.

Mum – thanks to mum who helped me taking photos and put my written report into word document

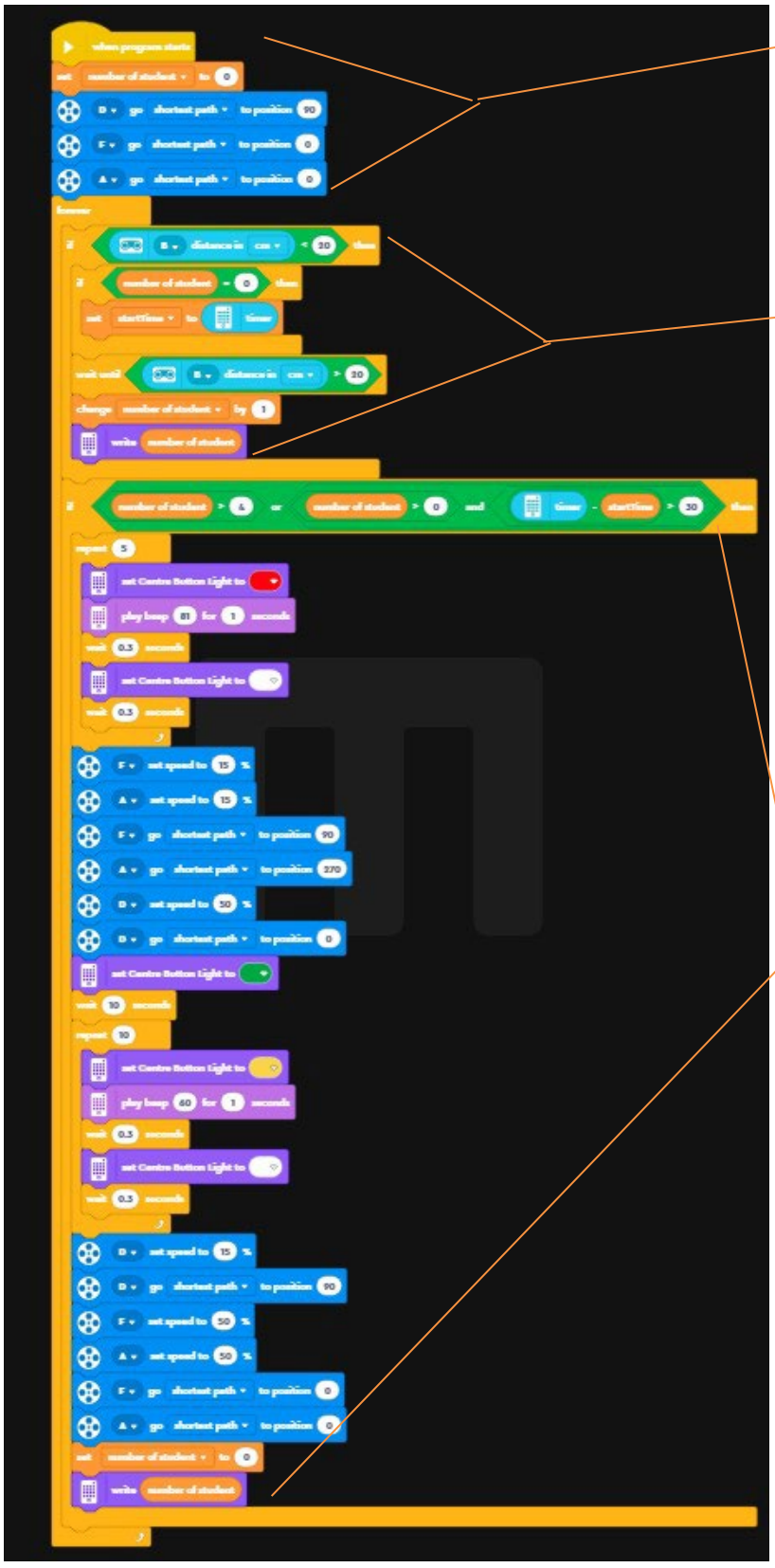
AI – Thanks to Gemini who helps me with data analysis

Video link: https://youtu.be/W0htgJVa5OA?feature=shared

Reference

1. Who waits the longest at Adelaide traffic lights? - CityMag | InDaily, Inside South Australia, visited on 01 June 2026 https://www.indailysa.com.au/citymag/design/2025/03/19/who-waits-the-longest-at-adelaide-traffic-lights
2. Analysis of Pedestrian Crossing Speed and Waiting Time at Intersections in Dhaka, visited on 05 June 2026 Analysis of Pedestrian Crossing Speed and Waiting Time at Intersections in Dhaka

Lego Word Blocks



Get the bars to get into the ready position, reset the variables.

This is the part where it starts counting the people.

This is the part when there are enough people or time, so the crossing program starts.