Dec. 23, 2025

Brainstorming a project

Today I was brainstorming innovative science fair topics and I shortlisted these ones:

- Making a maglev train system
  - ↳ explores the concept of maglev trains and allows to demonstrate the principles of electromagnetism
- Creating an automatic line following robot
  - ↳ demonstrates the capabilities of technology and how it can do things and tasks in the real world
- Making an AI-enabled walking stick
  - ↳ demonstrates how the use of technology can benefit people with impairments

I chose the AI-enabled walking stick and I will start working on it on the 26th.

Dec 26.

Problem

Dec, 26, 2025

Problem

Rough Copy:

Everyday, visually impaired people have to manage difficulties regarding navigation. Visually impaired or blind people have to navigate around obstacles, uneven surfaces, stairs and more. This is where traditional walking sticks come in use. They allow the user to move around as the user can tap the stick in front of them allowing them to gain information on their surroundings. Though, with the traditional walking stick, multiple problems arise. A traditional walking stick can not give the user about oncoming people, animals or other objects. This poses a significant risk to the visually impaired user and can be a threat to their life. This is why I have created a model that can fix most of these problems.

Side note:

- I will complete my hypothesis today as well
- I'll take a look at some components online and then I'll order them so I can start building soon

Hilroy

Dec, 27, 2025

Background Research

(Rough Copy)

Today I was researching through multiple sites to answer my 3 background research questions.

1. What is AI recognition and how does it work?
2. Are there existing smart canes, and what problems or errors do they have?
3. How do different sensors help detect obstacles, and what are their limitations?

1. AI recognition allows computers to see and process/understand visual info. To make AI recognition possible, people have to feed a large amount of data to an AI model. Using Machine Learning (ML), the AI will learn by recognizing certain patterns that apply to that object. Based on probability, the system will then classify the object into a certain classification. For instance, if the computer thinks it sees a cat, it will classify it into the cat classification. Finally, after the classification, a human can use that information to do things like sorting images of cats and dogs.

2. There are many smart canes out there that allow users to navigate easier. Though, there are some errors in most of them. One being that the user can't get a Semantic experience. For them, it's like walking around with a bunch of boundaries around them as many walking sticks only have one sensor to detect their surroundings. This affects the users behavioural decisions as, if they know what's in front of them, they can react accordingly. The second problem that occurs in most commercial walking sticks is that they can't detect water on the ground which could lead the

user to unintentionally walk into puddles. The third and final problem is that most walking sticks are out of the price range for visually impaired people as they can be approximately $500-$1200.

- I will answer question 5 tomorrow
- I will start building after answering question 5 as most of my components have arrived

Dec, 28, 2025

More Background Research

(Rough Copy)

Today I will answer my third question of my background research which is: How do different sensors help detect obstacles, and what are their limitations?

Sensors detect obstacles in many ways but they all have their own limitations. There are four main types of sensors. A camera, a LiDAR sensor, a Radar Sensor and a Ultrasonic Sensor. Cameras capture visual data from their surroundings. Advanced algorithms and machines can look at that visual data and make use of it in different ways. Though cameras have a problem, their performance is highly susceptible to weather as rain, fog or snow can reduce visibility.

Cameras

LiDAR sensor work by emmitting rapid pulses of laser light and measure the amount of time it takes to reflect back from these objects. One major problem with this is cost as LiDAR sensors are really expensive, plus weather that can scatter the beams of light can also affect the efficiency.

LiDAR Sensor

Radar sensors emit radio waves, and similarly to the LiDAR sensor, calculate the time it takes for the waves to bounce back. Compared to cameras and LiDAR sensors, radar sensors offer lower resolution often resulting in false outcomes.

Radar Sensor

The final sensor is the Ultrasonic Sensor. These work by emitting sound waves and measuring how long it takes to bounce back. Some limitations to these are that the range for these waves are low and their accuracy can be affected by noise, temperature and soft materials.

Ultra-Sonic Sensors

My expert, Gaurav Bansal, said, "LiDar stands for Light Detection and Ranging."

-I will start building my walking stick tommorow

Dec, 26, 2025

Hypothesis

Parts:

- If: obstacle detection and object recognition using AI is added to a walking stick with multiple sensors
- Then: I think that It'll provide more accurate and useful feedback than a traditional walking stick
- Because: the user can navigate in a much better and safer way, and can do more things with the feedback they recieve from the AI walking stick

Entire thing:

If obstacle detection and object recognition using AI is added to a walking stick with multiple sensors, then I think that It'll provide more accurate and useful feedback than a traditional walking stick because the user can navigate in a much better and safer way, and can do more things with the feedback they receive from the AI walking stick.

Hilroy

Dec 29 2025

Building the walking Stick

Today I started building my walking stick by getting the AI portion of the build done. I started by connecting the AI camera to the Pi 5 and booting it up. First I made sure that all my packages were downloaded and installed before I started putting in the run commands. One of these installations was the imx500 one. IMX500 is basically the software needed to run the camera. After this, I ran the command to start the camera with the in-built AI recognition model on it. A preview window popped up, and boxes started appearing around objects with their name written beneath it. Now I had to integrate the speaker. For this I needed to code. So I searched for the parts I needed to install and so I installed "espeak" and "pyttsx3". The code was available on github, so I forked it and added it to my Pi 5. I now created a virtual environment so the packages and code wouldn't interfere with my Pi 5 and I integrated the code and the camera system by making the preview window open while accessing the script. But there was a problem, espeak and pyttsx3 (the speaking packages) were clashing with the imx500 packages as they could not be integrated together.

- I will fix this problem hopefully by tomorrow
- I will research other ways to do this project without dependency clashes.

Nilroy

Dec 30 2025

Building the walking Stick pt. 2

Today I researched about ways to use object recognition without IMX500 and I found something called a YOLO model. In a YOLO model, the Raspberry Pi did all the processing unlike right now where the AI camera is doing the processing. So I didn't need the AI camera anymore and I could just get a cheap 20-30 dollar pi 2 camera. Luckily I had one lying around. So I installed the YOLOv11n packages as well as some data set packages along with it and I forked the source code from a public github repository by the person who made the YOLO packages. After I integrated the code and YOLO packages by putting it in a seperate virtual environment, I ran it. A preview window opened and there was a camera view detecting everything it saw and classifying it. Though, the framerates were slower, but this shouldn't affect anything.

Now I have to integrate the camera. For this I installed the pyttsx3 and espeak packages on my new virtual environment. Then I copy-pasted my previous and old code into my new script. I made sure to add whatcard my speaker was on and I turned on the script. This time, whatever the camera detected, it spoke. It spoke at a good rate and I didn't need to change the settings.

- tomorrow I'll add the ultrasonic sensor, I'll make sure it works on a power bank, and I'll make sure it works without a monitor

Dec 31 2025

Making the walking stick Part 3

Today I first needed to connect my ultrasonic sensor to the Raspberry Pi 5 so the camera's AI recognition only works when there is something within a metre's distance. So first to the code I added basic stuff such as making a variable for the pins, adding if-statements in the while true loops and some delay times. Then I used Pinout, the vcc command, and I connected the Trig and Echo and gnd pins to 23 and 24 respectively. I then activated the script but it gave me a warning. "Echo pin is on high." I researched what that meant and discovered that I need a voltage divider. A voltage divider reduces the voltage before the Echo pin's signal goes to the raspberry pi. So I used a breadboard, and two resistors, one being 1k ohms and one 2k ohms. I connected one to the echo and gnd and one to echo and ~~trig~~ the second echo wire. I tried the script again and saw that it worked this time. If something was within a metre, it would turn on the speaker and TI recognition part.

Now I needed it to work on a power bank, and this was all hope. I connected the raspberry pi to the power bank, and it turned on. I then tried [redacted] turning on the script, and suprisingly, on the power bank, it stayed up. The power bank could power the Pi 5 with the script for about 6-7 mins before turning off. I then replaced the cable, as I was using a slow one, to one that can power computers. Now the script can stay on for much longer.

I had to now make it so that it ~~started~~ turned on the script without a monitor, and when it just becomes powered on. For this I needed systemD service, which is a Linux provided service. I created a certain folder on my Pi called YOLO and I made it as a systemd service. I put my code in there (like my script basically) and told it to get packages from all my system including my virtual environment. Now when I tested it without a monitor and with just a power bank, it worked.

- I will make the Arduino part in two days as this should be quick

Jan 2 2026

Making my walking stick
Part 4

Today I made my Arduino Nano part of the project. I'm adding this so that there is a water level sensor and instant object detection feedback. I first made a very simple code on Arduino IDE. I added the variables and functions which define the Pins and repeat stuff. And then I added 1 simple if statement with sensor values and greater / less than symbols with a seperate buzzer hertz for each of them. I also made it so that the buzzer buzzes on and off so the user knows it's on. I downloaded this code to the Arduino Nano and started connecting the pins, through wires. I used a breadboard to make it easier to connect and connected the pins. The buzzer connected to Gnd and D7. The Ultrasonic sensor to Gnd, 5v, D9 and D10. And the water Level Sensor to Gnd, 5v, and A0. I used a power supply module connected to the 9V battery and turned it on. If my hand or any object came in front of the Ultrasonic sensor, the buzzer would buzz in a certain tone. If the water level sensor detects water, then the buzzer will buzz in a seperate tone. All the while in the background, buzzing on and off when no sensor detects something.

Assembly: I simply put the Ultrasonic sensors, both of them, in the middle with the Pi system on top and Arduino on the bottom. The camera is at the very top with the power bank, the Pi 5, and the speaker in the middle. At the bottom (Arduino part), the Water Level Sensor's at the bottom, the buzzer, power supply module, Arduino Nano, and 9v battery in the middle and Ultrasonic on the top (of Arduino system).

Jan, 3, 2026

Innovative Solution

(Rough copy)

Today I wrote why my project is ~~good~~ innovative:

I think my design is innovative because my walking stick:

(My thumb's injured so sorry for the bad hand-writing)

Has a lot of sensors like the Raspberry Pi camera 2, the Ultrasonic sensor, the water level Sensor, to give accurate information. It uses a Pre-built AI model called YOLO, (just the name), to process the info from the camera & classify it into different categories. It gives feedback to the user through buzzers and speakers. It can, through the Water Level Sensor, detect water on the ground. It isn't as expensive as the other walking sticks, about $240. Since the components are split between two mother-boards, you can save battery.

Innovation (difference):

- Innovative because goes beyond simple distance detection - it tells the user what is there, not only that something is there. This allows the user to react/ behave more appropriately.
- There are two main circuit boards as the Nano can handle all the components, but cannot handle the YOLO AI model. The Pi consumes too much power resulting in the loss of the capability to connect multiple components. Plus, seperating the components made the code easier.

- Tommorow I'll start listing the components I used to make my walking stick

Hilroy

Jan, 4, 2026

Components Used

- Today I'll just list my components and say what they do.

• 2 ultrasonic sensors → for object detection on my Raspberry Pi 5 and Arduino Nano
• Raspberry Pi 5 → for the main YOLO AI model processing, connects the camera and one of the ultrasonic sensors
• Raspberry Pi Camera 2 → This is used to capture visual info
• Mini Speaker → to give feedback to the user based on what the AI model sees through the camera
• 2 resistors → used to create a voltage divider for ultrasonic sensors echo pins to not damage the Raspberry Pi 5 GPIO pins
• Power Bank → used to power all of Raspberry Pi system
• 2 Breadboards → one used to connect all Arduino components, another to create voltage divider
• Arduino Nano → This is the main board for Arduino system, used for instant object and water detection, has multiple components attached to it
• Passive Buzzer → will buzz at different hertz based on which sensor, ultrasonic or water level, detects something - used mainly for feedback
• Water level sensor → detects water on the ground.
• Arduino Power Supply → used to give power to all Arduino system

Next page →

- 9V battery → Battery to power all arduino components
- PVC coated wires → Wires to connect all components together and completing the circuit
- PVC pipes and PVC connectors → carries all components, creates main physical stick for user to hold

Total cost: ~~≈$242.00~~ → I bought $30 worth of components

Jan 5, 2026

Design & Method

(Rough Copy)

- Today I worked on my design and method part of my project

Raspberry Pi 5:

The design is meant to give meaningful and timely feedback using multiple sensors and AI. The feedback is processed through a multi-step system on the Pi 5. The Ultrasonic sensor stays active to detect objects within 1.75 metres. If it detects something, then a signal is sent to the Pi 5, telling it to activate the YOLO AI model. Then the camera feeds visual data to the Pi so the AI can categorize it into one of 80 categories. The result of this classification is the output through the speaker.

Arduino Nano

The Arduino system is meant (mainly) to provide istent danger feedback. It uses a water level sensor and an ultrasonic sensor to collect data. If an obstacle is detected, the buzzer sounds at 320HZ. If water is detected, the buzzer sounds at 500Hz.

Combined

The processes combined create a semantic experience. Plus the user can use only one system based on their needs. This system helps visually impaired people better understand their surroundings.

Jan 6, 2026

Testing and Analysis

- Today I did my testing and analysis

I tested my model in my house, a pathway and a park. In the house, I aimed at furniture and miscellaneous objects. In the park and pathway, I aimed at benches, signs, stopped vehicles and volunteer participants.

I mainly tested object detection and ~~[illegible]~~ object recognition.

Object detection: I tested the Ultrasonic sensor.

Car: Actual: 21cm Sensor: 21cm
Dog: Actual: 57 cm Sensor: 56 cm
Chair: Actual: 66cm Sensor: 64 cm
Sign: Actual: 35 cm Sensor: 36 cm
Person: Actual: 47 cm Sensor: 48 cm

Object Recognition: I tested the AI's object recognition.

Car: 67
Dog: 43
Chair: 82
Sign: 56
person: 94

Analysis:

Look on other side →

Hilroy

	Arduino	Raspberry Pi
House	The ultrasonic sensor worked almost perfectly. The object detection was accurate as well as the buzzer feedback.	The AI recognition successfully activated within 1.75m. It performed well in detecting people and furniture, though, since the model is limited to 80 objects, it often misclassified unknown objects.
Pathway	The obstacle detection was reliable and the water level sensor "worked". Though, there would be residual moisture on the sensor causing it to continuously buzz, cutting out the ultrasonic sensor's buzzing.	The battery would shutdown, due to low voltage, every 10-15 minutes. Though, it did well in, detecting people and animals.
Park	It was generally reliable. There was the residual moisture issue, and the buzzer stopped working due to the cold.	The cold caused the recognition accuracy to falter. Plus, ~~no further~~ shutdowns required manual reboots.

Jan 7, 2026

Improvements and future work

After Analysing the testing data, the following are some ideas that will improve my stick. I could use adaptive learning or add more inbuilt recognizable objects to fix the confusion of some unidentifiable objects. I could use a more energy-efficient cpu or use a higher voltage battery source to fix some problems regarding low voltage. Adding extra insulation to the components would allow the usage of the stick in colder temperatures.

Here are some future enhancements. I can replace the PVC pipes to something more durable as PVC pipes are generally flexible and not a good long term solution. I can replace it with wood sticks, aluminium rods or even carbon fibre rods. [redacted] Adding GPS navigation would allow for the visually impaired user to get where they're going quickly. Plus, voice directions would be a good feature to add as the user can easily turn on the stick with a simple voice prompt rather than having to find a button amongst all of the components.

Hilroy

Jan 8
2026

Impacts & Applications

(Krough Copy)

- Today I finished my Impacts & Applications

Here are some impacts of the AI Enabled Walking Stick. It helps visually impaired people walk more safely and independently. It gives users more confidence while walking in new places. It alerts the user about puddles using the buzzer which reduces chances of slipping. It encourages people to make more assistive devices.

Here are some applications of my project. The AI recognition can be used in many fields. Heres one of them. In healthcare, the AI recognition can be used to find diseases in images or blood samples. It also shows how two seperate systems can be used to create one projects This multi-processing can be used in robotics, smart devices and automation.

Hilroy

Jan 9, 2026

Conclusion

- Today I finished my condusion and acknoledgments to finish the project.

I think, based on my testing and analysis, that my hypothesis was fairly true. Adding AI recognition to a walking stick with myltiple sensors provided more accurate and useful feedback than a traditional cane. Also, my hypothesis for adding obstacle detection to a walking stick along with AI recognition provided instant feedback which helps the user react quicker than a traditional cane. The AI enabled smart cane used a Raspberry Pi 5 and an Arduino Nano to provide semantic feedback. Though, there were some issues related to power and sensor performance, the device still provided information about detected obstecles and objects. This stick overall, allows visually impaired users to navigate more safely and with more awareness than a traditional cane.

Hilroy

Jan 9, 2026

Acknoledgments

(Rough Copy)

- I finished my project by writing my acknoledgments

I would like to acknoledge Gaurav Bansal, a software engineer, who is my expert and who helped with formatting and some code integration.

I would also like to acknowlcdge Mrs. Fourie Mrs. Turner, Mrs. Tanner for helping me get set up and get a start on my project. They are teachers at Louis Riel school.