Project Intro:

In the light of the ongoing pandemic, safety ambassadors are deployed around places to enforce social distancing rules. Common rules include not exceeding a certain number of people in a group(cluster) and maintaining a certain distance between clusters. As much manpower are needed for such enforcement tasks, we hope to reduce the needed manpower through the use of autonomous robots and artificial intelligence

Project aim:

Design and build an autonomous robot that tracks cluster size and inter-clusters interactions and distance. Using machine vision algorithms, the robot detects clusters of people through object detection (YOLO) and groups people into clusters based on walking direction, speed and behaviours. Once a cluster is detected, it tracks the number of people in a cluster and the interactions with other clusters (interactions between members from other clusters and also distance with other clusters). Robot will track and follow a cluster for a set duration (or tracking is lost) before switching to find other clusters.

Materials needed:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Components (SGD) | Link | | Price(SDG,excluding shipping fees) | Quantity | Total cost |
| Batteries | [Batteries](https://www.amazon.com/Tenergy-Battery-Projects-Equipments-Portable/dp/B08J4H39JV) | | 42.99 | 1 | 56.93 |
| Arduino uno rev3 | [Arduino](https://sg.rs-online.com/web/p/arduino/7154081) | | 39.72 | 1 | 39.72 |
| Raspberry pi camera | [Camera](https://www.amazon.sg/Raspberry-Pi-Camera-Module/dp/B07Y5NZ832/ref=asc_df_B07Y5NZ832/?tag=googleshoppin-22&linkCode=df0&hvadid=389214270625&hvpos=&hvnetw=g&hvrand=12925540855170449127&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9062524&hvtargid=pla-891737399277&psc=1#customerReviews) | | 9.90 | 1 | 9.90 |
| Servo | [MG90](https://www.lazada.sg/products/mg90s-micro-metal-gear-9g-servo-for-rc-plane-helicopter-boat-car-48v-6v-i1718573326-s8408927619.html?exlaz=d_1:mm_150050845_51350205_2010350205::12:12266637336!116209940086!!!aud-1456122117997:pla-297963845945!c!297963845945!8408927619!144005839&gclid=CjwKCAjwsNiIBhBdEiwAJK4khvDnS7-WbLC4PuezMFAbbSjzs0f28-nnIq74nVDwyJqCEOpykAH4aRoCKeAQAvD_BwE) | | 3.10 | 1 | 3.10 |
| motor+wheel | - [12V](https://sea-m.banggood.com/Machifit-25GA370-DC-612V-130rpm-Gear-Reduction-Motor-with-Mounting-Bracket-and-Wheel-p-1532246.html?utm_source=googleshopping&utm_source=googleshopping&utm_source=googleshopping&utm_source=googleshopping&utm_medium=cpc_organic&utm_medium=cpc_organic&utm_medium=cpc_organic&utm_medium=cpc_bgcs&gmcCountry=SG&utm_content=minha&utm_content=minha&utm_content=minha&utm_content=sxxx&utm_campaign=minha-sg-sea-en-mb&utm_campaign=minha-sg-sea-en-mb&utm_campaign=minha-sg-sea-en-mb&utm_campaign=sxxx-ssc-sg-sea-all-1101-2quad-11sale&currency=SGD&cur_warehouse=CN&createTmp=1&ID=49552&gbraid=0AAAAADshcaUCykzSoCmzzge3zvmtqAtLp&ad_id=476217116848&gclid=EAIaIQobChMIoPXf46Kv8gIV-5JmAh3gLQ0OEAQYDSABEgL-BfD_BwE) (preferred)    Or  - [6V](https://www.amazon.sg/Electric-Magnetic-Gearbox-Plastic-Yeeco/dp/B07DQGX369/ref=asc_df_B07DQGX369/?tag=sgsmrtphshopg-22&linkCode=df0&hvadid=404365158182&hvpos=&hvnetw=g&hvrand=898323028352080639&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9062526&hvtargid=pla-487856373581&psc=1) | | - 13.52  Or  - 27.38 | 4 | 54.08 |
| Lidar sensor(360 degrees) | [Lidar](https://www.amazon.com/Slamtec-RPLIDAR-Scanning-Avoidance-Navigation/dp/B07TJW5SXF/ref=sr_1_5?dchild=1&keywords=Lidar+Sensor&qid=1628910827&sr=8-5) | | 99.99 | 1 | 99.99 |
| Raspberry Pi 4 | [Raspberry Pi 4](https://www.amazon.com/dp/B07V5JTMV9/ref=sm_n_ma_dka_SG_pr_ran_0_1?adId=B07V5JTMV9&creativeASIN=B07V5JTMV9&linkId=306b0c1c9362a2f107929adc5d79b018&tag=makerportal-20&linkCode=w43&ref-refURL=https%3A%2F%2Fmakersportal.com%2Fblog%2F2020%2F3%2F21%2Fraspberry-pi-servo-panning-camera&slotNum=0&imprToken=e439f374213975d48ecba49e6708c1ef&adType=smart&adMode=manual&adFormat=grid&impressionTimestamp=1629011329342) | | 91.95 | 1 | 91.95 |
| Total­­ | 355.67 |

A toy truck on a white background

Description automatically generated with low confidence

Mechanical design of the robot:

A picture containing LEGO, toy

Description automatically generated

A picture containing toy, gear

Description automatically generated

Software/programmes:

* Python (AI models, openCV for object detection?)
* Arduino (Motors and servo controls)
* Raspberry pi (computation)
* Ros2 (Robot navigations)

Methodology:

YOLO V3 is an object detection model that balances speed and accuracy, setting up the boundary boxes for the objects detected. Due to the height of the camera, shoes will be tracked instead of the entire human body. Deep sort is the object tracking model that classifies each unique object using unique IDs. Cluster tracking will prioritise the cluster’s size (minimum of size 1).

Generation of random coordinates will provide a target location for the robot in order to set a default path using ASTAR search or any other pathfinding algorithms when there are no clusters to be tracked.

Algorithm for robot control:

If people/cluster detected (tracking mode):

1. Starts a 3minute timer
2. Rotate until the front faces same direction as the direction of the cluster’s movement
3. Track and follow the cluster, maintain within x distance, and apply kalman filter
4. If the front sensor detects an object, priority turns towards the person using a pathfinding algorithm
5. If person is lost and kalman filter no longer converges, OR timer is up, switch to free roaming mode

Free Roaming mode:

1. Generate a random coordinate (changes after each tracking, which means practically, the robot will never reach any generated coordinates) and finds the shortest path to the location using a pathfinding algorithm
2. Obstacles detected. Priority turns: right > left
3. When people detected, goes to tracking mode

YoloV3 model

* Dataset from: https://blogs.sap.com/2018/07/25/object-detection-with-yolo-for-intelligent-enterprise/