

A lightweight, head-mounted, interface for controlling a collaborative mobile manipulator

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Outline



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3. Value to the population
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5. Implementation & motivation
6. Evaluation & Demo
7. Next steps (future work)
8. Support from the literature, interactions with stakeholders, state of the art





Problem Definition:

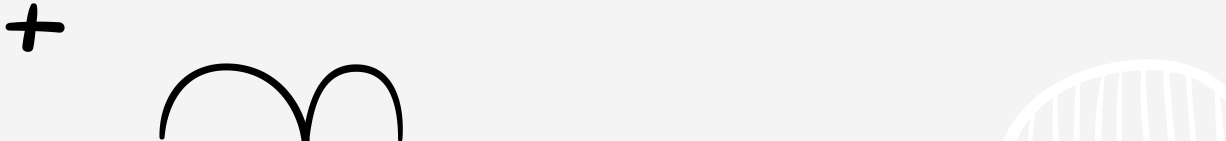
It is really hard for an individual with motor impairments to fetch something without help of their caregivers. This is a more serious problem when caregivers are not around.

Population:

Quadriplegic/Tetraplegic individuals.





Proposed Solution:

We are providing Quadriplegic/Tetraplegic people with a lightweight, head-mounted, interface for controlling a collaborative mobile manipulator such that they can perform a task of fetching an object in close proximity when the caregiver isn't around to help.





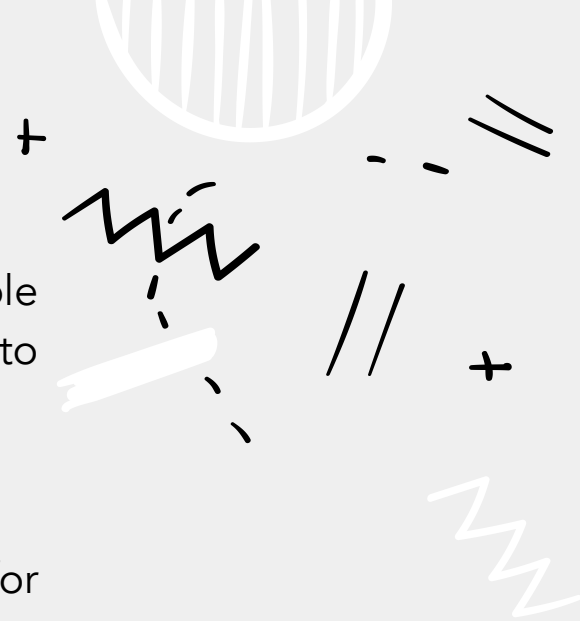
Challenges:

- The head's movement thresholds can vary from person to person – Person A might prefer (or be capable of) tilting their head 20 degrees forward for the forward movement while Person B might prefer 30 degrees tilt for the same movement – added calibration functionality.
 - There should be a way for a care-receiver to control the bot and fetch remote objects – added teleoperation.
 - View of what exactly robot is looking at was not available earlier – added multiple camera views for blank spot views and ease of use.
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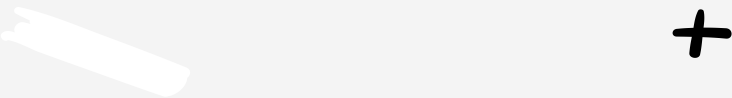
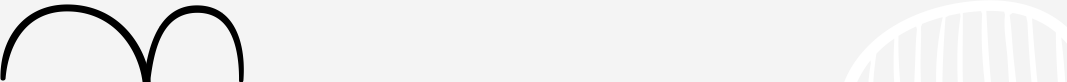
Value to the population –

- Our project will liberate physically challenged people from dependencies, consequently enabling them to fight social stigma and improving their self-esteem.
- It will highly reduce the dependency on caregivers for daily tasks
- The project will enable Quadriplegic/Tetraplegic individuals to retrieve objects, scratch itches and bringing smiles on their faces.





Assumptions:

1. The care receiver can move his head around in 4 directions.
 2. The care receiver has an access to a good internet connection.
 3. The care receiver can either use his finger to press button or puff/sip to switch robot modes.
 4. The care receiver is always within the bluetooth's range.
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Task Decomposition

Teleoperation



- Adding a cam to the wrist for gripper's vision.
- Using existing depth camera for the front vision.

Modes Switching



Adding a button to switch robot modes – base, arm, wrist, and gripper modes.

Headset Calibration



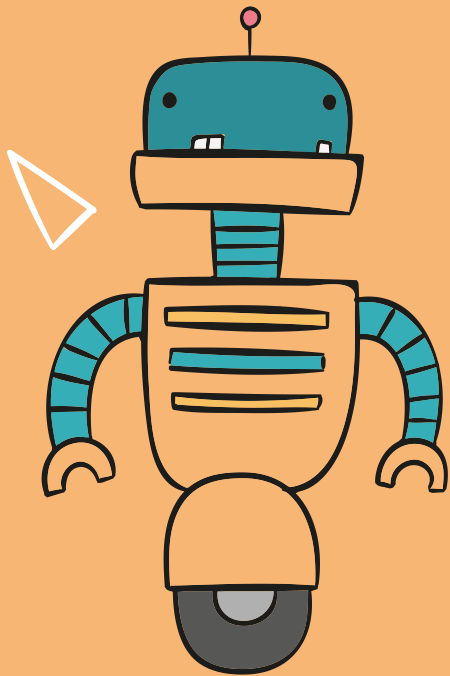
Adding the headset's calibration functionality.

Shared Autonomy Roles

	Robot	Caregiver	Care Receiver
Put the device on care receiver's head		✓	x
Activate stretch		✓	
Calibrate motors	✓		
Telling about the activated control mode	✓		
Control stretch by tilting head and sipping/puffing			✓
Calibrate the headset		✓	✓

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Implementation & Motivation



In terms of the limitation of movements of our stakeholders, a lightweight headband controller could be very useful and helpful to manipulate the robot by capturing the head tilting and getting feedback by multiple cameras. The core motivation of idea is to help an individual with quadriplegia for retrieval and scratching when their caregivers are not around.

Interactions with Stakeholders



- Henry Evans (email correspondence)
- Jane Evans (email correspondence)
- Varun (home visitation)



1] for deaf people ,use an LCD/light indicator to indicate submenu in addition to audio

2] figure out a way the user can pause the robot to use the sip n' puff/mouse switch for something else [like their regular computer], or just to take a break

also, my headtilting is much less pronounced than the hand tilting you demonstrated.

Cheers,

1. Everyone has a different level of comfort for leaning their head on either side. Therefore we need a calibration set that can work for everyone as per their requirements and the calibration set should be on the go.
it needs to respond to a 2" head tilt [make it 10x more tilt-sensitive]

2. We thought using switches to change mode would be really nice idea and we did so. Puff/Sip is always there if needed (The attached video doesn't cover this feature)make one of the modes 'Select Step Size'

3. While the robot was coming back the tilt angles inverses and we are finding a way to automate it. In the worse case, we will add a reverse mode. i don't understand-just have a 'Return to Starting Pose' signal

4. I have planned to add a camera on the gripper and stream video from the head camera on the user's computer for a more robust application since currently, the user cannot determine if an object is in grip of a robot or not.The Stretch i used already had the optional gripper cam [its critical.]

5. For the quick prototype we had mounted things on a bicycle helmet but soon it would be on a thin neat headband that is comfortable to wear all-day make sure its hands-free

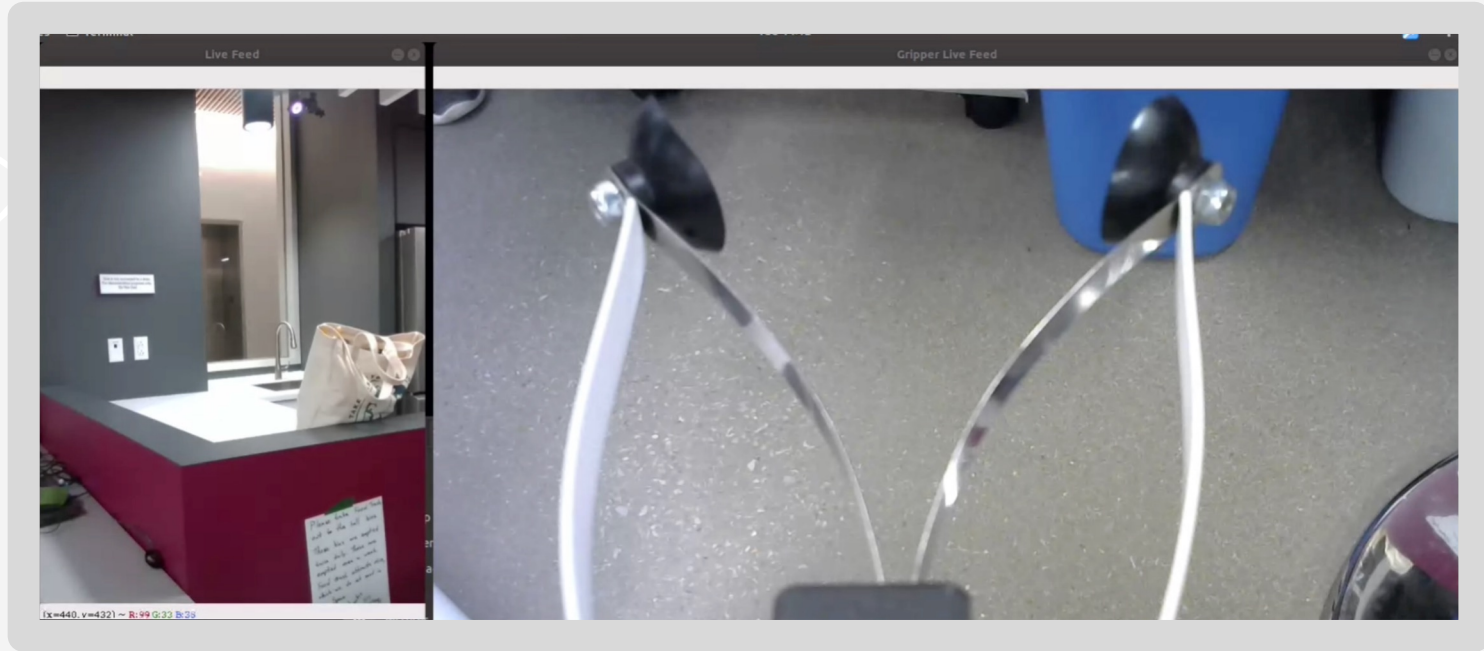
The background is a solid pink color. It is decorated with several hand-drawn geometric shapes: a dashed white line in the top left, a black plus sign in the top center, a black zigzag line in the top right, a white triangle in the middle left, a yellow circle outline on the right edge, a white plus sign in the bottom left, a white circle outline at the bottom center, and a white triangle in the bottom right.

System Upgrades



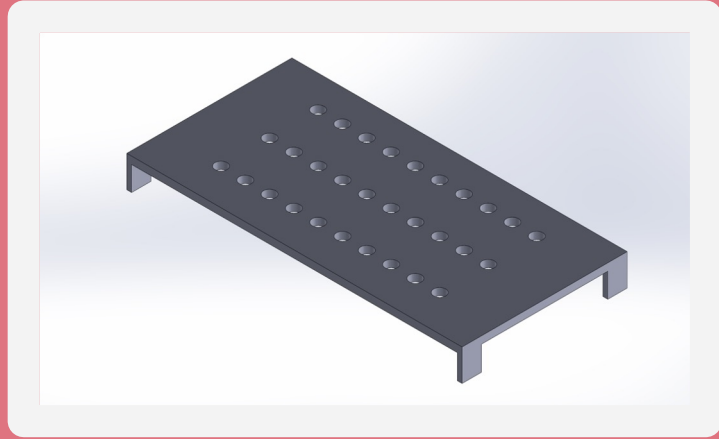
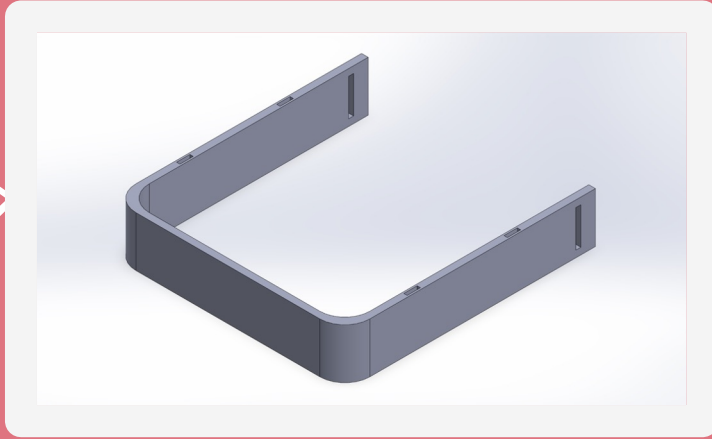
**Additional Wrist
Webcam**

Multi camera views



Headband

3D printed and lightweight



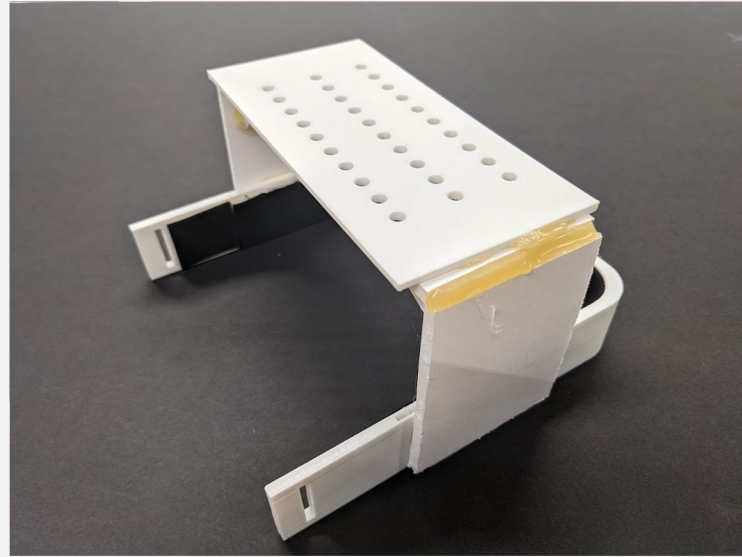
Headband v1.0

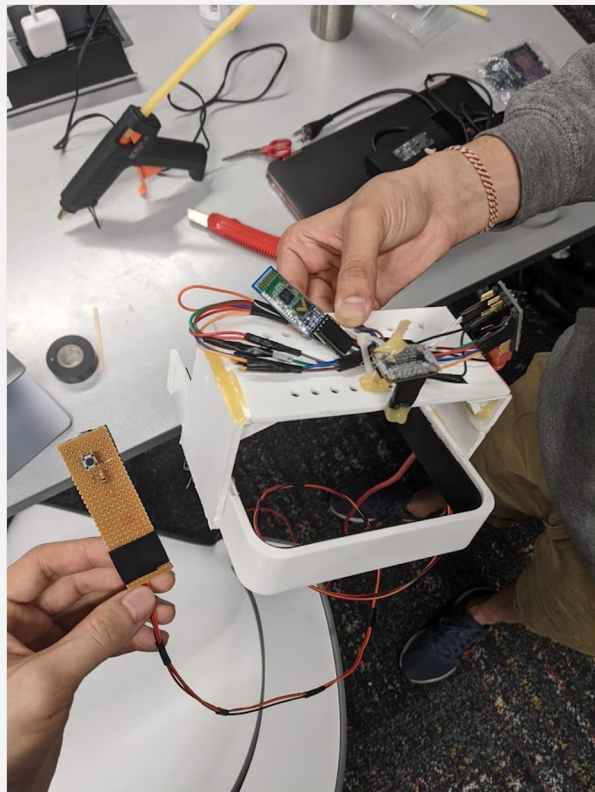
3D printed and lightweight



Headband v2.0

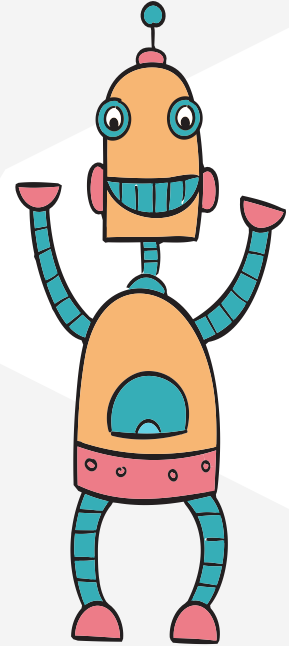
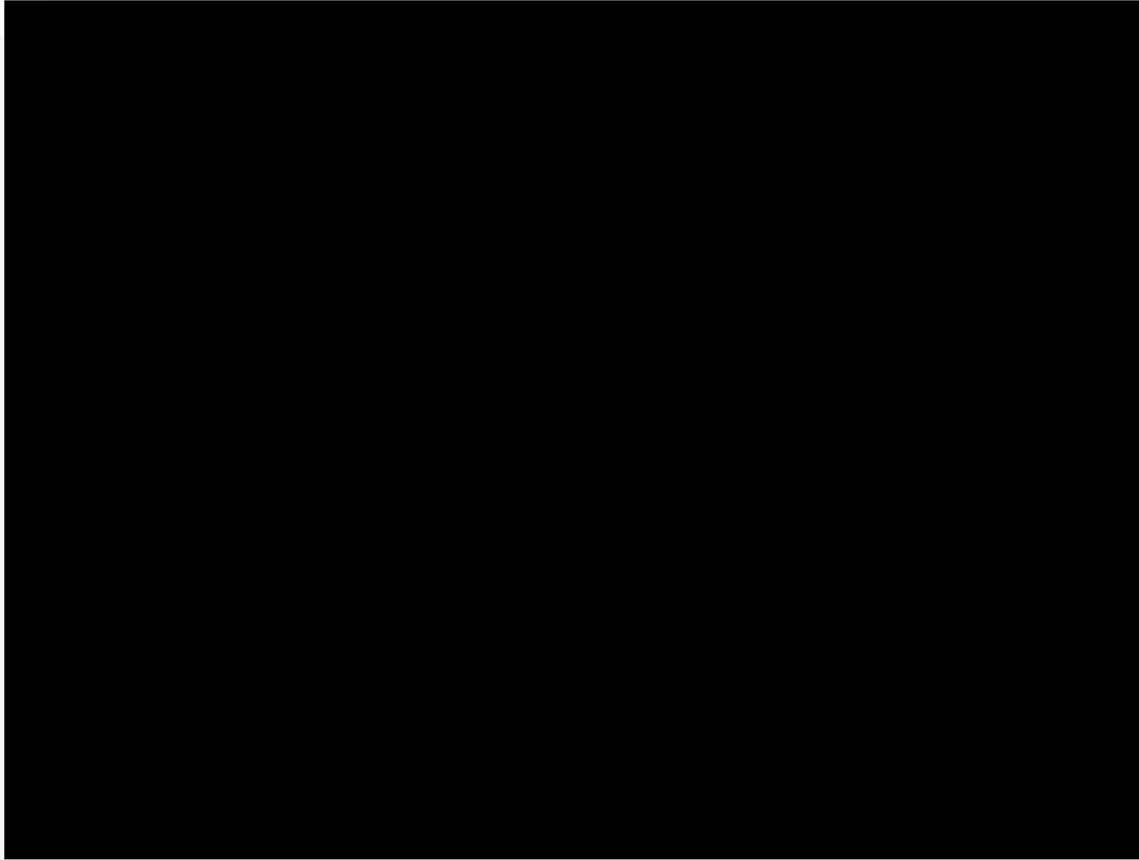
3D printed and lightweight



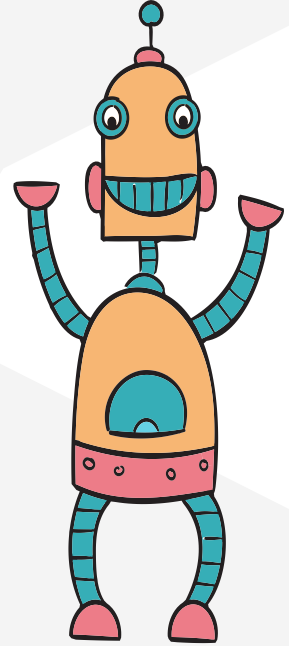


Headband with electronics

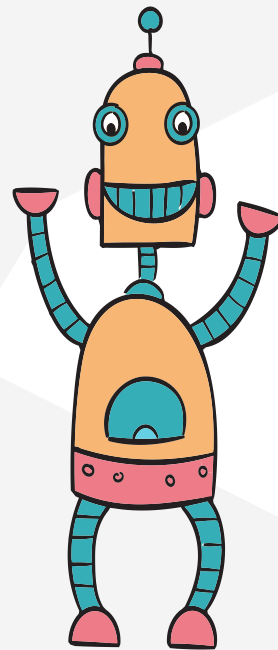
Demo Video - IMU Teleop



Demo Video - Itch Scratch



Live Demo



Evaluation 1

No. of trials : 10 in each case

	IMU Band	Teleop
Object retrieval	3m 20s	1m 29s
Itch scratch	2m 6s	52s

Evaluation 2

No. of trials : 10 in each case

	Helmet IMU Band	3D Printer IMU Band
Object retrieval	~6m 10s	~3m 21s
Itch scratch	~4m 20s	~2m 6s

Evaluation 3

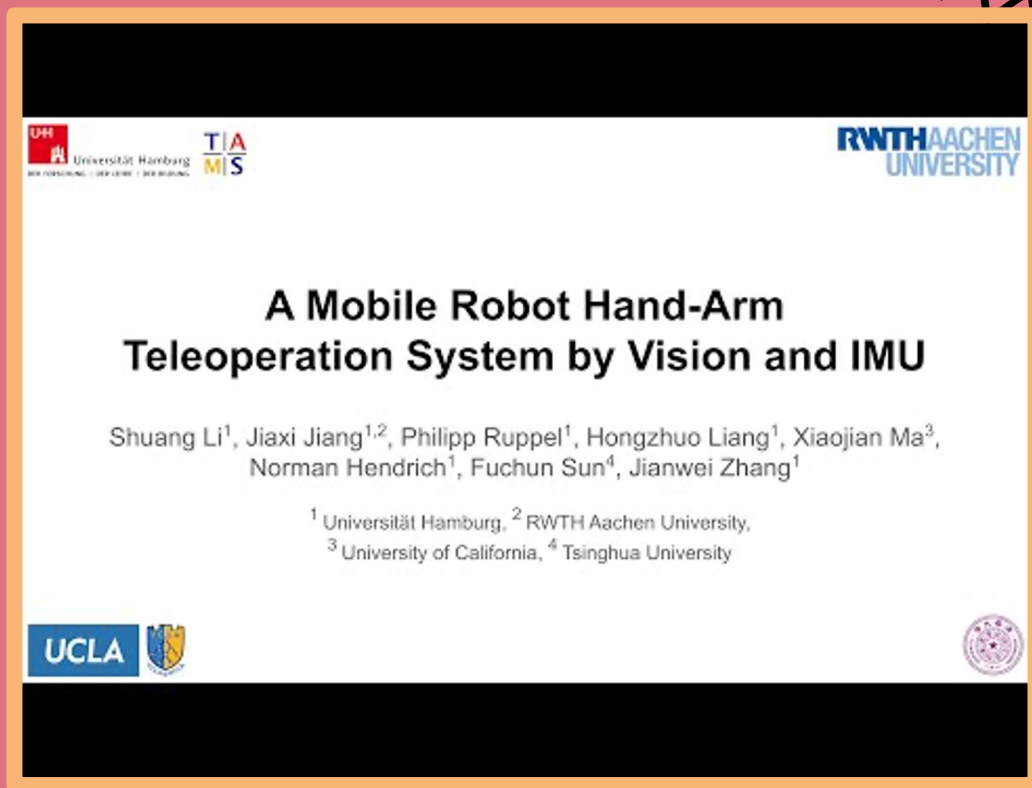
No. of trials : 10 in each case

	No Gripper cam	w/ Gripper cam
Object retrieval	60%	80%

Failure Criterias:

- Object retrieval takes over 6 mins
- Object to be retrieved gets knocked off by the robot
- On activating the gripper, it fails to pick up the object

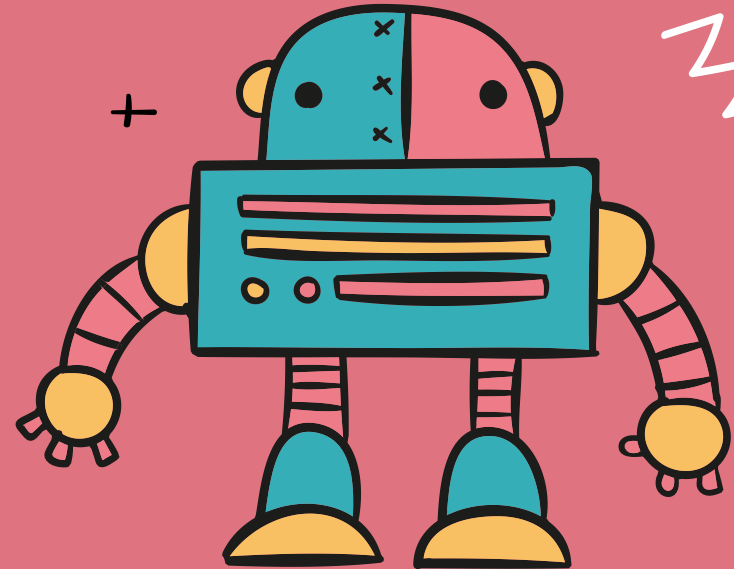
State of the art/Similar Work



Video [Link](#)
Paper [Link](#)

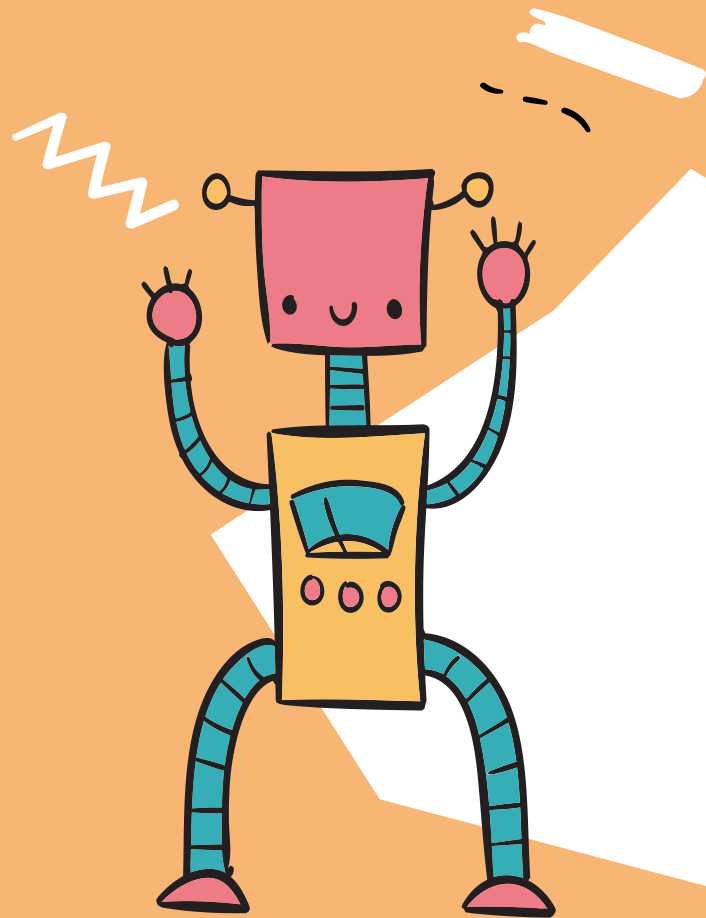
Future scope –

- Adding object detection for quicker gripping
- Autonomous navigation to selected key locations of house/space
- An e kill switch operation
- WiFi based communication for better range



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Thanks!



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