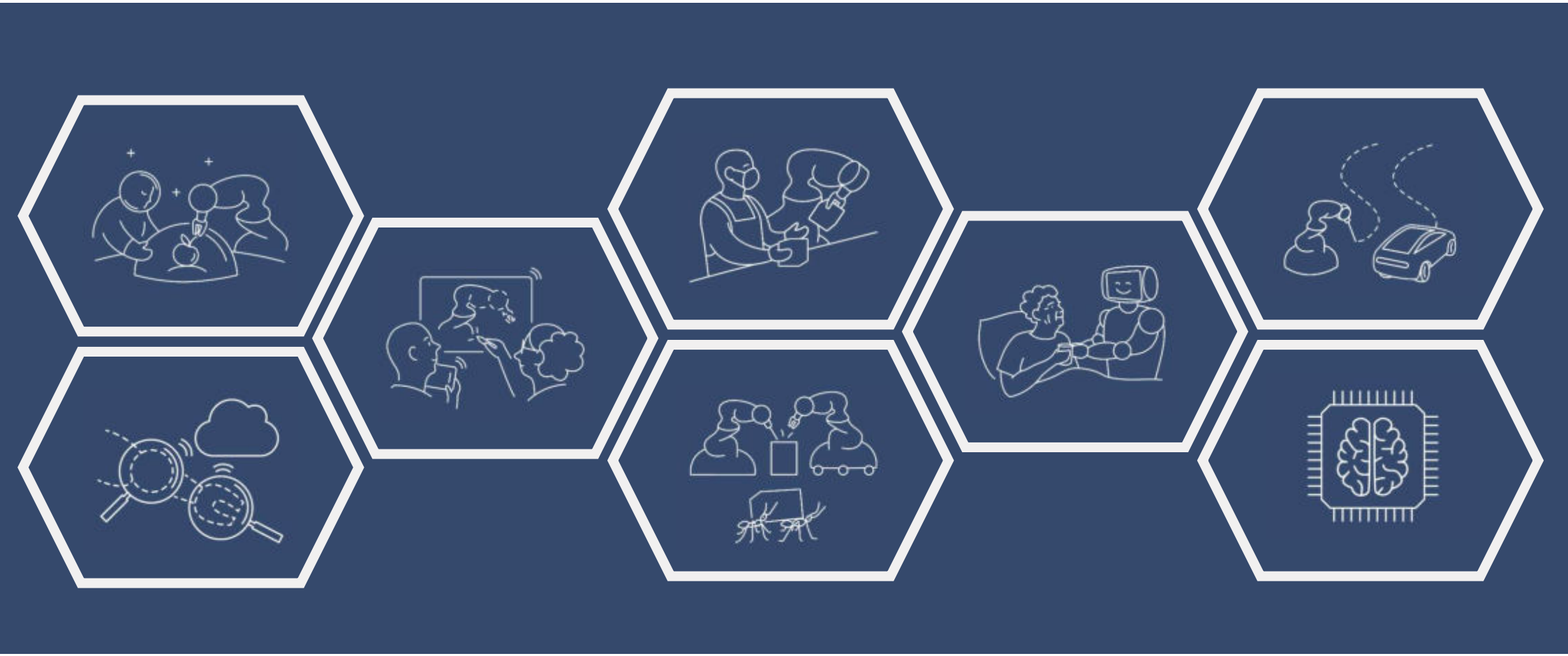

INTELLIGENT, TEXTILE BASED ROBOT SKIN FOR ENABLING NEW AREAS OF COBOT APPLICATIONS

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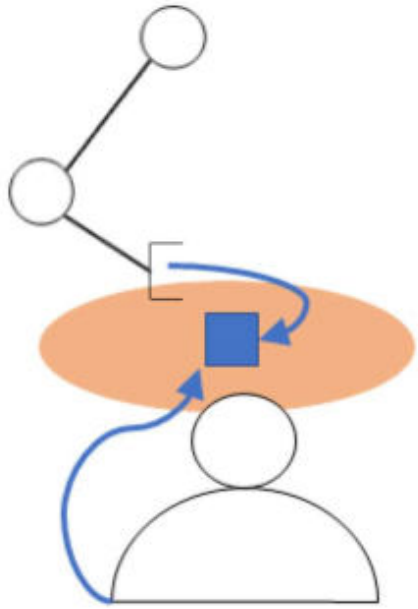
Introduction

- Cobots (Collaborative robots) are a type of robot designed to work alongside humans in a shared workspace.
- Humans are essential for tasks that require decision-making, problem-solving, and critical thinking and cobots assist humans by performing repetitive or dangerous tasks.
- Accidents may occur if the cobots couldn't detect the human presence in an inappropriate region.



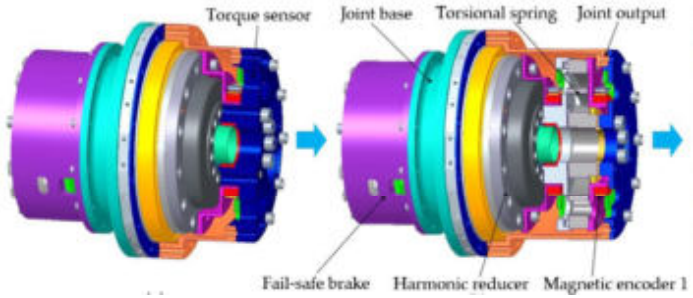
Source: https://www.mdpi.com/2218-6581/8/4/100

State of the Art

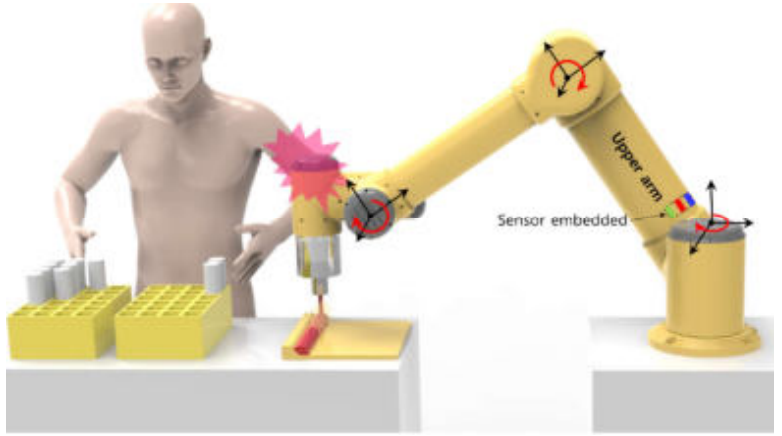
- Inspired from some of the major producers of cobots

1. Yaskawa Motoman
2. KUKA Robotics
3. Universal robots

- Mainly use force/torque sensors to determine the collision with the human which stops the cobot.
- Cobots can detect the presence of human only after the collision has occurred which is a major disadvantage.



Source: https://www.mdpi.com/sensors/sensors-18-01869/article_deploy/html/images/sensors-18-01869-g001.png

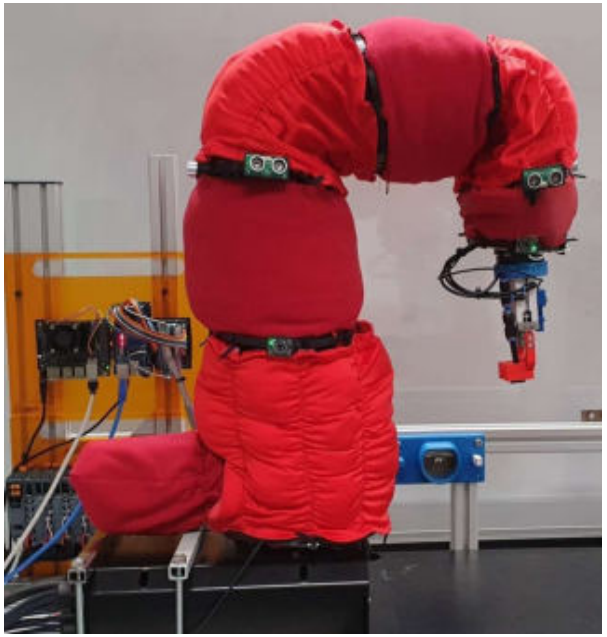


Source: https://www.mdpi.com/sensors/sensors-22-01222/article_deploy/html/images/sensors-22-01222-g001.png

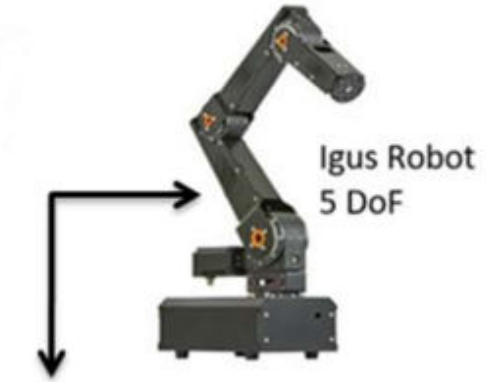
Overall Concept

- To build a Intelligent textile based robot skin with the synchronization of multiple affordable, robust and reliable sensors which can provide a new system of intelligence to the cobots.

Source: https:// www.igus.com/product/17662?artNr=RL-DCi-5S-M-B-00



Hardware Architecture



Igus Robot
5 DoF

Control System

- B&R PLC X20CP0484-1
- Power supply Unit X20PS9600
- Stepper Motor Drivers X20SM1446-1
- Digital Output Module X20DO6322
- Digital I/O Module X20DM9324

Modbus TCP IP
Through Ethernet
real time communication
of processed signals from
sensor arrays

Arduino Mega 2560
Microcontroller to process the data from several sensors and send signals to control the movement to the PLC

Ultra Sonic Sensor US-100
Sensor for detection up to 4 meters in Dynamic light environment
Low Distance Accuracy

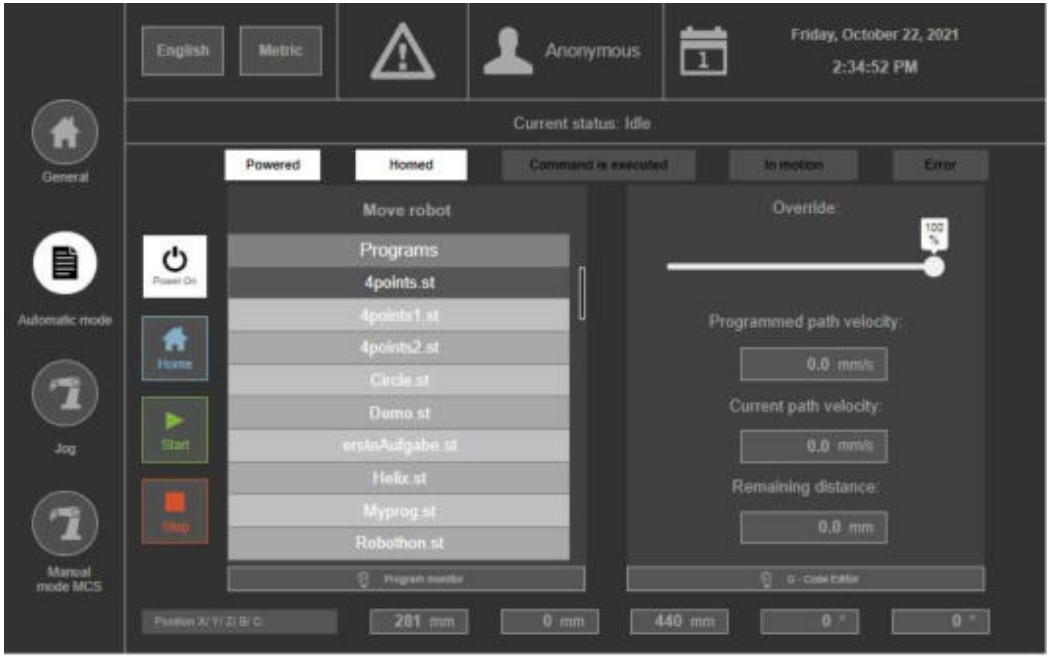
Time of Flight Sensor VL53L0X
Sensor for detection up to 2 meters in controlled light environment
High Distance Accuracy

Capacitive Proximity Sensor MTCH101/2/5/8
Sensors for the close range detection of the surroundings

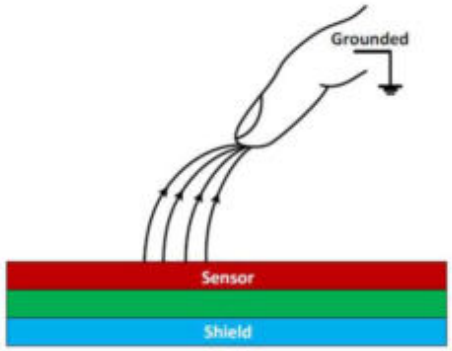
IGUS Robot

- Robolink RL-DC, 5 Degree of Freedom – developed by IGUS GmbH
- This robot have Industrial standard and cost effective.
- Driving elements – NEMA 23, NEMA 17, NEMA 11 stepper motors
- Integrated with the B&R PLC
- Web based Human Machine Interface
- LAN network

Source: https:// www.igus.com/product/17662?artNr=RL-DCi-5S-M-B-00



Textile Skin



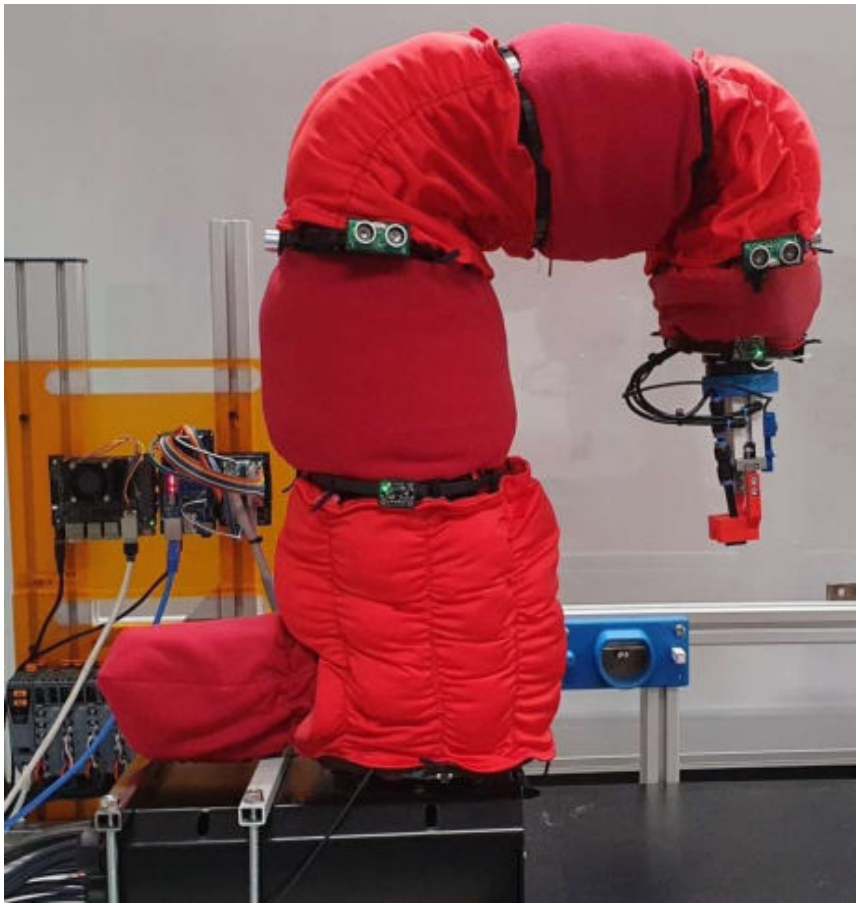
Source: https://www.eeworldonline.com/wp-content/uploads/2017/07/capacitive-touch-switches-fig-1.png

- Developed in collaboration with Gesellschaft für Intelligente Textile Produkte GmbH [ITP GmbH]
- Capacitive sensing - detecting the change of capacitance on the sensor due to user's touch or proximity.
- Textile based sensing element has flexible metal strands that forms the capacitor plates and generates capacitance throughout the surface of the textile.
- MTCH105 capacitive proximity sensor- continuously monitors the capacitance of the plates, and upon significant change it triggers the output signal to the microcontroller.

Textile Skin

- Four segments of textile sensing elements are placed on the internal side of the robot skin.
- Thermal activation of the conductive fleece and sensing element.
- Contact legs were connected to the electrical leads by crimping.
- Elastane tapes are used to connect the outer skin with the multiaxial fasteners on the robot.

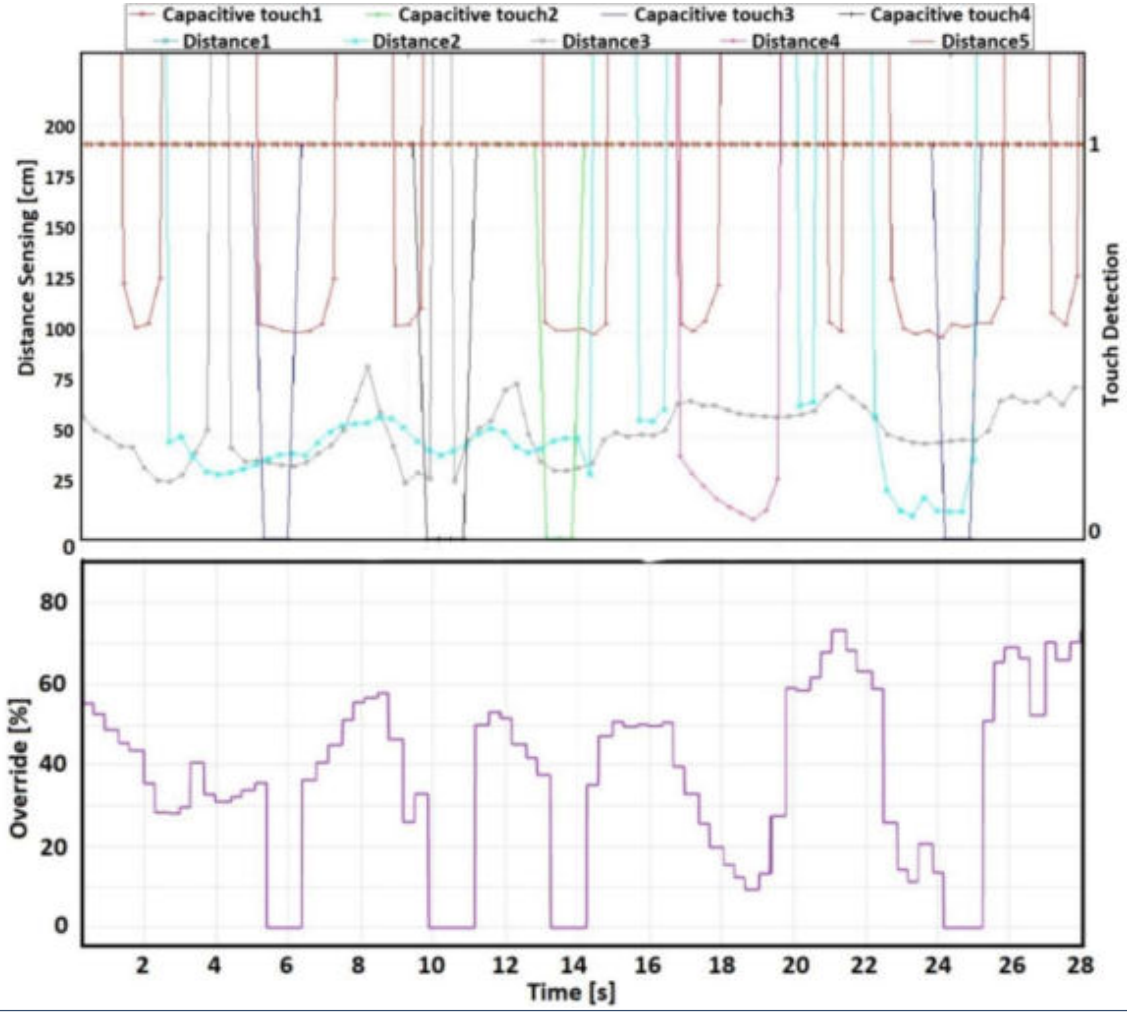
Ultrasonic and ToF sensor



- Textile skin enables both passive and active safety for Human Robot Collaboration.
- 6 - (US 100) Ultrasonic and 6 - (VL53L0X) Time of Flight sensors are placed on each sides of the robot to ensure broad sensing range.
- The drawbacks of one sensor are offset by the advantages of the other sensor.

Testing and Results

- The cluster of outputs form all the sensors are sent to the Arduino microcontroller.
- The minimum distance value among all the sensor is determined based on which the Override percentage is calculated.
- Override percentage is transmitted to the B&R PLC using Modbus communication.
- Actuation speed is proportional to the Override percentage



Working Video

Conclusion and Future Scope

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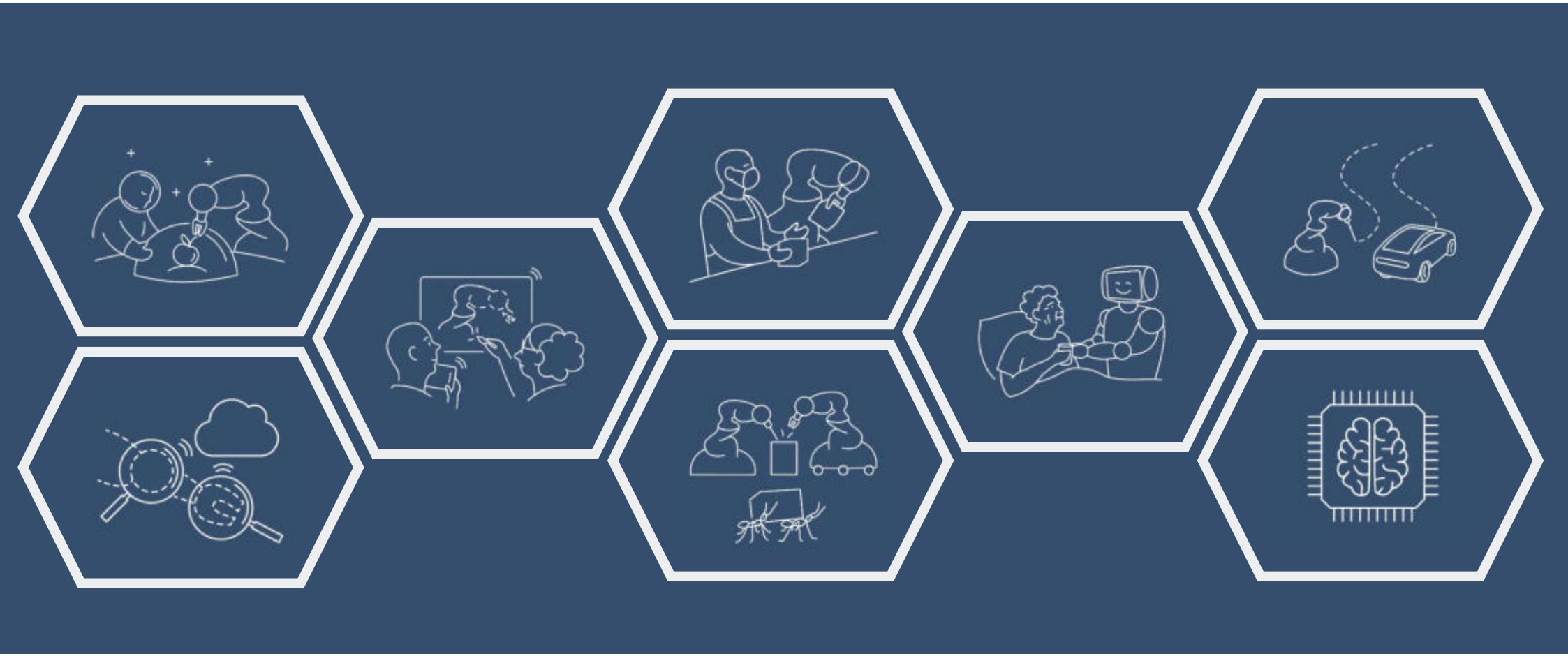
Conclusion:

- Robot is not work space bound, rather flexibly adapt in various work spaces and applications.
- Can be used for a wide range of assistance systems in medical technology.
- Arduino microcontroller consumes more cycle time to detect the values from every sensor.

Future research:

- Upgrading the system with embedded systems instead of Arduino.
- Integration of the Ultrasonic/Time of Flight sensors with in the Textile based skin.
- New applications which really need the cobots with this Intelligence.



THANK YOU

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