PSP : Pick, Sort and Place Bot

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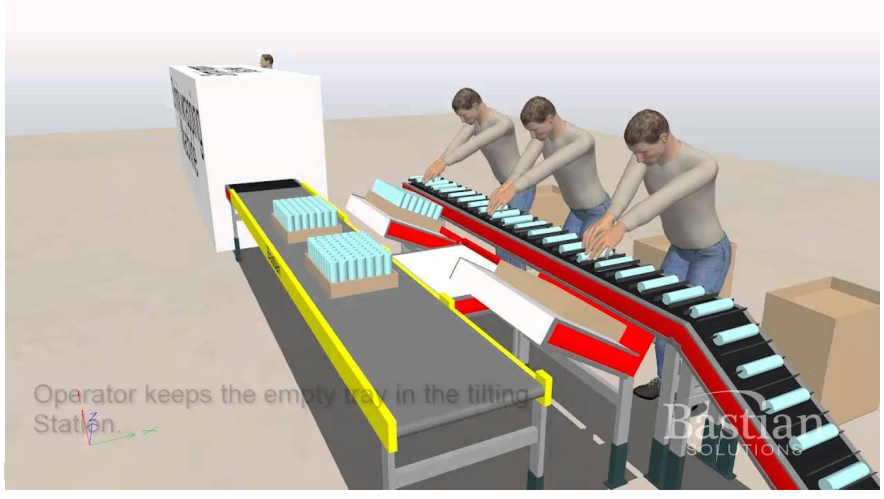
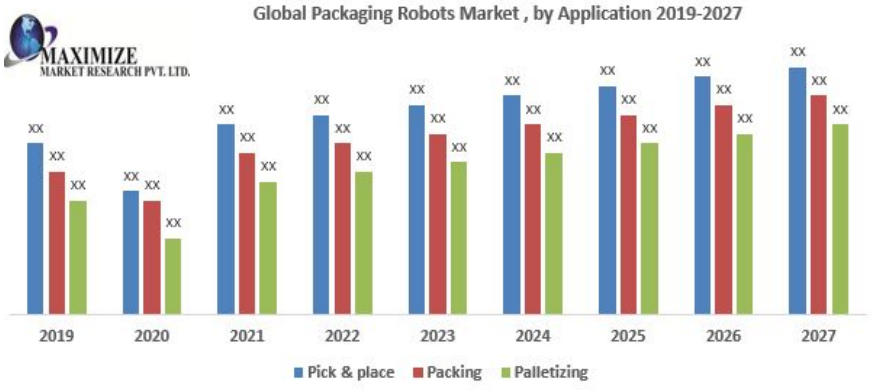
THE PROBLEM

- When dealing with items of **varied sizes**, the packaging industry is handicapped by relying on **manual labour** or a large succession of machines to handle those different items.
- Similar is the case with items to be packed and shipped for a certain **locality or location**.
- The first being too **inefficient** and the latter being too **capital intensive**, for midsize companies, both are a resource problem.

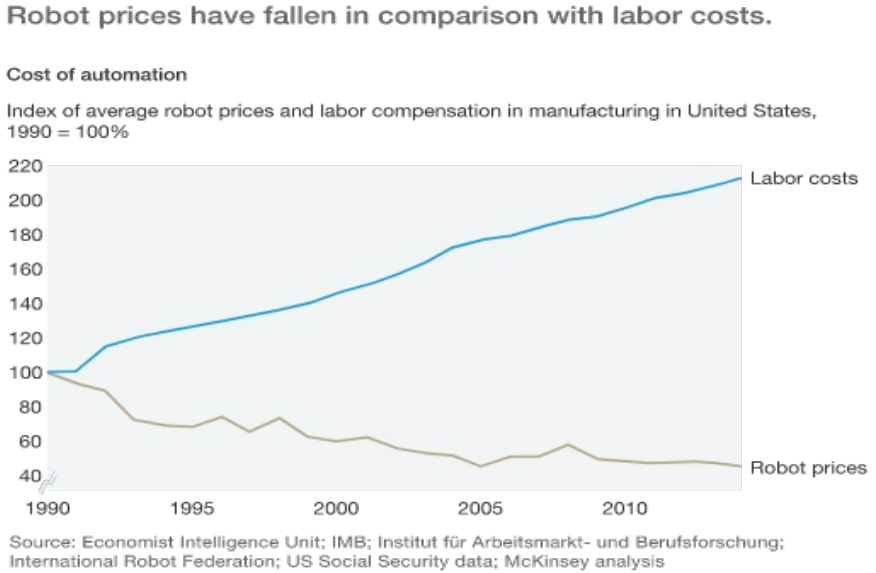


STATISTICS

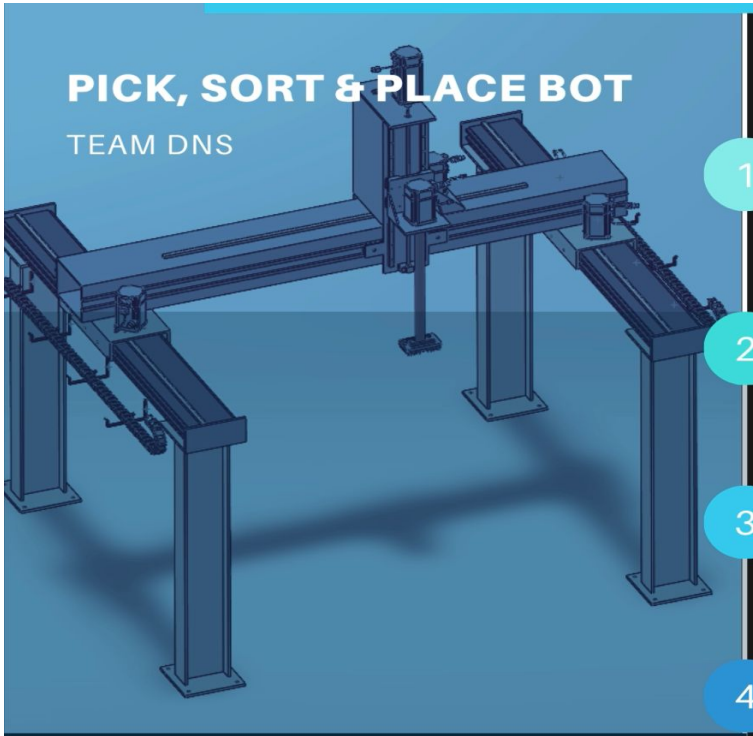
The global Packaging Robots Market was valued US$ 2.53 Bn in 2019 and is expected to reach US$ 6.40 Bn by 2027, at a CAGR of 14.18 % during a forecast period.



The price of **Labor has increased exponentially** while the **price of robots has dropped significantly**. For the field of custom packaging, which is still heavily dependent on the human resource, this is a money pit.

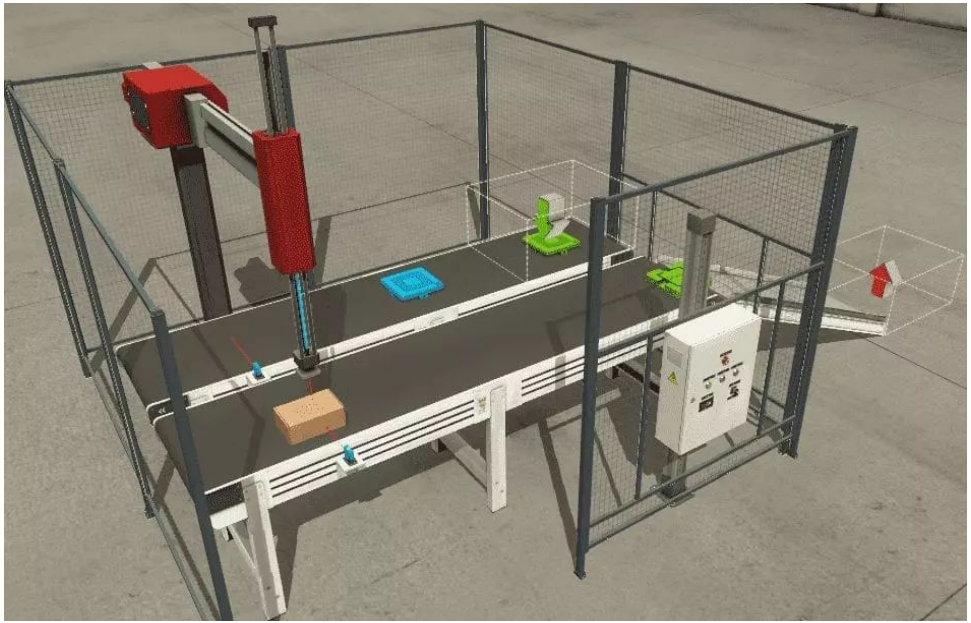


OUR TIMELINE



1. Ideate
2. Proposal
3. Design Modelling
4. Automation Equipment Selection
5. Model Refinement
6. Algorithm Design
7. Got industry Feedback
8. Manufacture

BASE VISUALIZATION

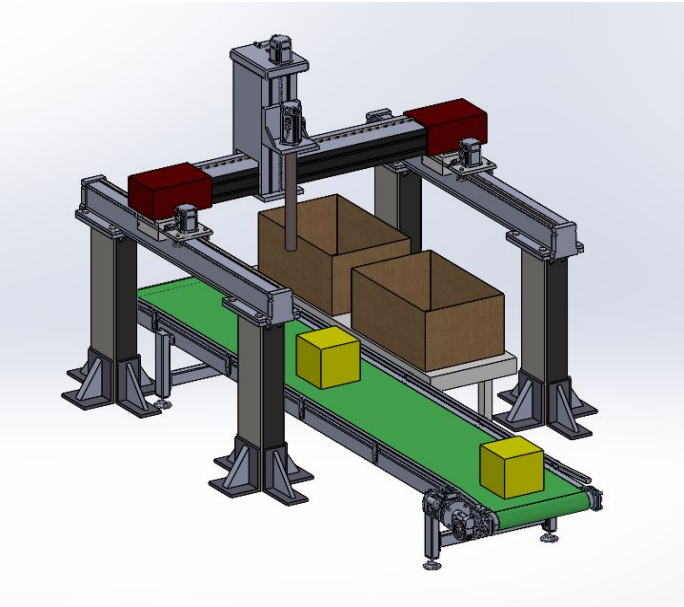


BOT Assembly

Electrical Panel

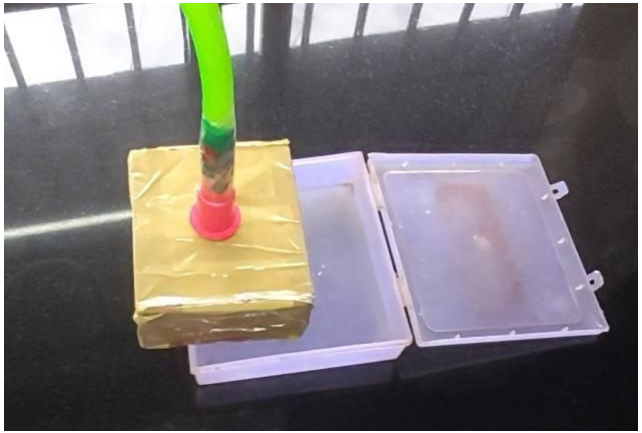
OUR SOLUTION

1. Our solution is to provide a **scalable, economical** pick and place bot.
2. It is a **XYZ Gantry** based design which maps and places an object in 3 dimension plane
3. **Variable sized input items** will be coming on a **conveyor**

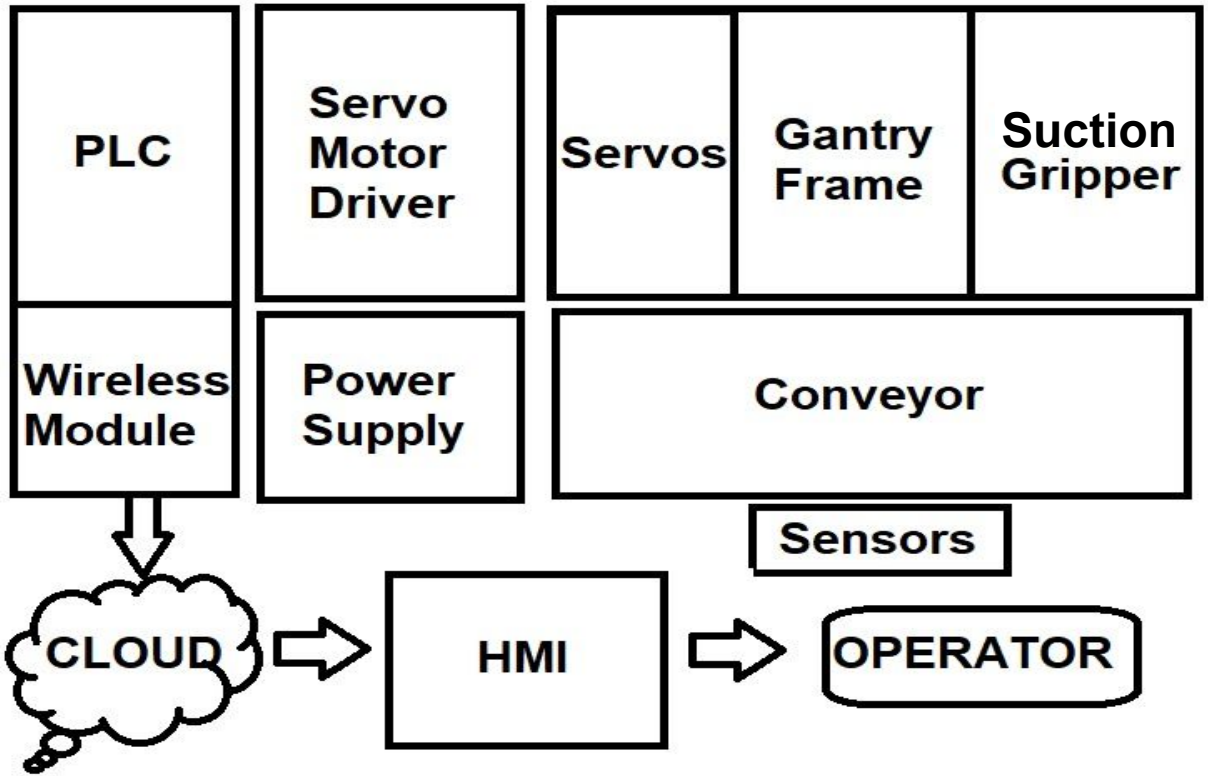


OUR SOLUTION

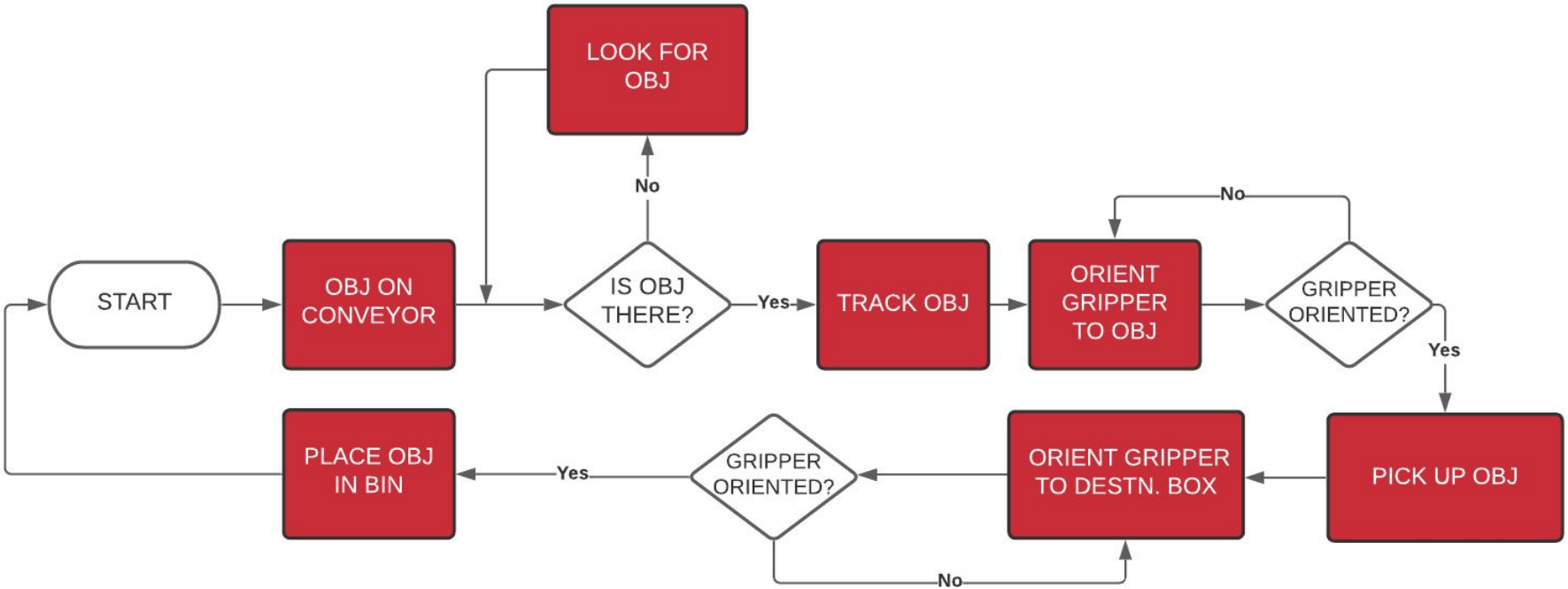
4. These items will be scanned and the **orientation, co-ordinates, shape and dimensions** of the input boxes will be emulated by image processing taken by Delta's **Machine Vision System**.
5. Then the bot will be pick and place them into **bigger output containers.**
6. The pick and place operation will be carried out using suction generated from a vacuum blower.



BLOCK DIAGRAM

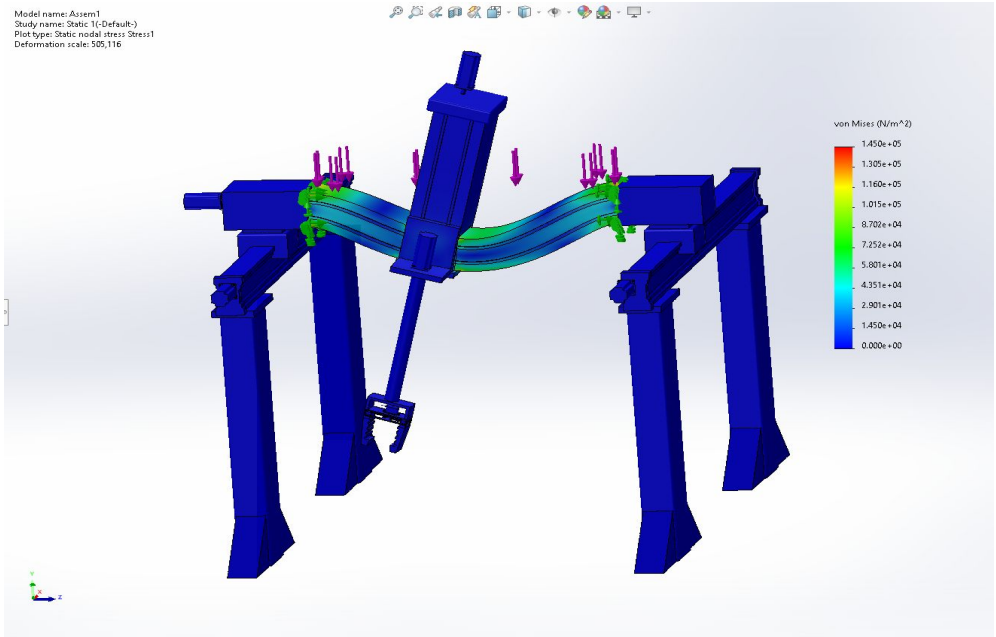


ALGORITHMIC WORKFLOW



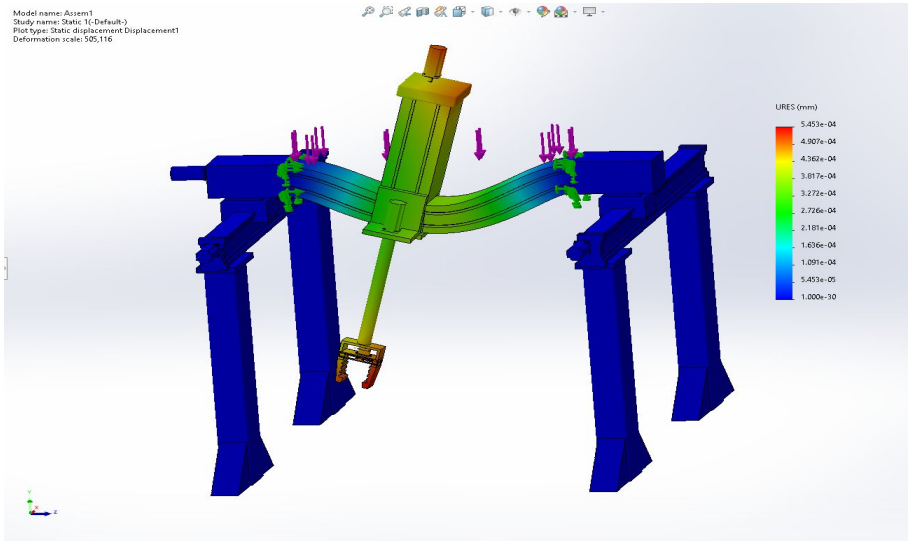
STRUCTURAL EXPERIMENTATION

- We experimented with the concept, design and materials to find the best compromise between quality and cost.
- Thereby, we were able to construct the designs in very industry friendly rates and quality.
- We talked to many vendors and performed multiple analyses during selection of the materials and designs.

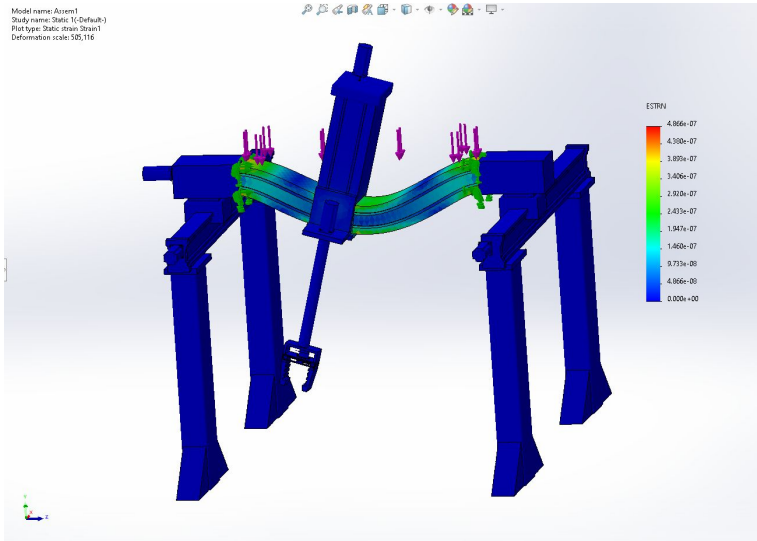


VON MISES STRESS ANALYSIS

STRUCTURAL ANALYSIS



URES DISPLACEMENT ANALYSIS



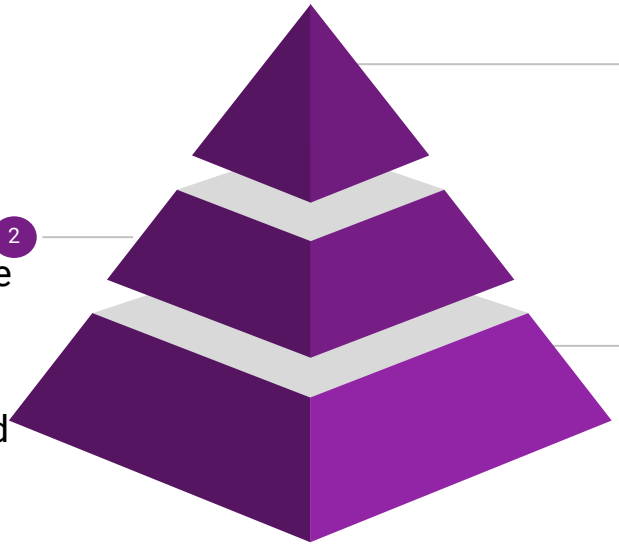
STRAIN ANALYSIS

INTEGRATION PYRAMID

Automation and Motion Components

Devices Communicate each other to realise the logic based on algorithm.

- **Motion Controller PLC**: Controls the Motion
- **HMI**: Human-Machine Interfacing
- **Machine Vision System:** Image and object detection
- **Servos and Servo Drives:** For motion in XYZ axes and for rotation
- **Lidar Sensor:** For measuring depth
- Other Sensors and devices



Algorithm

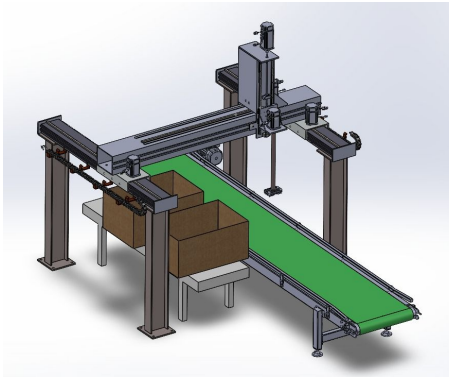
The software logic that controls the actions of the PSP BOT

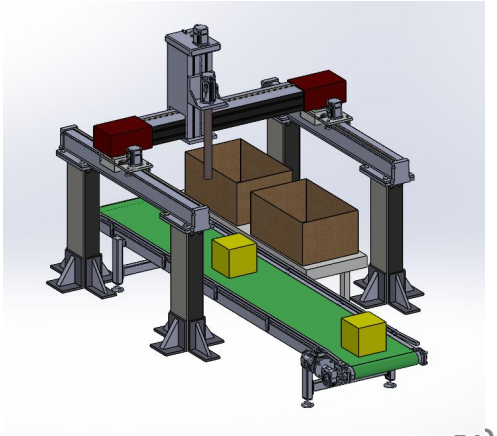
Mechanical Structure

Manipulated using the automation equipment to create productive motion and realise the goals of PSP Bot.

Gantry Frame, C channels, ...

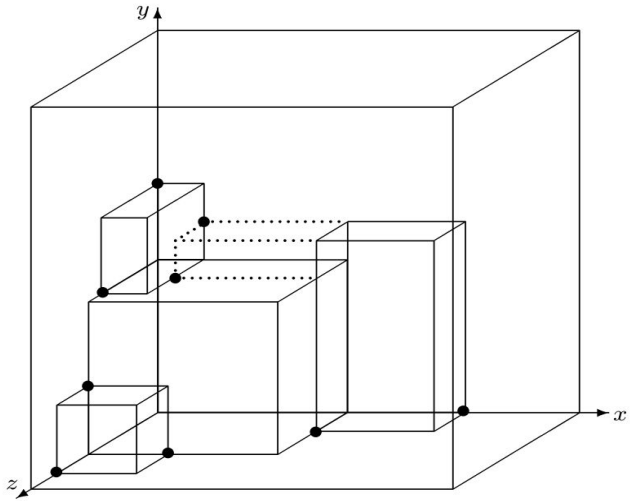
MECHANICAL STRUCTURE AND DESIGN

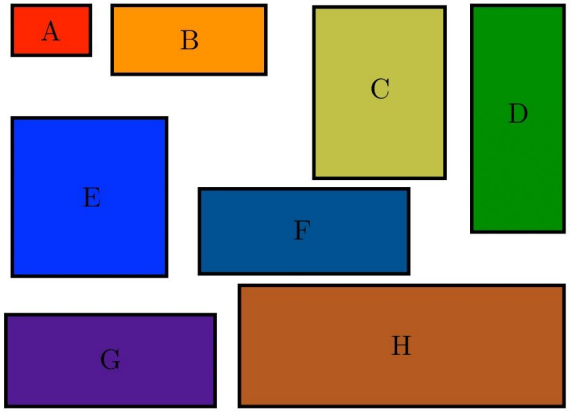


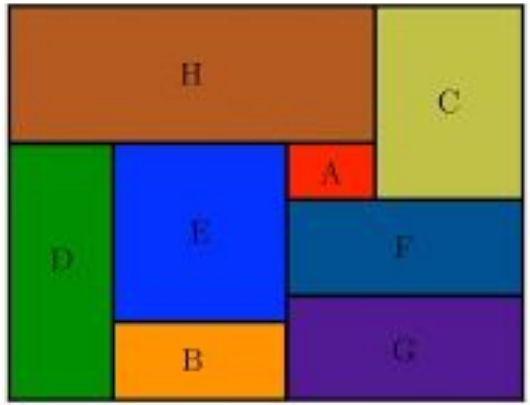


SORTING ALGORITHM

- We have tried to implement a **3D Packaging algorithm**
- It works on the principle of **efficient fit of items** in the number of available **output container or bins**
- This basically localises the items and maps it in 3-Dimension.

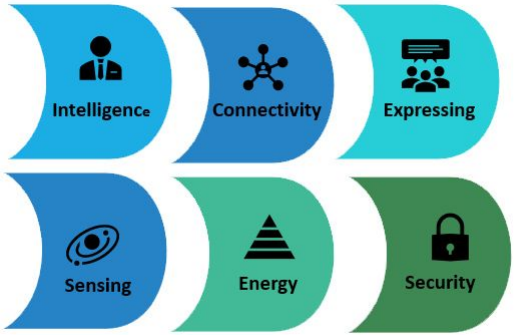






INNOVATION AND FEATURES

1. **Economical and Timely Solution**: Production cost and time consumed are relatively low as compared to ideal industry
2. **Mobility** : Can be easily disassembled and moved.
3. **Scalable** : By making minor design changes, size of the bot can be adjusted as per required application
4. **Vacuum Cleaner/ Blower based Suction** : Ensures friendly and efficient Pick and Place operation, End effector is easily changeable as per surface nature of the input items.
5. **Device Interfacing :** Easier Interfacing implemented using Delta's IIOT smart solution.
6. **Customizable End Effector :** For different input sized boxes
7. **Efficient Algorithm :** A 3D Packaging Algorithm which minimises the space wastage
8. **Conveyor:** Input Items will be coming on a conveyor, the gantry system will pick and place them into output boxes.



APPLICATIONS AND USES

1. **Multinational Supply chain Companies (**like Amazon, Flipkart, Alibaba, etc**)** : Packaging and shipping parcels and items based on common location in a single container. This includes Items of:
   - *Variable Sized Packaging*
   - *Location based Packaging*

2. **Customised Subscription Boxes** : Packaging custom products into a common container based on subscriptions made.

FUTURE SCOPE

1. Transforming Bot into a **ready, full fledged economical Industrial product**.
2. Making our algorithm more **robust and dynamic** for **different inputs and service parameters**.
3. Integrating **absolute bot control** and other device communications using **advanced IIoT** to fully **automate** the process and establish an **easier control flow**.
4. Also, integrating the current model with **Machine Learning** could definitely make it more **smart and efficient**.

Smarter. Greener. Together.

Thank You

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