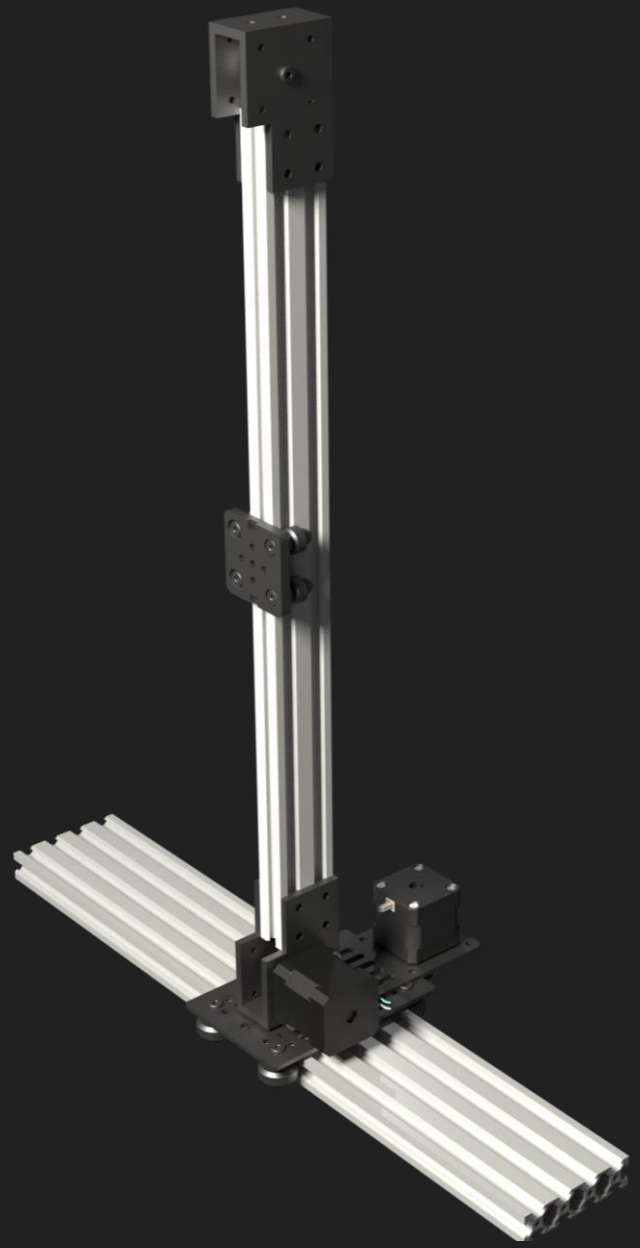
SHELFY

~ A Smart Automated Storage And Retrieval System



Team Details

- **Proposal Title**: Smart automated storage-retrieval system
- **Participated as: T**eam as Educational Institute
- **Hardware Resources Used**: SHAKTI Pinaka (E32-A35) on Artix7-35T
- **Registration Number: 8849173**
- **Contact details of SPOC:** Aditya Nirmale / 9769298001 / aditya.nirmale@learner.manipal.edu

Our Team

Name of Team Members	Email Id	Contact	Branch / Area of Specialization	Name of Institute
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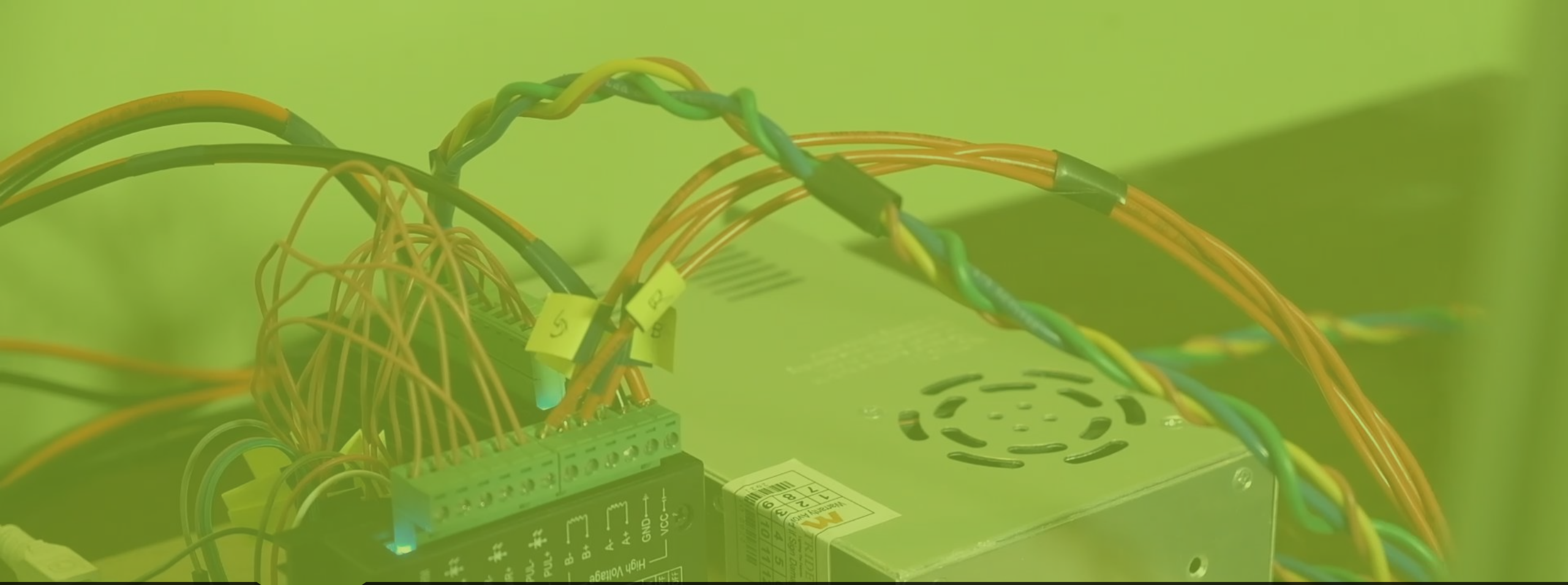
SHELFY

Shelfy aims to provide a more accessible and useful warehouse automation system that is capable of managing inventory, placing and picking objects, and being controlled remotely. The project is targeted specifically for the Indian market, where issues such as small scale of operation, non-standard stocking techniques and employee errors plague the industry.

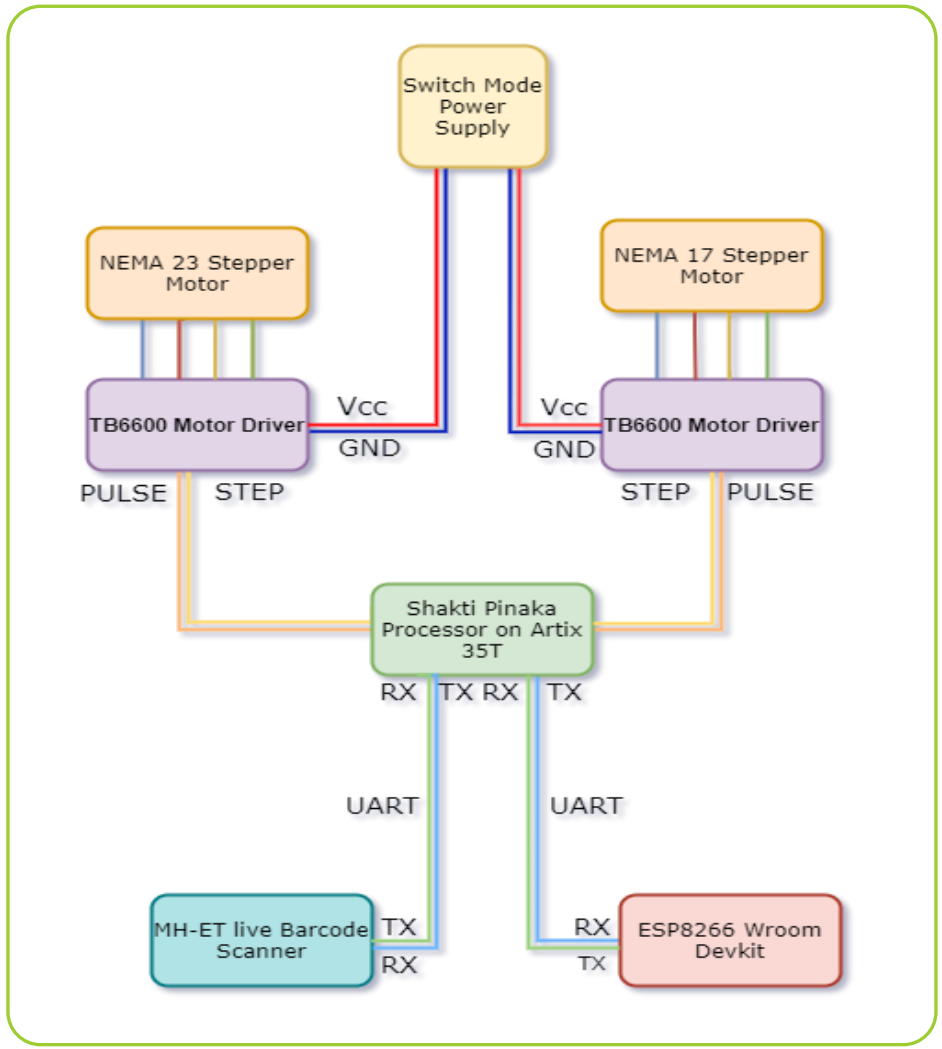
Shelfy aims to solve this by being modular ,affordable and smart while targeting the multibillion dollar warehousing industry



Technical Details

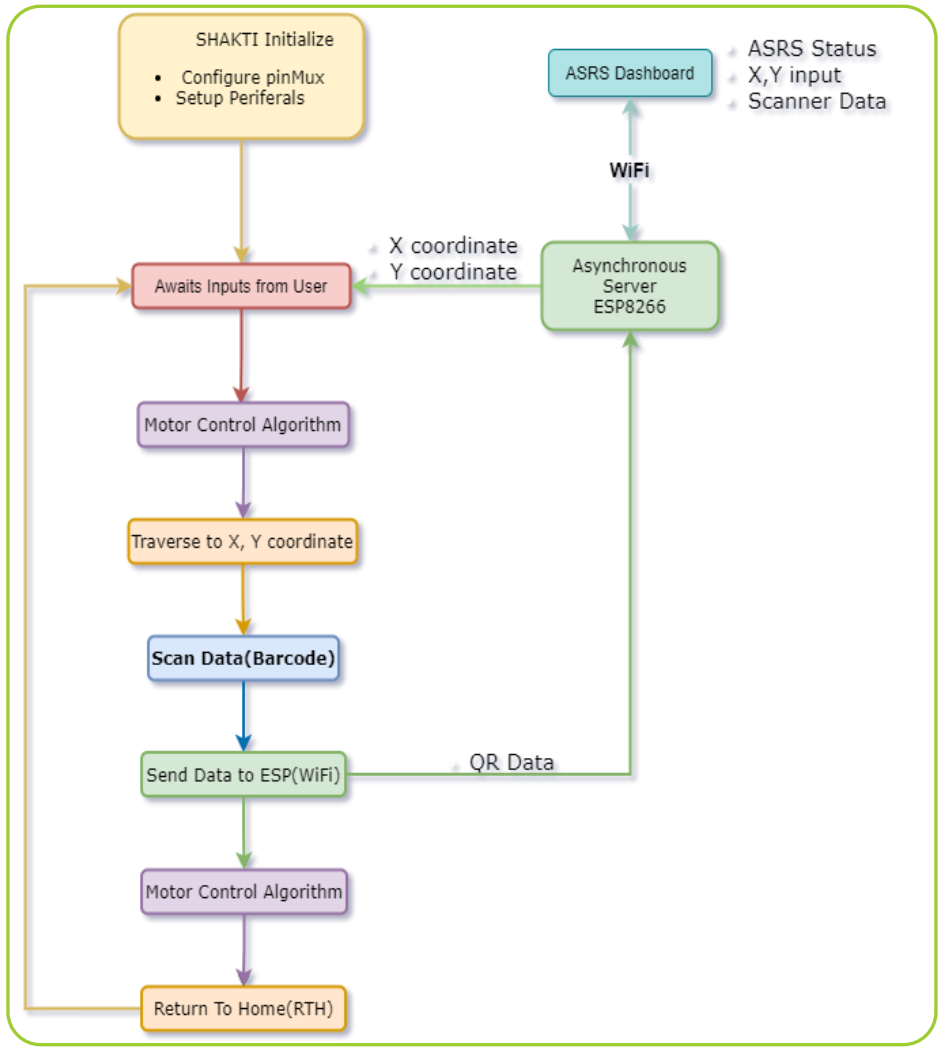
Electronics -Hardware

- Shakti Pinaka Processor on Artix 35T
  - Controls main electronics and communicates with the esp8266
- ESP8266 Wroom Devkit
  - Hosts the Asynchronous Web-Server for Low latency and easy implementation
- NEMA Motor's with TB6600 Motor Driver's
  - Both motors are actuated using 2 Gpio pins each being pulse and directions
- MH-ET live barcode scanner
  - Scanner capable of scanning QR and Barcodes and communicating via UART

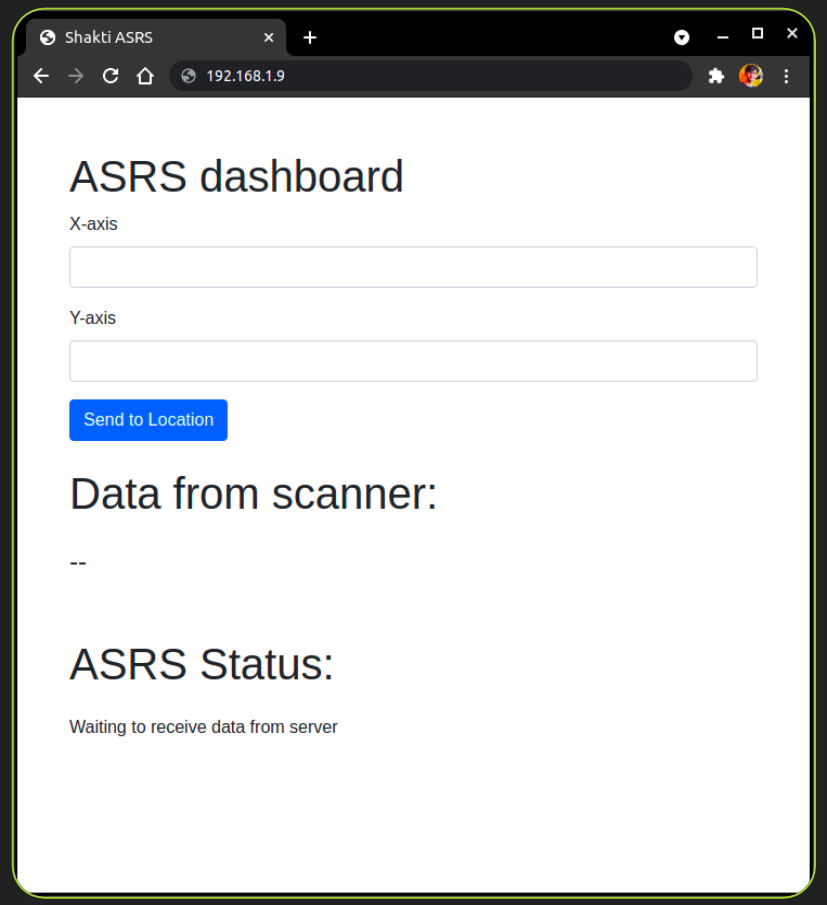


Electronics - Software

- Time.h
  - For accurate time delays using the CLINT timer
- Scanner.h
  - Functions for communicating with the scanner
- Stepper_motor.h
  - Functions for Co-ordinated control
- Shakti-SDK on platform IO
  - Easy user interface and setup
- Blog Published on the Shakti Blog
  - Tutorial on simple web interface using esp8266



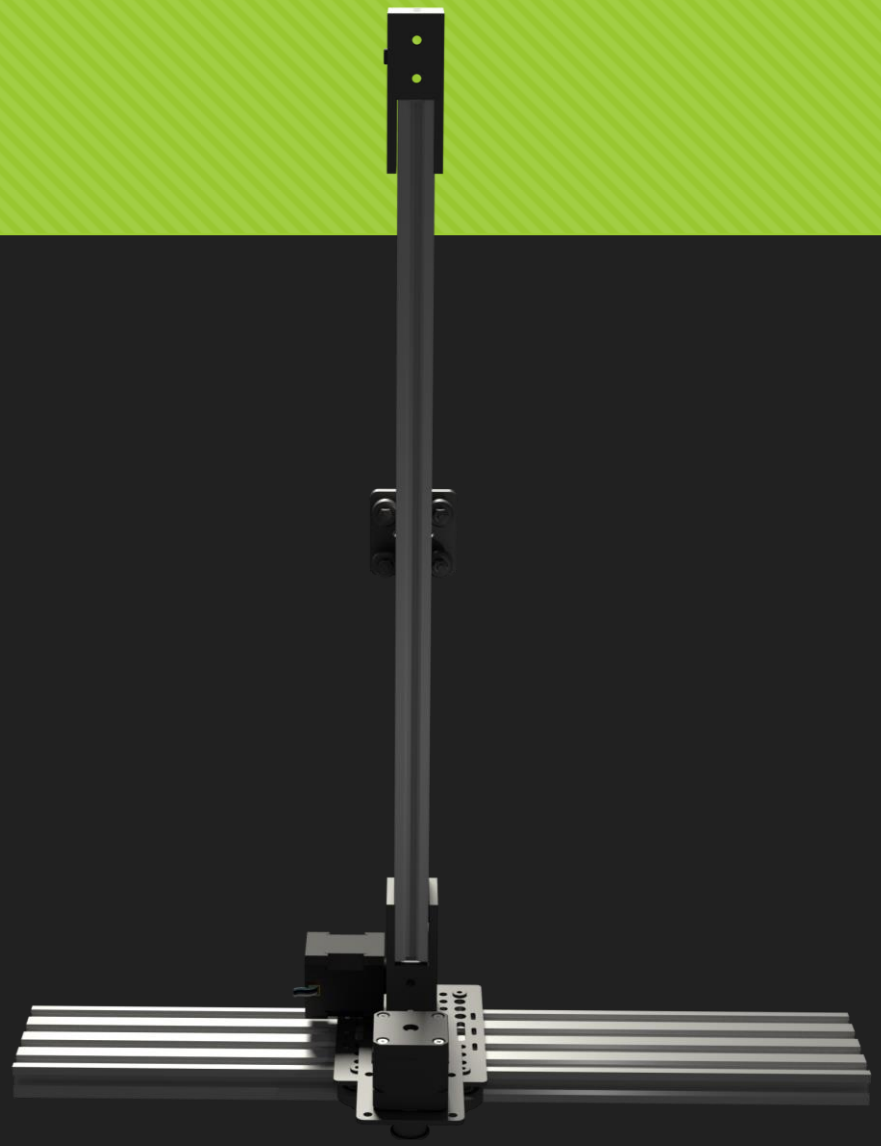
ASRS - Dashboard



- ESP8266 Wroom Devkit
  - Multiple libraries available to simplify development of web interface
- Asynchronous server hosted on esp8266
  - Quick real time updates without and software on client end
- Website Features
  - Co-ordinates input – Easy Input Interface to Control shelfy
  - Scanner data – Inventory tracking and prevention of false storage and retrievals
  - Shelfy Staus - For remote monitoring of system

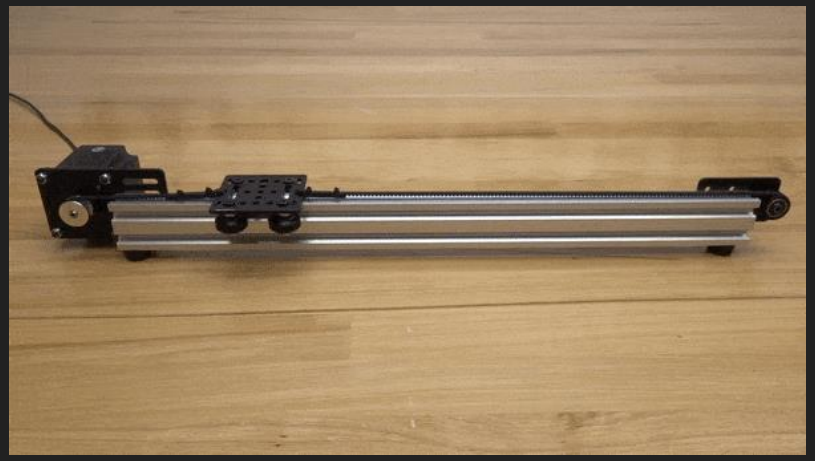
Mechanical

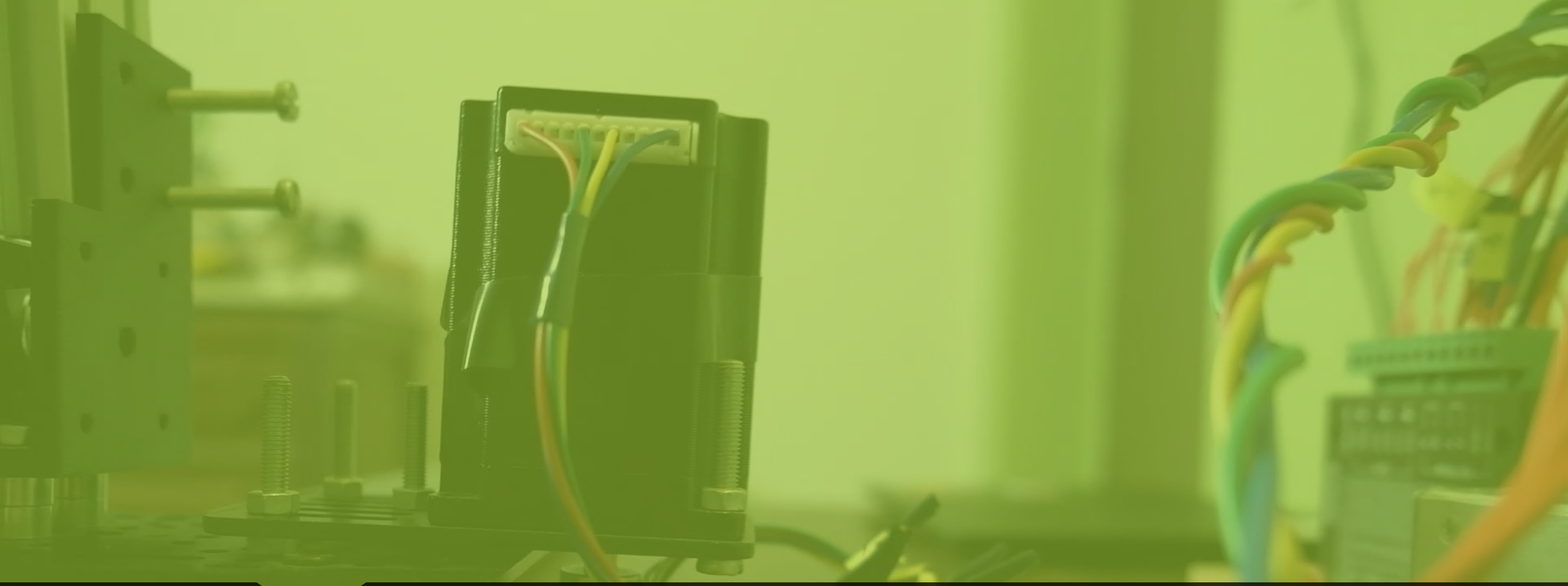
- The Core concept of shelfy revolves around a Plotting Mechanism to cover the entire shelf with ease
- The design is based on belt drive along the vertical axis in sync with a belt & pinion arrangement along the horizontal axis
- Belt based systems are
  - Easily scalable and adaptable
  - Lower cost of Repair and maintenance
  - Reduced wear and tare
  - Cheaper to implement



Axes Mechanism

- Horizontal-Axis -Belt and Pinion
  - 2060 V-slot Aluminum Extrusions
  - GT-2 Timing Belt and pulley
  - NEMA-23 Stepper Motor
  - Gantry Plate mounted with Free V wheels
- Vertical Axis - Belt Drive
  - 2040 V-slot Aluminum Extrusions
  - GT-2 Timing belt and Pulley
  - Idler Pulley
  - NEMA-17 Stepper Motor
  - Gantry Plate mounted with Free V wheels
  - Custom 3D printed L-bracket to join two Axes





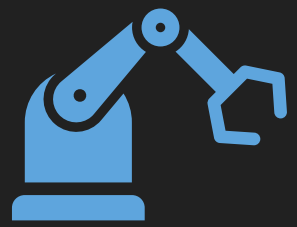
Deliverables During Competition

Deliverables at Semifinals Stage

- Real-time tracking and Inventory management with the help of Barcode Scanner

- Business Model and Commercialization for Final product
  - For quick deployment of product on completion of development

- Mechanical Prototype of Shelfy with dual axis movement capabilities



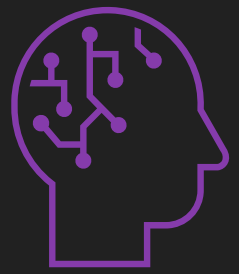
- Storage and retrieval mechanism for light weight cargo
  - Simple Tray mechanism with palletes to support a wide variety of cargo

- Robust control for accelerated and Co-ordinated motion for X and Y axis

- Server and Communication interface with Database Management
  - Option to specify the coordinates for storage and retrieval capabilities based on inventory
  - Creation of a small database of current inventory and accessible through the Shelfy dashboard

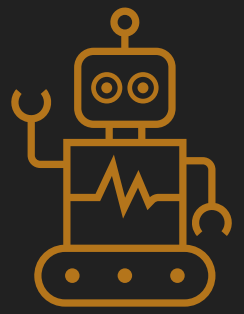
Deliverables At End of Challenge

- Central server-based monitoring station with User-friendly server interface



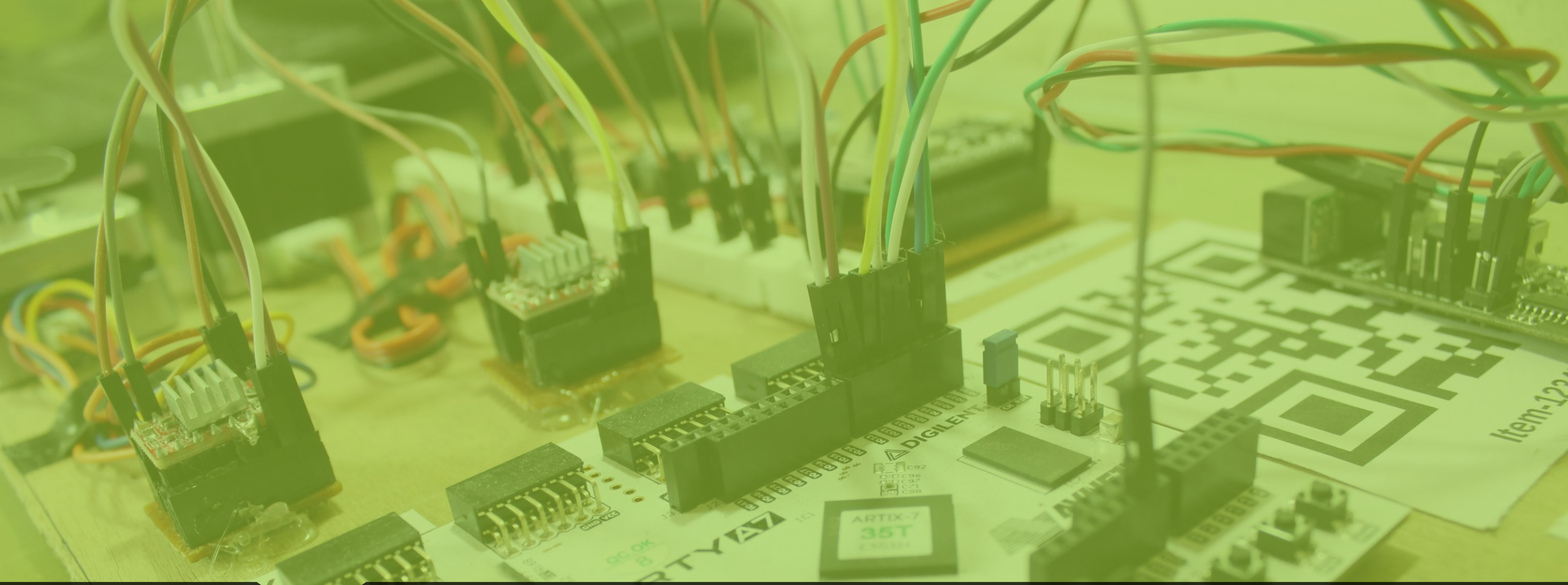
- Fully automated and true scale storage and retrieval system
  - Scalable and Modular Ready to be deployed in existing warehouses
  - High precision movement
  - Payloads up to 50 kg

- Improved Shelfy Dashboard for custom, productive and efficient operating warehouse



- Integration with other robotic technologies such as wheeled robots, drones, autonomous conveyer belts and robotic arms

- Automated data processing and AI based algorithms



Current Progress

Development completed

- Interface of Barcode scanner
- Setup of Shakti SDK with development of basic libraries and implementation of basic peripherals
- Mechanical Prototype with functional Horizontal and vertical motion
- Simple and primitive webserver interfaced with Shakti processor
- Co-ordinated control algorithms for motors
- Anonymous survey to Identify market potential

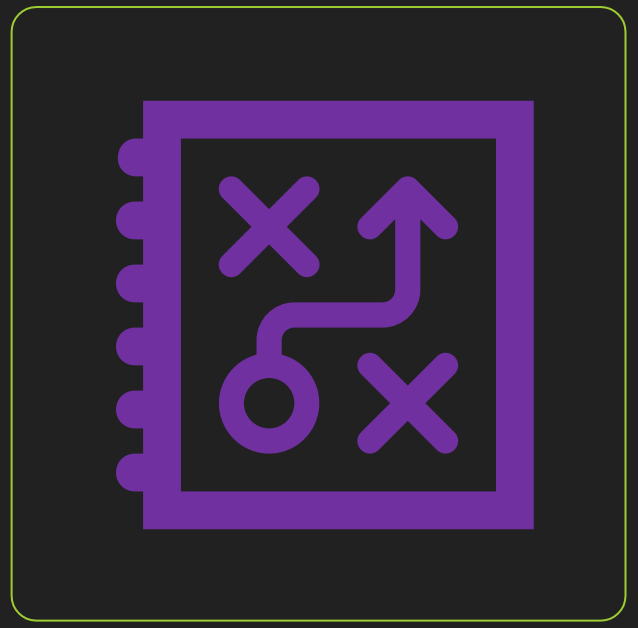
Targets for before Semifinal Submission

- Optimized business model
- Storage and retrieval mechanism
- Accelerated motion for stepper motors
- Improved Shelfy dashboard

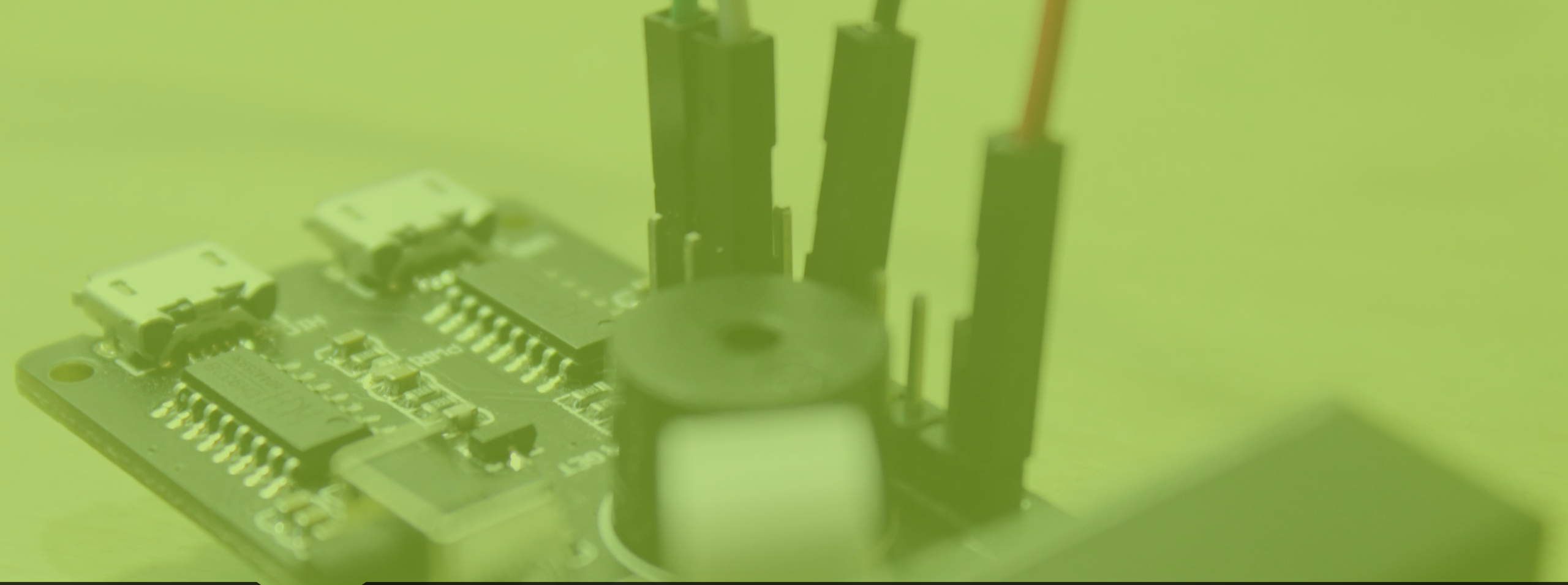
Challenges faced

- Initial esp8266 module was difficult to interface due to unavailability of libraries
- Due to unavailability of some parts in India, some crucial mechanical components had to be 3D printed and redesigned after a performance review.
- High torque stepper motors generate vibration and required a very secure and undisturbed platform for the mechanism to work perfectly
- Team split across 4 cities hence making complete integration a challenge

Deviation In mechanical design



- The earlier design that was proposed was a rack and pinion arrangement in sync with a lead screw mechanism for the Shelfy
- The new design is based on belt drive in sync with a belt &pinion arrangement
  - Design relied heavily on custom 3D printed accessories and how their performance
  - Lead Screw has high friction between threads leading to faster wear and tear and thus low efficiency
  - The new proposed is easily scalable and adaptable all being available at a much lower cost
  - The new design is easier to maintain and repair



Novelty And USP

Comparison to existing solutions in market

Cost Effective and affordable

Extensive Data Analysis

Highly Modular System

Smart Algorithms

IOT Capable

Novelty of Shelfy

Adaptable and Modular

- No redesign required
- Independent Operability

Customisable and Secure

- Custom Routines
- Automated Ordering
- No unauthorized access
- Speedy operation with reduced product damage

User Friendly

- Instant inventory updates
- One-click retrievals
- Simple GUI Integration with existing IoT
- Remote Access

ML/AI based Data Analysis

- Automated generation of storage maps
- Priority based storage and retrievals

Novelty Demonstrated at Semifinal Stage

Modular Design

Online database Software

Priority based retrieval

Efficient Tracking Using Barcodes

Business Viability

Market survey

- 46 Participants
  - Warehousing service providers
  - Factory and Production Storage
  - Distribution Centers
  - 27out 46 expressed need for an automation solution
- Main issues for not automating
  1. High Initial Cost
  2. Redesign of warehouse
  3. Downtime for automation

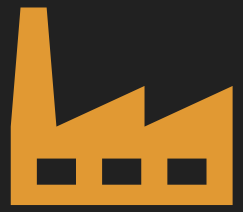
Warehouse size : *50,000 square feet*
Problems faced : *Cutoff analysis inventory count*
Interested Features : *Faster Storage and Retrievals, health monitoring. Inventory Optimization and stock prediction*
Proposed Budget : *2 Crores*

~Rajnikant Surve,
VP Operation, Hikvision

Warehouse size : *20,000 square feet*
Problems faced : *Speed of picking*
Interested Features : *Faster Storage and Retrievals, Instant Inventory Updates, Optimized Storage*
Proposed Budget : *50 Lakhs*

~Sanjay Agrawal
Director SC Alstom Transport

Potential Market



Addressable Market

Small Warehouses

Unorganised Sector

Cost conscious organisations

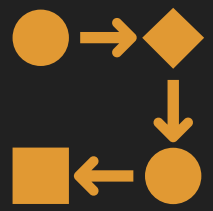
Interest from Customers

4 customers intent on investing in proposed solution

27 customers interested if promised results are reflected

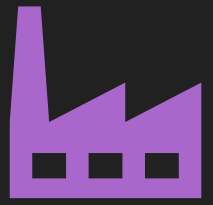
Potential Investments of ₹50L to ₹1Cr

Commercialization Plan



Business Model

Go To Market Strategy



Production Plan

Business model

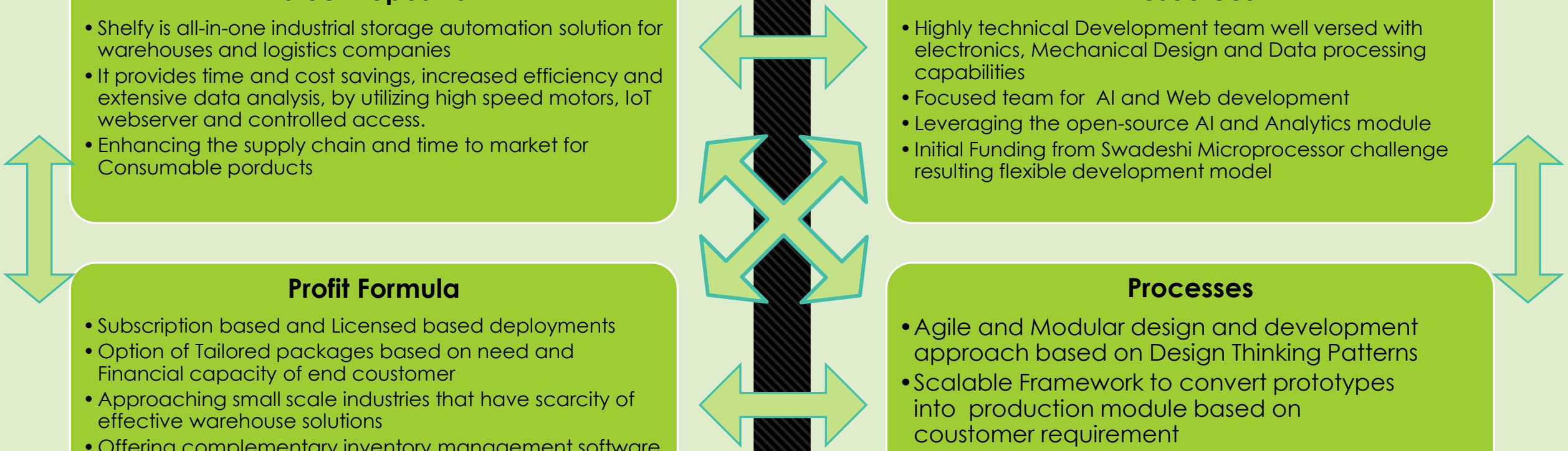
Priorities

Value Proposition

- Shelfy is all-in-one industrial storage automation solution for warehouses and logistics companies
- It provides time and cost savings, increased efficiency and extensive data analysis, by utilizing high speed motors, IoT webserver and controlled access.
- Enhancing the supply chain and time to market for Consumable porducts

Profit Formula

- Subscription based and Licensed based deployments
- Option of Tailored packages based on need and Financial capacity of end coustomer
- Approaching small scale industries that have scarcity of effective warehouse solutions
- Offering complementary inventory management software and chargeable regular OTA after sales updates



Capabilities

Resources

- Highly technical Development team well versed with electronics, Mechanical Design and Data processing capabilities
- Focused team for AI and Web development
- Leveraging the open-source AI and Analytics module
- Initial Funding from Swadeshi Microprocessor challenge resulting flexible development model

Processes

- Agile and Modular design and development approach based on Design Thinking Patterns
- Scalable Framework to convert prototypes into production module based on coustomer requirement

Go To Market Strategy

Distribution Channels

- Direct B2B sales
- 3rd Party Warehouse service providers

Strategic Partnerships/Channels

- Tie ups with Govt SME schemes – Subsidised pricing
- Collaborations with logistics companies like Mahindra Logistics LTD, Gati LTD etc.

Marketing

- Warehousing Expos and Exhibitions
- B2B segment marketing via tenders, cold emails and calling

Promotions

- Extended After Sales support with regular OTA updates
- Installment payment options to provide relief for COVID-19 affected businesses
- Flexible Installation scheme

Production Plan

In-house Mechanical System Design

- Robust
- Adaptable
- Scalable

In-house Software Development

- Full-Scale web server
- Management software
- IoT integration tools

Finished Product

- Demo version
- Sales Product

Sourcing and Manufacturing

- Tie ups with metal manufacturing and fabrication companies
- On site assembly

After Sales Support

- Basic Complementry Inventory Management software
- Nominal Charges for Regular OTA updates with advanced features
- Initially Service and Parts would be provided company
- Plans to tie up with 3rd Party Vendors and Service agents

THANK YOU