



Space Saving Furniture



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॥ सिद्धः भूयते विद्याम् ॥

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Abstract

Space-Saving furniture spaces are designed in order to satisfy different demands at less area. Also, in contemporary era, inner city congestion is an increased problem, and the preference of Space-Saving furniture spaces is an ideal approach in order to improve the situation.

Space-Saving furniture space/Space-Saving furniture forming space ,the chosen topic defines in this case is multipurpose usage of a particular area with different forms of Space-Saving furniture used ,to justify or help the given area to achieve the purpose of ease and satisfy the demands required to be fulfilled.

Large spaces have become a thing of the past as more and more people opt for the city-dwelling lifestyle. With the rise of small-space living, compact furnishings are sitting on the forefront of home decor. The economic recession and ensuing credit crunch caused consumers to increasingly look for products that offer more for less. Designers of space-saving furniture found success within this environment, as these innovations appealed to homeowners and apartment-dwellers alike. Companies can take advantage of this opportunity by strategically designing Space-Saving furniture consumer products with a small form factor.

This type of Space-Saving furniture use is probably been introduced in India but has not been in consideration to use in our day to day life. In place like Mumbai, ` where u get the job easily than a place to stay". This statement has been used many times and its somewhat true ... Mumbai has been overpopulated for quite a time now the reason is being the financial capital of India many people immigrates from other states towards Mumbai for their career or education and to get a good job, & now the state is that people have small spaces even if they find space to live in and the rates are at boom. In such a situation they can't have bigger space in their budget according to their needs. So there we need a solution for all of these problems.

The parallel trend has been environmental sensitivity to where almost all products these days are either "green" or "organic". Even before the recession, the construction industry was moving toward green building practices as the benefits of sustainable design were too sensible to ignore. Most do not argue the merits of energy efficient buildings, nor low maintenance materials, and as more studies prove the health benefits of increased indoor air quality and daylight, the decision to go green makes good investment sense.

This convergence of fundamentals has generated the perfect situation to reset our building ideals to meet future needs. Already, the real estate investment community has embraced the benefits of green buildings. But what remains questionable is whether they have learned from recent past and adjusted for new trends and generational ideals for living space. Is it not time to stop building large, and start building smart?

The commercial office market has undergone a major shift in the past couple of decades to where open office plans with flexible space has become the norm and not the unique. Our residential designs have been slow to adopt open plan homes with multi-functional uses. Now may be the time to look at typical living spaces with open plans where space could be more flexible and better utilized resulting in smaller, but more efficient plans. More housing magazines are promoting these types of living spaces framed as a casual lifestyle, but one that is really pragmatic and allows for varied lifestyles.

Space-Saving furniture furniture is evolved greatly in foreign countries like China, America, etc but mostly in china because most of their spaces are too small to live in. but mostly in India there are only few stores that actually even sells this kind of furniture and few who bases their whole house into Space-Saving furniture environment so the basic purpose of this study is to enlighten the topic which is old but sounds new and their pros.

| Problem Background



WHY FREE SPACE
MATTERS

- **1**

Small apartments are a result of the ongoing growing population and the urban housing development. The marketing prices and the increasing urbanization forces people into less space. The human needs are still the same.
- 2**

Several articles are underlining and discussing the health risk of this housing development. Both a crowding and claustrophobically feeling is proven.
- **3**

Multifunctional furniture as a flexible method can increase space sustainability and improve the quality of living by serving several functions at once.
- 4**

But still Multifunctional furniture's could only solve flexibility problem, it still can't address the problem of space sustainability. For this we need flexible furniture which could act programmatically and balance spaces in terms of beauty and efficiency.

❖ **Domain Selection:**

Space saving furniture.

❖ **Title:**

LCOVE Space Saving Furniture

❖ **Identified Problem:**

The current problem deals with manual surpluses of converting the space saving furniture from one form to the another, manual working is the slumpiest process which makes the human effort to least accept it rather than the automatic and smarter one.

❖ **Problem Research:**

Primary Research:

Reading books and articles also gone through the research articles.

Below is the research work, which tells about the existing solutions and current challenges faced and the future of space saving furniture.

[Research Paper-1](#) | [Research Paper-2](#) | [Research Paper-3](#) | [Research Paper-4](#)

Secondary Research:

Asking people about the space saving furniture, usage and taking feedback for the same, getting inputs from the industry expert and understanding their requirement.

User's Need- Constraints and Challenges:

• **Needs:**

1. Furniture frame size – (**queen size**) 5ft x 6 5ft.
2. Basic material assumed - MS 2x1 pipe + MS 1x1 pipe.
3. Design of the basic MS frame – **rectangular**.

Lifting column mechanism -

1. Option 1- **Scissor Lift** with electric linear actuator .
2. Option 2 - **Electric hoist machine.**
4. Weight capacity along with all peripherals - **250kgs** (approx.).
5. Guiding Rails - Parallel guide rails on the sides with wheel support.
6. Wooden panelling on the top for beautification.

Target Price –

12,000 excluding wooden panelling.

- **Challenges:**

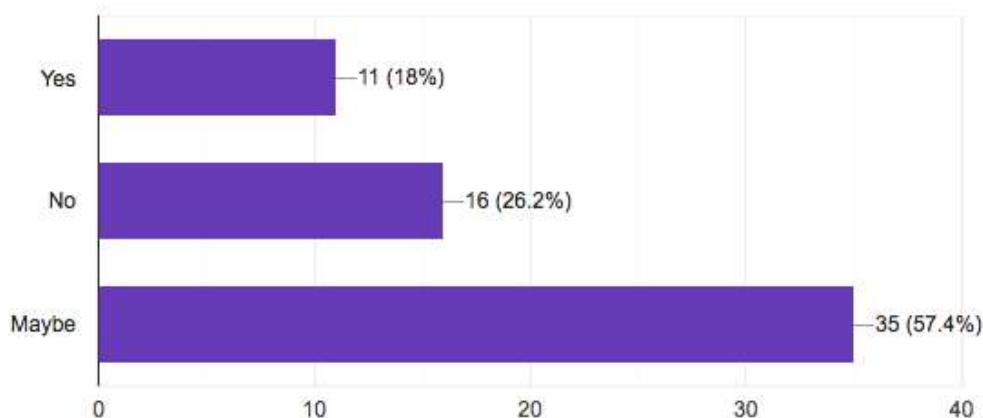


1. Manual adjustments needed to be done for furniture transformations.
2. Mechanical jam or failure leads to malfunction of the whole system.
3. No cost-effective solutions till date.
4. No child safety feature or intelligent safety lock for the mechanism proposed till date.
5. Lack of smart/IoT devices attachment for smart electronic moves.

Statistics:

Do you think renting furniture is economically feasible than buying furniture?

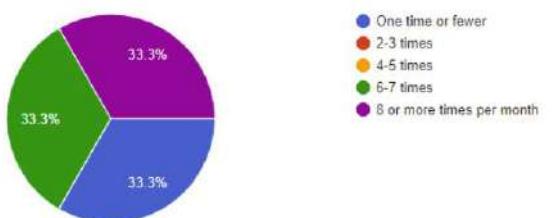
61 responses



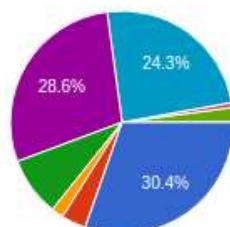
This furniture depicts the need of the space saving furniture by the customer needs whether they prefer to buy it or not.



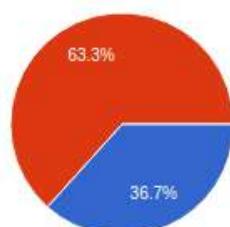
How many times you feel the need of multifunctional furniture?



What features of sensors, voice assistant (Alexa, Siri, Assistant) would you likely to enable in the solution?



Do you prefer space saving furniture?



❖ Origin of the research work:

We have been sent for an industrial visit to one of the furniture factories in Indore we saw space saving furniture's, we captured concern for the need of an optimal space saving furniture as most cities face problems with continuous population growth, while human needs increases at the same pitch. Urbanization growth and marketing prices force citizens into less space. These problems lead to the congested appearance of small houses and flats, resulting many apartments fail to provide spaces with quality and comfort. Thus, we decided to build something which could address this issue and enhance in the existing solutions.



Problem addressal and discussion with the owner.



Working of machines in creating wooden planks.

❖ Defining the problem: -

After going step by step procedure from understanding the user's need to key learnings from the research papers, articles and our own understanding about this domain we came upon the conclusion of what actually the problem is which is likely to be as –

"Human in today's world likely to automate the things or make them simpler rather giving a manual effort so, problem is space saving furniture exists but not with automated or smarter solutions with challenges as discussed above."

❖ Objectives, Project need and Scope: -

Objectives:

1. To make the furniture move/convert in space electronically.
2. To create a convenient UI for the space saving furniture.
3. To enhance the safety features of furniture safer and smarter.

Why this problem matters/ need of this project:

1. Small apartments are a result of the on-going growing population and the urban housing development. The marketing prices and the increasing urbanization forces people into less space. The human needs are still the same. How does the lack of space affect the people living there? Both a crowding and claustrophobically feeling is proven.



2. Flexibility in housing is designed to improve the quality of life in interior architecture. Since furniture is a duty and a luxury, everyone needs it. Furniture occupies a lot of space and causes a lot of irregularity and wasted spaces.
3. Multifunctional furniture as a flexible method can increase space sustainability and improve the quality of living by serving several functions at once.
4. Need of flexible furniture which could act programmatically and balance spaces in terms of beauty and efficiency.

Scope of the project:

1. Building a space saving furniture with the help of certain mechanisms and reducing manual efforts by enabling the electronic means of conduct.



2. Enhancing UI for the furniture ensuring better user experience from existing ones.
3. Interconvertible furniture from one form to space saving in forms of ceilings/walls by the electronics medium done programmatically.

4. Enhanced safety feature, detects its obstacle and transform the furniture accordingly.
5. Beautification of the structure using wooden paneling or other creative means.

❖ **Problem Statement:** -



Building an economical space saving furniture which conceals on the ceiling of the room programmatically by means of advance electronic system.

❖ **Literature Survey:** -

<http://www.custommade.com/blog/multifunctional-furniture>

<http://www.rnrassociates.com/wordpress/multifunctional-furniture>

<http://www.stylepark.com/en/news/the-small-world-of-multi-functional-furniture/327374>

<http://www.designbuzz.com/10-multifunctional-furniture-designs-add-extra-space-dwelling/>

<http://www.entrepreneur.com/article/207306>

<http://io9.com/incredible-transforming-apartments-turn-tiny-rooms-into-1612564245>

<https://anammanzo.wordpress.com/2011/02/08/folding-space-kinetic-architecture/>

<http://www.strategiesonline.net/multifunctional-furniture-design/>

Book references

Peaceful Spaces: Transform Your Home Into a Haven of Calm and Tranquility By **Alice Whatley**

Making the Most of Small Spaces and Making More of Small Spaces By **Stephen Crafti**

Christopher Lowell's Seven Layers of Organization: Unclutter Your Home, Unclutter Your Life By **Christopher Lowell**

Small Spaces: Good IdeasBy **Cristina Paredes**

Small Spaces for Modern Living: Making the Most of Your Indoor Space By **Caroline Atkins**

❖ Previous Findings: -

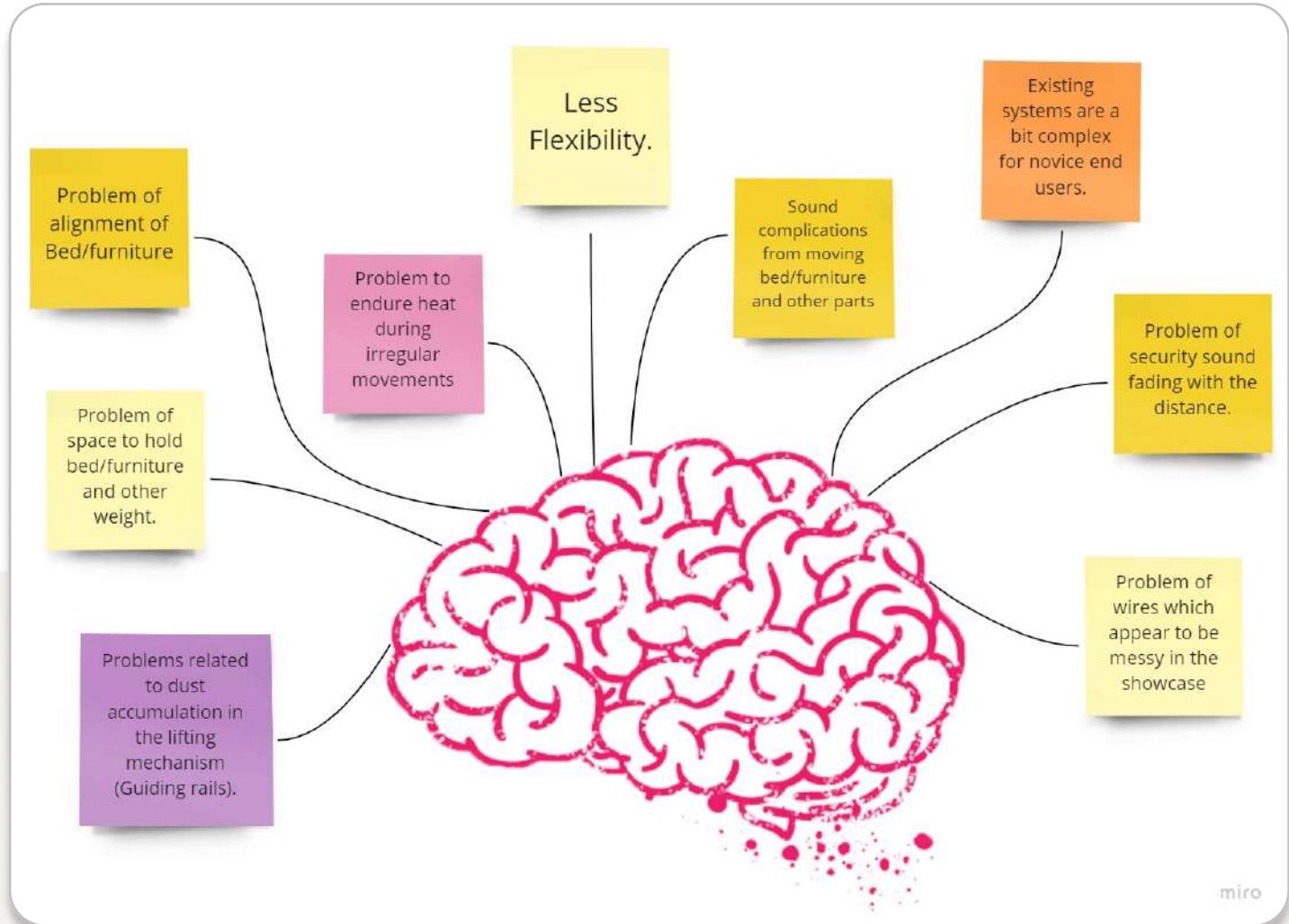
In history rarely meet with space saving furniture, in the form in which it is found nowadays. This is mainly due to the development of technologies and materials, which in the past were not known. And also today we have completely different criteria and requirements on how the furniture should look like and what features should be. I tried to find at least some examples of furniture, where designers were looking for a different form of portrayal than was known in some time.

An excellent example of space saving furniture is Chair of Joe Colombo from 1960. 20. of the century. This designer always took account of the flexibility of the consumer. He believed that the habits are changing, and that the Interior should change with them. This Chair can be adapted to various purposes. Various-the great pieces they can be attached to each other in different variations such as chairs, sofa, couch, etc. Joe Colombo created more of such space saving beds those fungo-mounds on a similar principle.

Another designer, who dealt with the variable furniture, is Ugo La Pietra. This Italian designer suggested a modular system for Berdonini in 1967. This is a stackable element, which creates a unique double-sided library.

IDEATION STAGE

| BRAINSTORMING

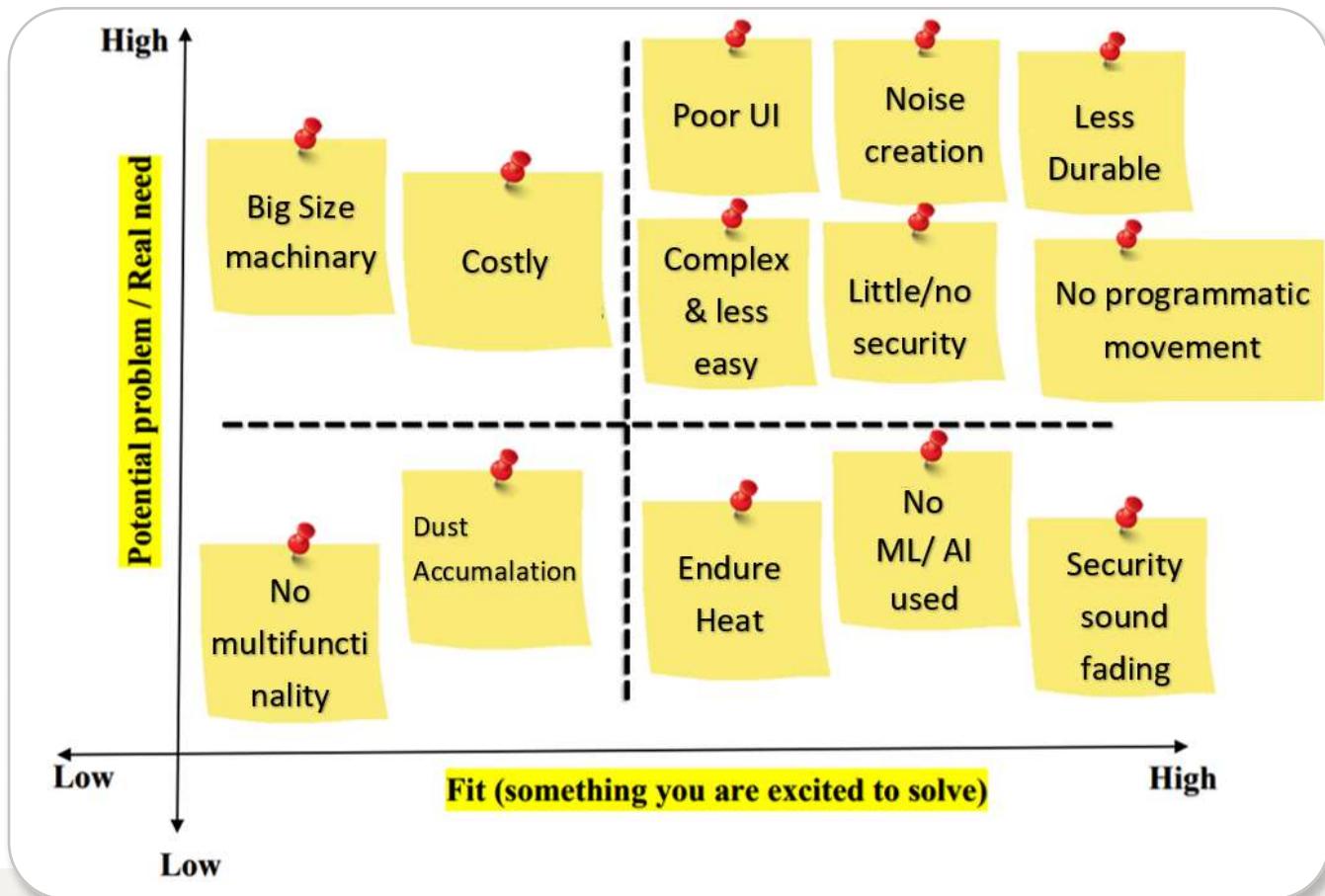


miro

USER REQUIREMENTS

- | | |
|--|--|
| <input checked="" type="checkbox"/> 1.The application should be easy to use. | <input checked="" type="checkbox"/> 7.Best and most optimal design frame. |
| <input checked="" type="checkbox"/> 2. The Furniture should be weight compatible. | <input checked="" type="checkbox"/> 8.Best option for pulling up the frame. |
| <input checked="" type="checkbox"/> 3. It should be fast and effective. | <input checked="" type="checkbox"/> 9.Structural stability and strength to ensure longer life. |
| <input checked="" type="checkbox"/> 4. It should be cost-effective. | <input checked="" type="checkbox"/> 10. Electronic features for better UI/UX. |
| <input checked="" type="checkbox"/> 5. It should identify and alert while system is ON/OFF | <input checked="" type="checkbox"/> 11. Security of operation. |
| <input checked="" type="checkbox"/> 6.Internal Machinery Size should not be too big. | <input checked="" type="checkbox"/> 12. Beautification. |

| KANO MODEL ANALYSIS



| USER PERSONA'S



Geetanjali

She is a design student and lives in Indore. Her hobbies include cooking, travelling, playing sports. She likes to explore new things and be creative.

Ideal Experience

Would like to eliminate the dust issue and sound issues related to the mechanism.

User interaction with the bed:

Likes to study on the bed every day and attend the classes. Feels very comfortable on the bed which is present in her small room.

Likes

Cushioning of bed, presence of multifunctionality, abundance of natural sunlight and ventilation.

Dislikes

Conversion into another form results noise sound which is irritating, dust accumulation in the guiding rails, space constraint when using traditional beds.

Gap in the Experience

Cleaning issue due to accumulation of dust from outside, swing has a limited motion due to restricted space, sound disturbs everyone in the house.



Shivani

She is an architecture graduate and is a freelancing architect based in Ujjain. She has previously been an interior designer.

Ideal Experience

Would love to have some storage spaces which could house some.

User interaction with the bed:

Does not use the living room much in person and does not prefer to work in the living room due to its small size.

Likes

The Bed provides an option for multiple arrangements for a comfortable experience. There is enough space for a person to move freely.

Dislikes

No storage space to keep books or notes in place. Not convenient to place new storages as it interrupts movements of the person.

Gap in the Experience

If new furniture accessories are introduced, space gets limited and may interrupt with the free movement of people, which as a result makes the room smaller in size.



Hussain

He is an analyst who loves to read books primarily novels, watch movies and play tennis. He likes to organise stuff around him.

Ideal Experience

Would love to have circulation of air throughout the room so that it gets fully utilized by the family, in spite of using only a certain portion.

User interaction with the bed:

He spends almost half of his time here by reading books. Because the room is very quiet and spacious, it is his comfort zone.

Likes

The quietness of the room permits him to carry on his hobby of reading novels. Provision of showcase to hold books and other such things.

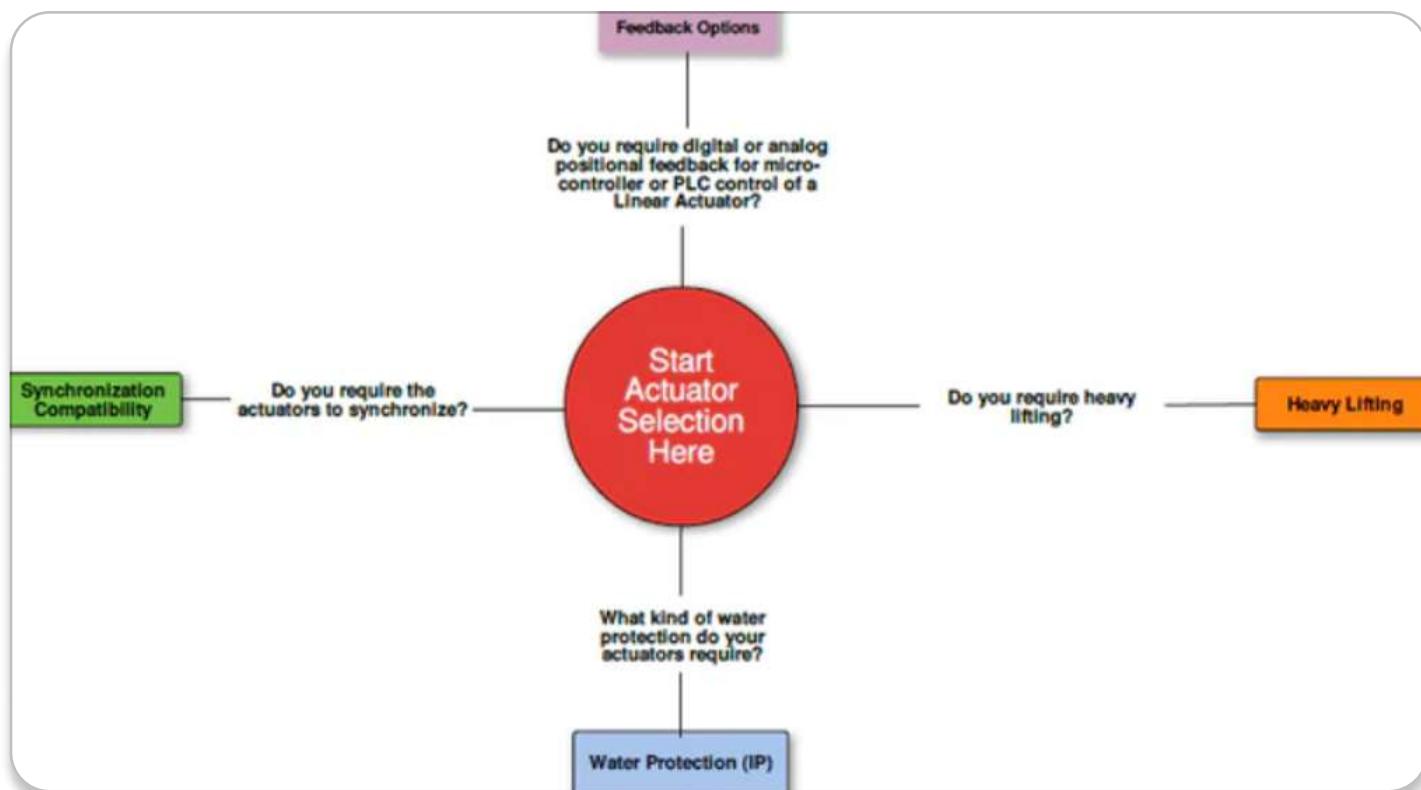
Dislikes

The wires associated with the electronic mechanism appear to be messy. Sound from the mechanism fades with the distance.

Gap in the Experience

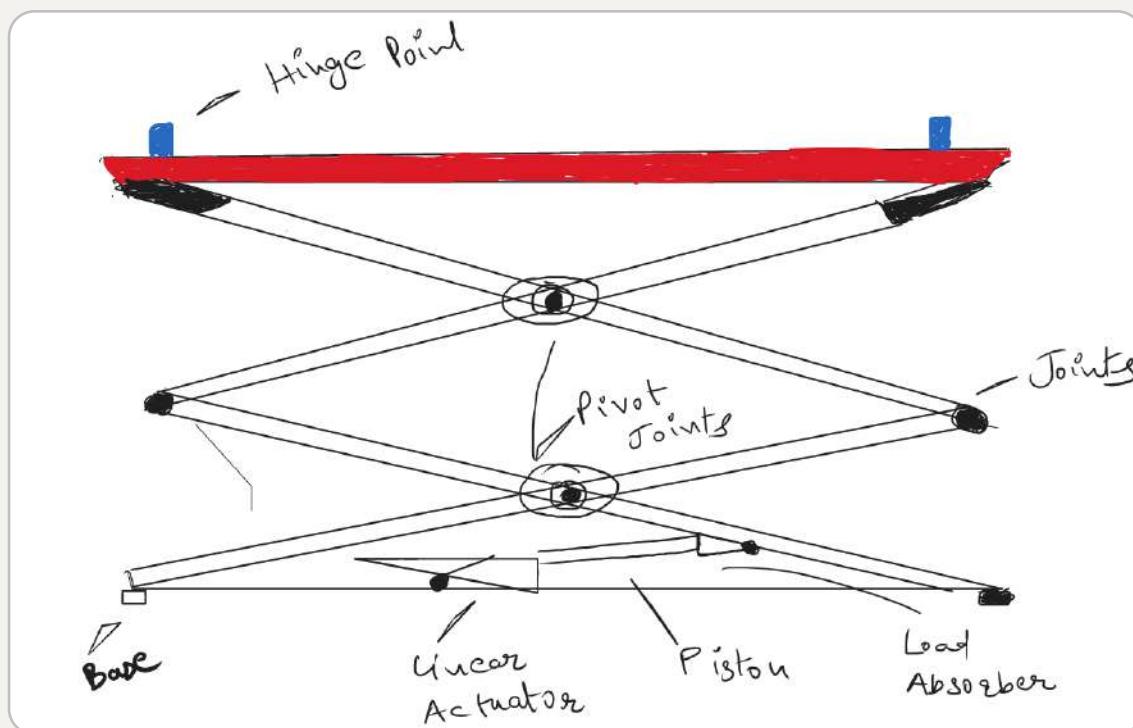
There is a problem with circulation of the air. Air does not reach every corner of the room. Strangled wires in the showcase spoil the experience of the room.

| FLOWCHART



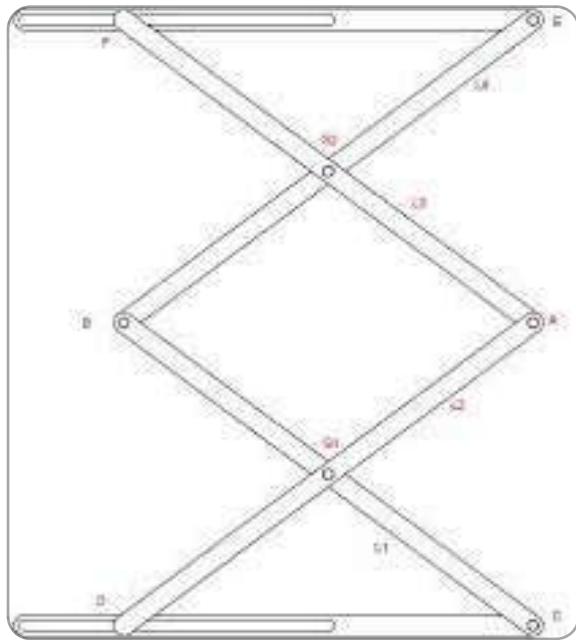
| IDEATION AND SKETCH

Concept - 1 (Scissor Lift)



Low fidelity hand drawn sketch

In this cloud bed ascends and descends with the help of lifting mechanism described below with certain load limitations with implementing the technical part.



Scaled model



3D - Render on Solidworks

Pro's

1 Safety

Scissor lifts are used to safely move workers vertically and can be moved easily to different locations.

2 Productivity

Scissor lifts can be moved easily and safely from one place to another . This will help reduce any physical effort and fatigue of your workers who operate them and instantly saves time.

3 Flexibility

There are several types of scissor lifts for specific jobs, such as electric powered scissor lifts are best known for indoor usage while diesel powered scissor platforms are great for outdoor usage and rough terrains.

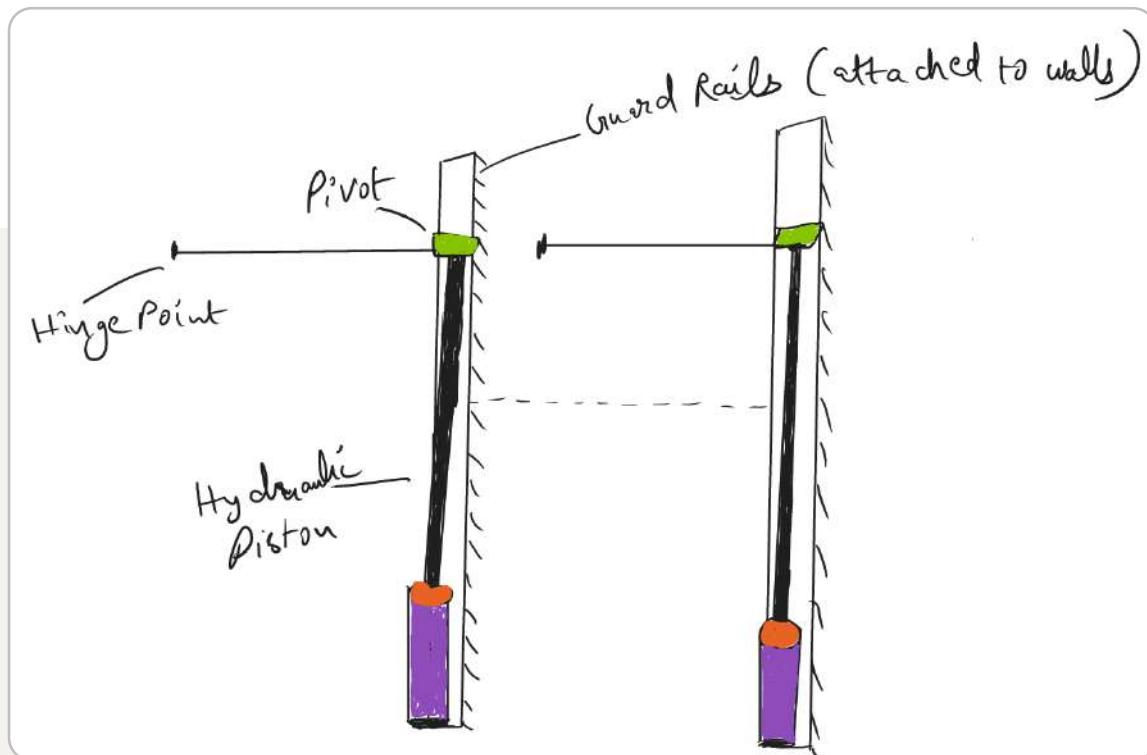
4 Compact Design

If you have limited space in your warehouse or storage area and your project requires you to work at height, scissor lifts are an excellent solution since they are designed to fully retracted and take up very little space .

Con's

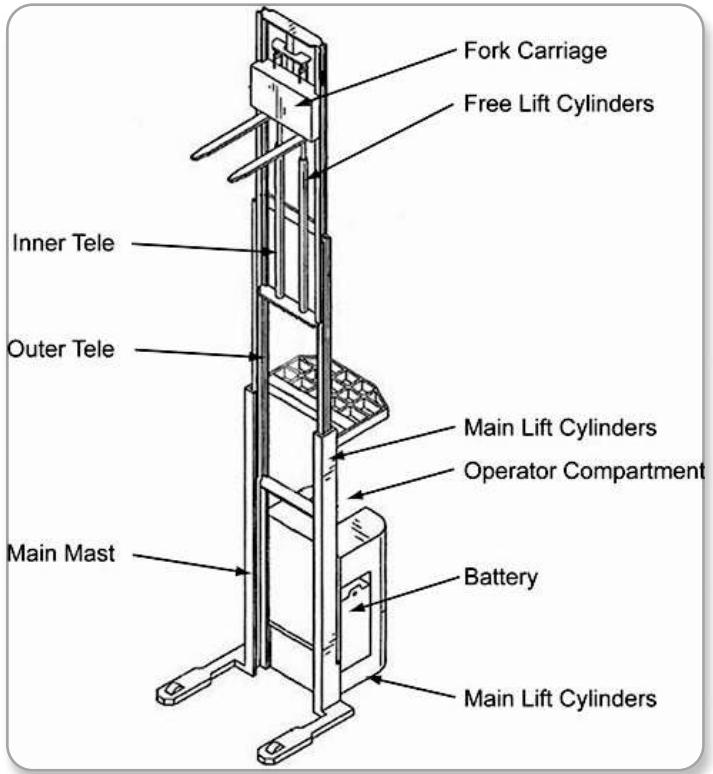
1. The relatively slow lifting speed. A Scissor lift cannot move faster than 150 feet per minute.
2. The hydraulic oil can emit an unpleasant odor when it becomes too warm from overuse.
3. Hydraulic lifts tend to be a little noisier than other elevator systems.
4. The lift movement is generally not as smooth as with other lift systems.

Concept - 2 (ForkLift)



Low fidelity hand drawn sketch

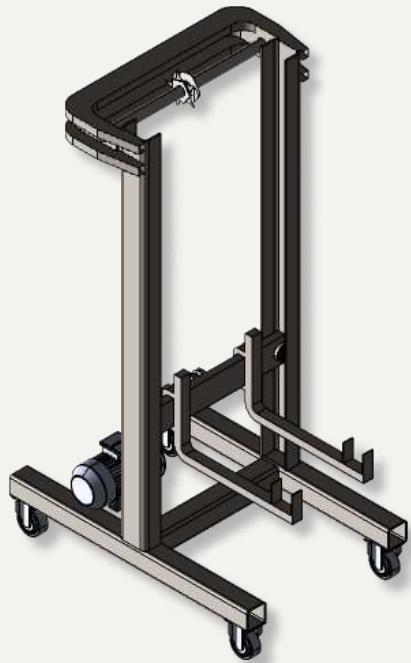
In this cloud bed ascends and descends with the help of vertical lifting mechanism described below with alignment and resting capacity totally invokable on the vertical ascend/descend bars.



Scaled Model view

A hydraulic cylinder comprise of a hollow tube closed at one end with a flexible lubricated piston fitting into the other. Air gets entrapped through the base of the cylinder that allows gasses to enter without leaking them out.

The volume of gas in the cylinder raises the pressure inside it. The pressure applied to the area of the piston head generates an upward force. This force causes the piston to move up, increasing the volume of the gas and minimizing the pressure.



3D rendered view on solidworks

Forklift consists of variety of components required to handle the task effectively. From Truck Frame, power source to counterweight are essential for the forklift to function efficiently.

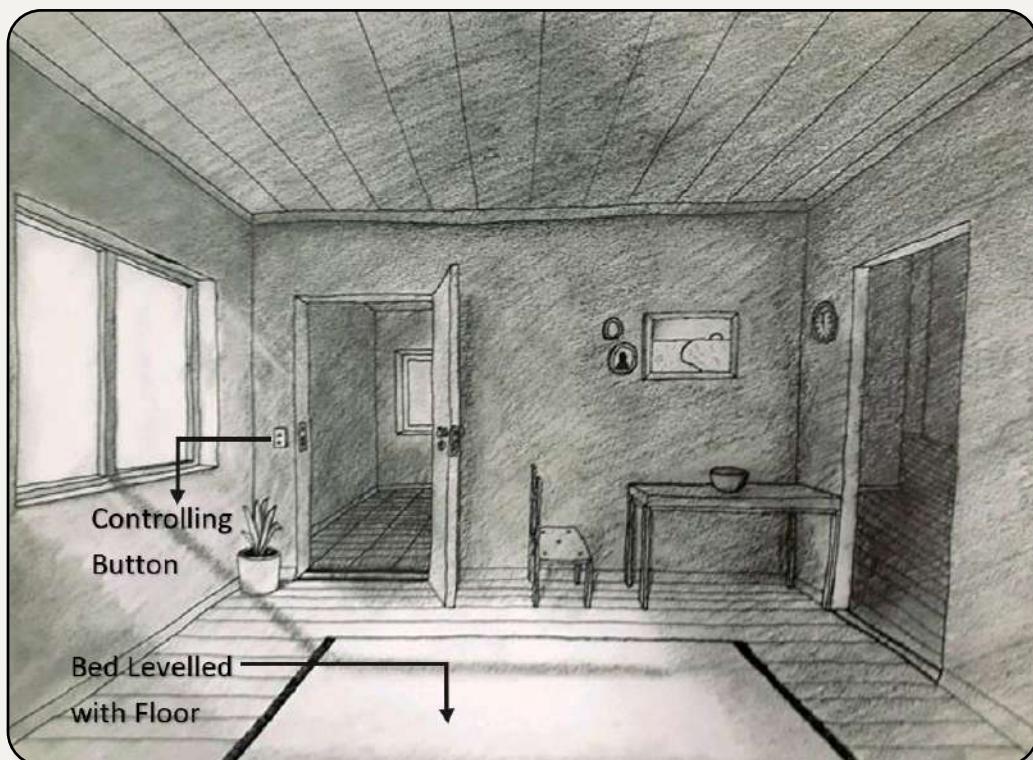
Pro's

1. Less noise during operation.
2. Low center of gravity = better capacity and stability ratings, Long major component life.
3. Fewer waste fluids.
4. The lift movement is as smooth as piston shocker systems.

Con's

1. May not perform well when required in high/constant duty or cold/wet applications.
2. Adequate ventilation around the lift is required when performing the moving operations.
3. Freezing temperatures may cause starting or reliability issues.
4. Initial cost of investment is high.

Concept - 3 (Grave wakeup mechanism)

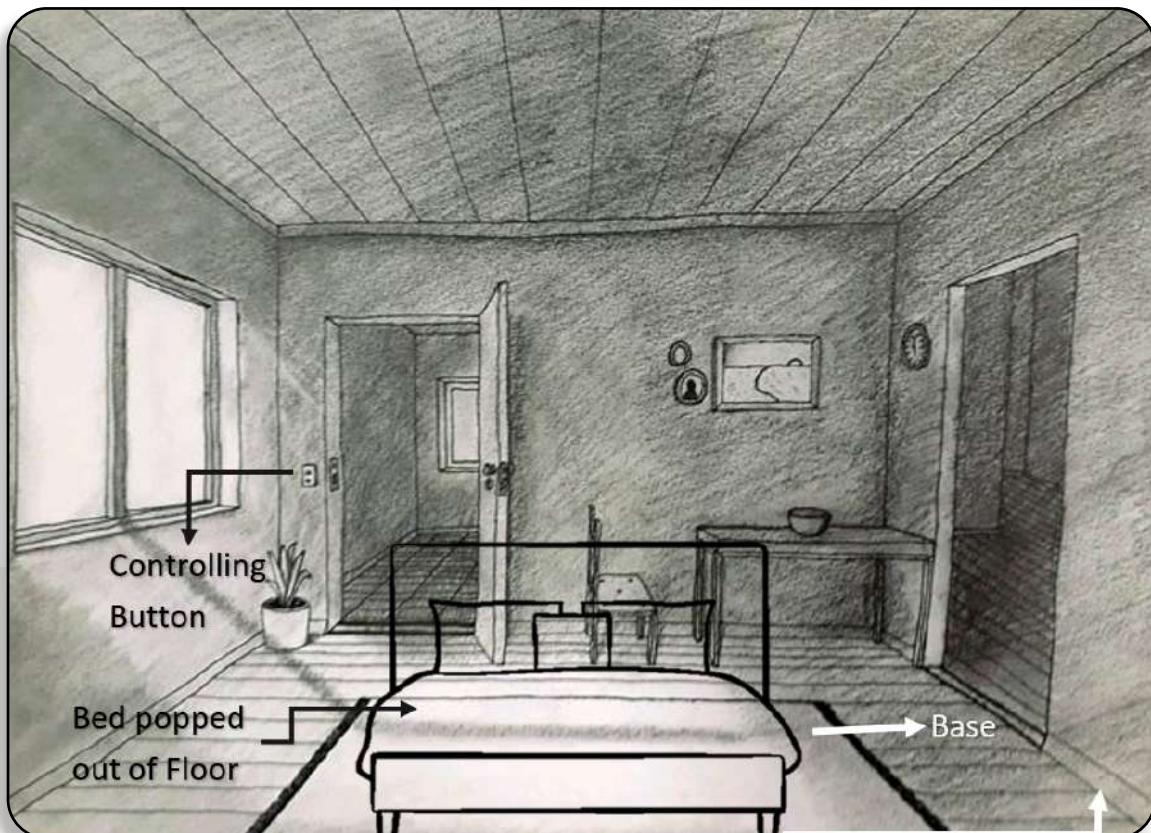


Low fidelity sketch

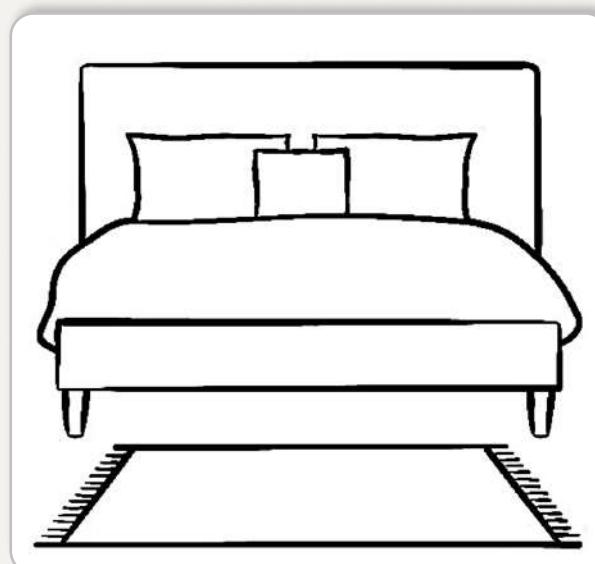
OFF Phase (when bed is levelled with the floor)

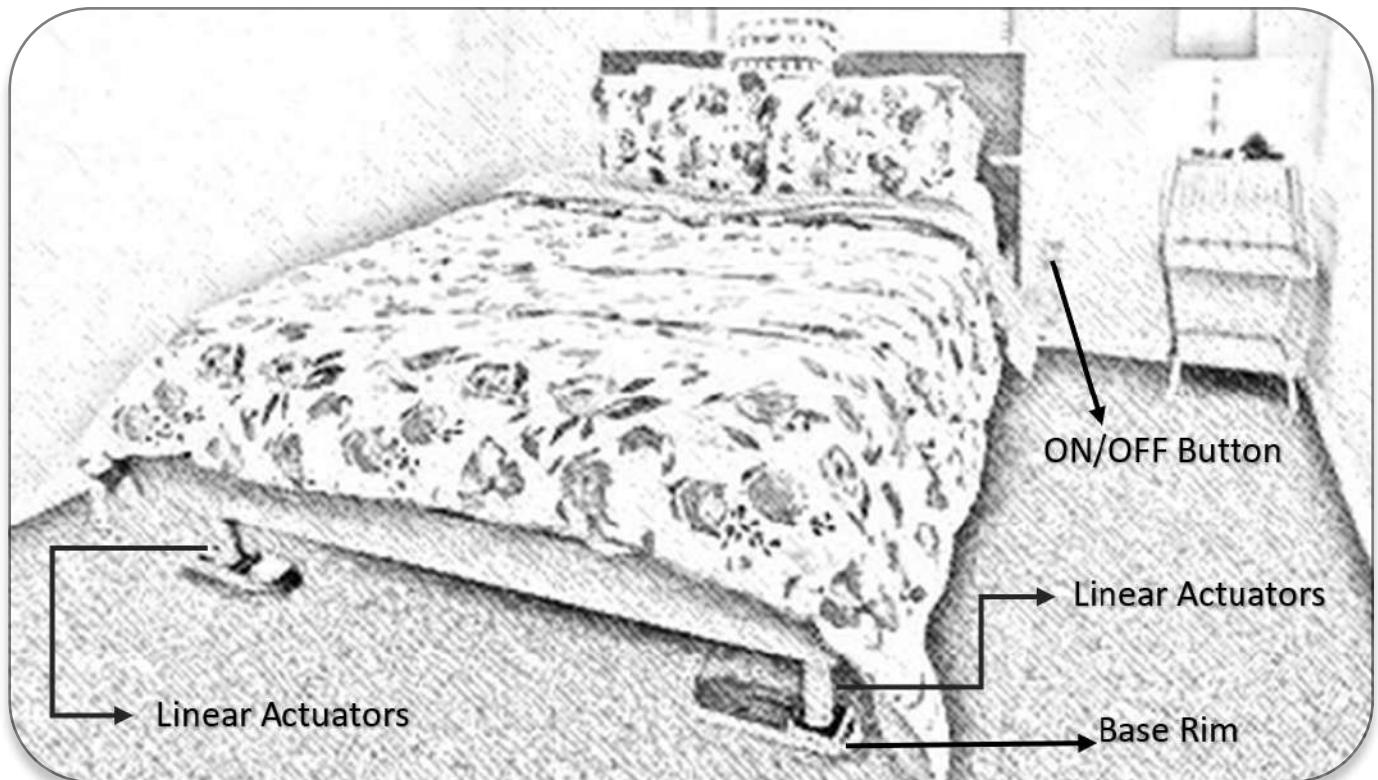
In this mechanism as the name itself defines grave wakeup means the bed will underground beneath the floor in OFF case, bed in ON case the hydraulic mechanism uplifts the bed and hold on to a certain height.

ON Phase (when bed pops out from the floor using actuators):



Depicting the
functionality in
Magnified Image





High Fidelity mapview of mechanism

Pro's

1. Less noise during operation.
2. Cleaner view form no additional space takeover for installation.
3. Easy and efficient to use.
4. sophisticated heightt adjustment.

Con's

1. Need underground hollow space to fit the mechanism.
2. Not applicable for people living in Flats/Apartments.
3. Dual load retention of mechanism as well as the person sleeping over bed.
4. High risk of mechanism failure.
5. Need of false ceiling covering once mechanism underounds the bed.

I CONCEPT FINALIZATION



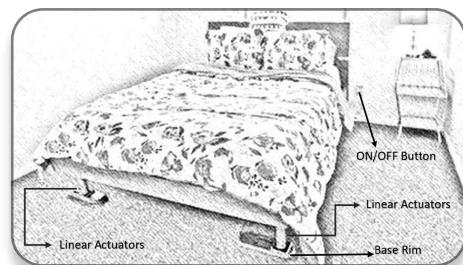
In this concept of Scissor lift we have seen that the mechanism has keen Pro's as

Durable
Long Lasting
Strong
Cost effective and efficient to use



In this concept of Fork lift we have seen that the mechanism has moderate Pro's as Con's

Durable
Strong
Mechanism Jamming
Costly/unaffordable



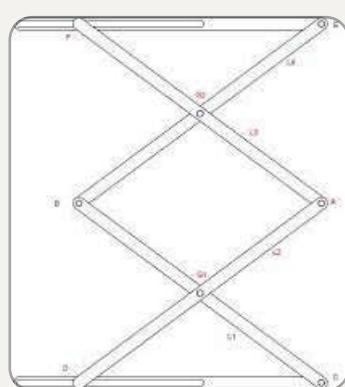
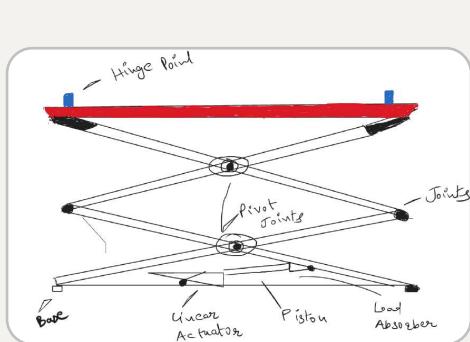
In this concept of Gravewakeup lift we have seen that the mechanism has many Con's rather than Pro's

Dual weight retention
Mechanism failure
Underground space Dug Up
Not applied to apartments/flats

After comparing the concepts studying their Pro's and Con's we can finally come upon the conclusion that the concept of scissor lift is best suitable for lifting the cloud bed as in terms of safety, durability, strength to handle the load, mechanism movement efficiency, cost effective, so comparing all the parameters with other concepts the scissor lift is best suitable for holding the bed and utilizing it for conversion from one form to another one.

I FINAL SELECTED CONCEPT

SCISSOR LIFT



I TECHNICAL REQUIREMENTS AND FEASABILITY

1. Size of the bed - queen size 5ft x 6 5ft
2. Basic material assumed - MS 2x1 pipe + MS 1x1 pipe
3. Grade of MS - Open for discussion
4. Design of the basic MS frame - rectangular
5. Lifting column mechanism -
Option 1- Scissor Lift with electric linear actuator
6. Weight capacity alongwith all peripherals - approx 250kgs
7. Guiding Rails - Parallel guide rails on the sides with wheel support.
8. Wooden panelling on the top for beautification.

I REFERENCES

<http://www.custommade.com/blog/multifunctional-furniture> <http://www.rnrassociates.com/wordpress/multifunctional-furniture> <http://www.stylepark.com/en/news/the-small-world-of-multi-functional-furniture/327374> <http://www.designbuzz.com/10-multifunctional-furniture-designs-add-extra-space-dwelling/>
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<https://anammanzo.wordpress.com/2011/02/08/folding-space-kinetic-architecture/> <http://www.strategiesonline.net/multifunctional-furniture-design/>

I ADDITIONAL REMARKS

Hypothesis:

- The space prior to the chosen topic, a 1 bhk flat is chosen that will be located in andheri west side area. 3 members live in that area. Mother father and their daughter.
- Now the client demands to have separate two work space area (tuition room for teaching, office work space and meeting area for lawyer work) and also a child space with the living requirements.
- The client to this space is Mr. Ronit Ahuja and Mrs. Mona Ahuja who are 35 and 29 years old, a advocate and yoga instructor respectively and their 5 year old daughter Kaira Ahuja. Residing in Andheri West side of Mumbai, in 1 bhk flat in Water Heights.
- This study is in respect of Mumbai lifestyle... Means it is to be designed to be fast according to fast pace life and easy to use to their comfort and living.
- My aim to study this particular topic is to learn more about this topic, this can be used in future aspect to the drastic stage of our living has become and also to show people a new and improved and convenient style of living moreover to those people who are having troubles living in small concealed areas.



Design Phase

Space saving cloud bed mechanism

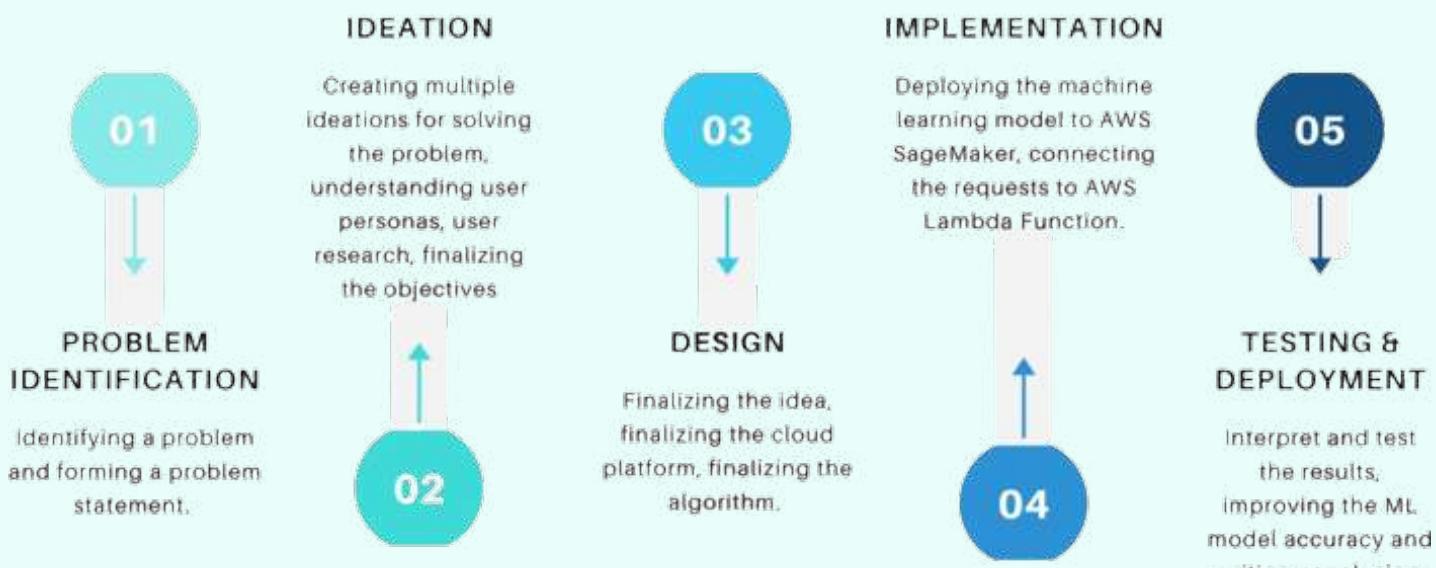
| FLOW DIAGRAMS

| PROJECT
REQUIREMENTS

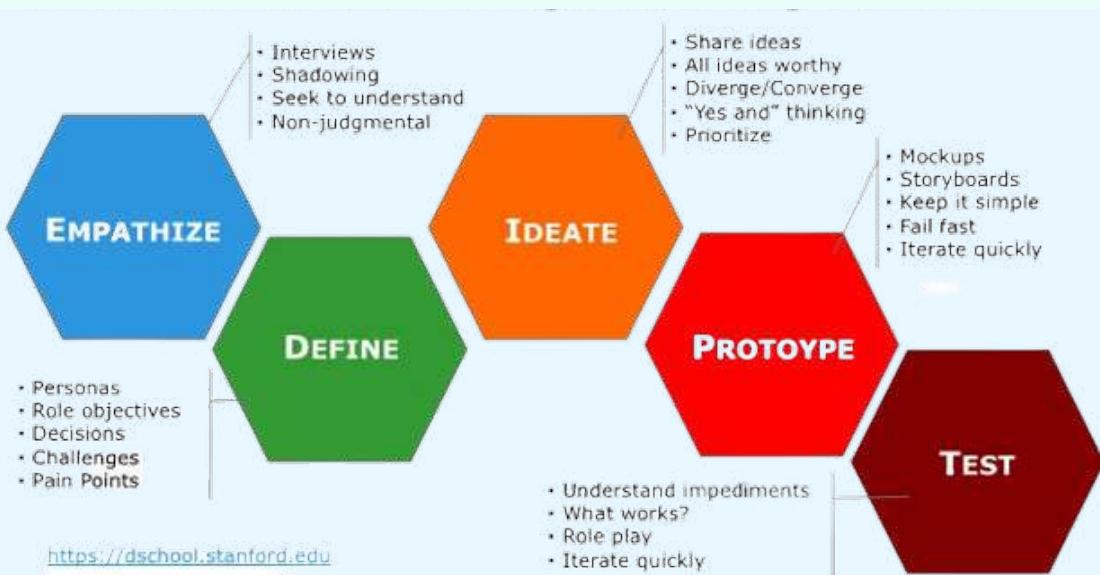
| DETAILED DESIGN

| DESIGN
LIMITATIONS

Project Lifecycle



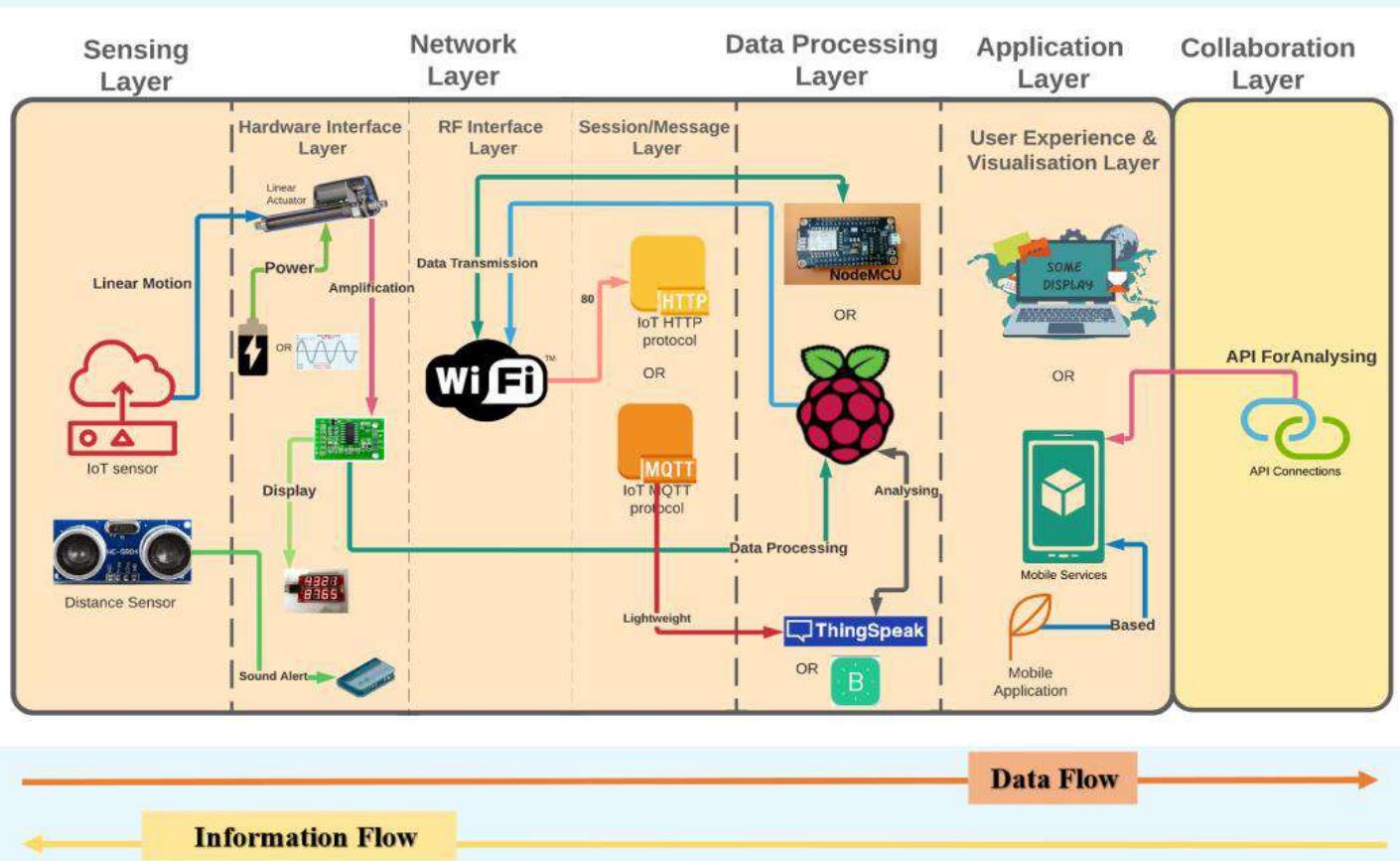
DESIGN THINKING PROCESS



Model Architecture

The architecture of LCOVE BED depends upon its functionality and implementation in different sectors. Still, there is a basic process flow based on which our model is built.

Based on that flow our Architecture for this project is given below



NOTE

From the above lifecycle diagram we can see that all the sensors are working collaboratively to process and send the data therefore the flow of information is left to right as they **collect | review | process** and thus the feedback to the same goes from right to left in the form information flow.

Project Requirements

Pre-Conditions

Adequate Space required for installation

Since as the part of beginning process we need ample amount of space in order to facilitate the cloud bed in working condition.

Free Plug point of 16A dedicated for mechanism

Since the cloud bed will be electronically operable therefore electricity is required for the operation to continue.

Minimum 9' ceiling height for model to hide

Since in this cloud bed mechanism we need false ceiling to hide the bed, therefore we require a minimum height to attain the false ceiling to hide the bed inside it.

Wifi required for sensors to send/recieve data to API

Since we are dealing with different sensors working in mechanism for different purpose therefore internet connectivity is required to send/recieve data to cloud for analysis

Wifi required for sensors to send/recieve data to API

Since we are dealing with different sensors working in mechanism for different purpose therefore internet connectivity is required to send/recieve data to cloud for analysis

Physical presence is required for bed to open/close

Bed mechanism work under someone physical presence its not like button is pressed and we can roam here there to operate the same

Functional Requirements



Peripheral Analysis



COMPONENT	QUANTITY	WHY IT IS REQUIRED	COST (APPROX)
RASPBERRY PI /ESP32	1	It act as a microcontroller which interface with sensors and interact with data for analysis	500
LINEAR ACTUATOR	2	They act as the backbone of the mechanism, they leaverate up and down the whole system	5500
DISPLAY	1	Display is required to show the system visibility status of current offset	500
BREADBOARD	1	For testing the prototype we will connect the circuit before finalizing on false PCB, that is breadboard	60
WIRES	as per requirement	For connecting sensors and controllers we require wires	300
USB CABLE	1	For changing modification of code in microcontroller	100

Target cost of project 13000 (Approx), as per industry requirement given

Component for Identification and Analysis

COMPONENT	WHY IT IS REQUIRED	COST (APPROX)
Distance Sensor	It will act as a security guard for the mechanism and provide child safety interlocks	3000
For Analysis		
COMPONENT	WHY IT IS REQUIRED	COST (APPROX)
Thingspeak / Blynk	It will be used to analysis the information and generate the results	N/A

Networking Component



Network	Connectivity	Pros and Cons	Popular use cases
Ethernet	Wired, short-range	<ul style="list-style-type: none"> ⊕ High speed ⊕ Security ⊖ Range limited to wire length ⊖ Limited mobility 	Stationary IoT: video cameras, game consoles, fixed equipment
WiFi	Wireless, short-range	<ul style="list-style-type: none"> ⊕ High speed ⊕ Great compatibility ⊖ Limited range ⊖ High power consumption 	Smart home, devices that can be easily recharged
NFC	Wireless, ultra-short-range	<ul style="list-style-type: none"> ⊕ Reliability ⊕ Low power consumption ⊖ Limited range ⊖ Lack of availability 	Payment systems, smart home
Bluetooth Low-Energy	Wireless, short-range	<ul style="list-style-type: none"> ⊕ High speed ⊕ Low power consumption ⊖ Limited range ⊖ Low bandwidth 	Small home devices, wearables, beacons
LPWAN	Wireless, long-range	<ul style="list-style-type: none"> ⊕ Long range ⊕ Low power consumption ⊖ Low bandwidth ⊖ High latency 	Smart home, smart city, smart agriculture (field monitoring)
ZigBee	Wireless, short-range	<ul style="list-style-type: none"> ⊕ Low power consumption ⊕ Scalability ⊖ Limited range ⊖ Compliance issues 	Home automation, healthcare and industrial sites
Cellular networks	Wireless, long-range	<ul style="list-style-type: none"> ⊕ Nearly global coverage ⊕ High speed ⊕ Reliability ⊖ High cost ⊖ High power consumption 	Drones sending video and images



Mode of Networking Finalized



WiFi 



Wireless 



Long-Range 



High Speed 

OPERATIONAL Requirements

01

AUTOMATIC MOTION METHOD



First step in CLOUD BED is linear motion, initiated immediately after the button is pressed on control panel.

02

OBJECT IDENTIFICATION SYSTEM

Object detection could be done using quality distance sensors and beep using sounds and light.



03

DATA ANALYSIS FOR BED MECHANISM



The Bed will record the opening/closing time results and adjust opening/closing hours based on these conditions automatically.

DETAILED DESIGN

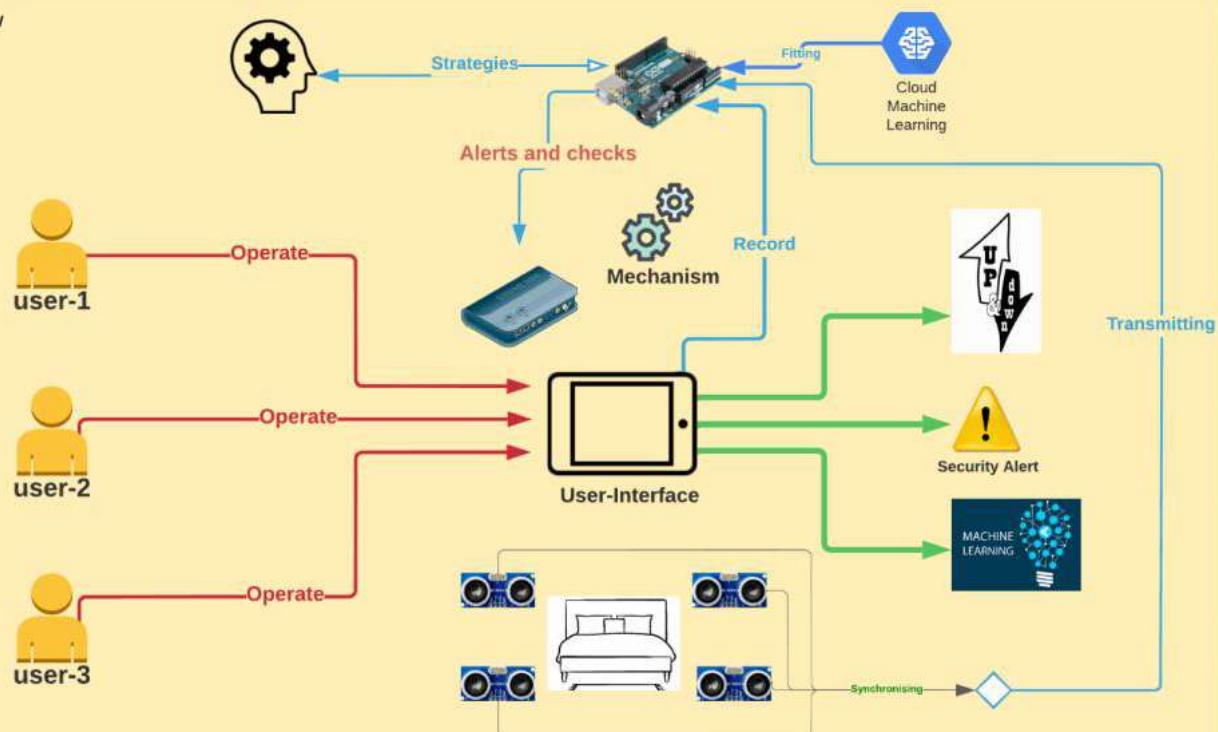
FINAL CONCEPT

Algorithms | Architectures |
Designs | Flowcharts | Model

CLOUD BED MECHANISM

Functional Flow

Overview

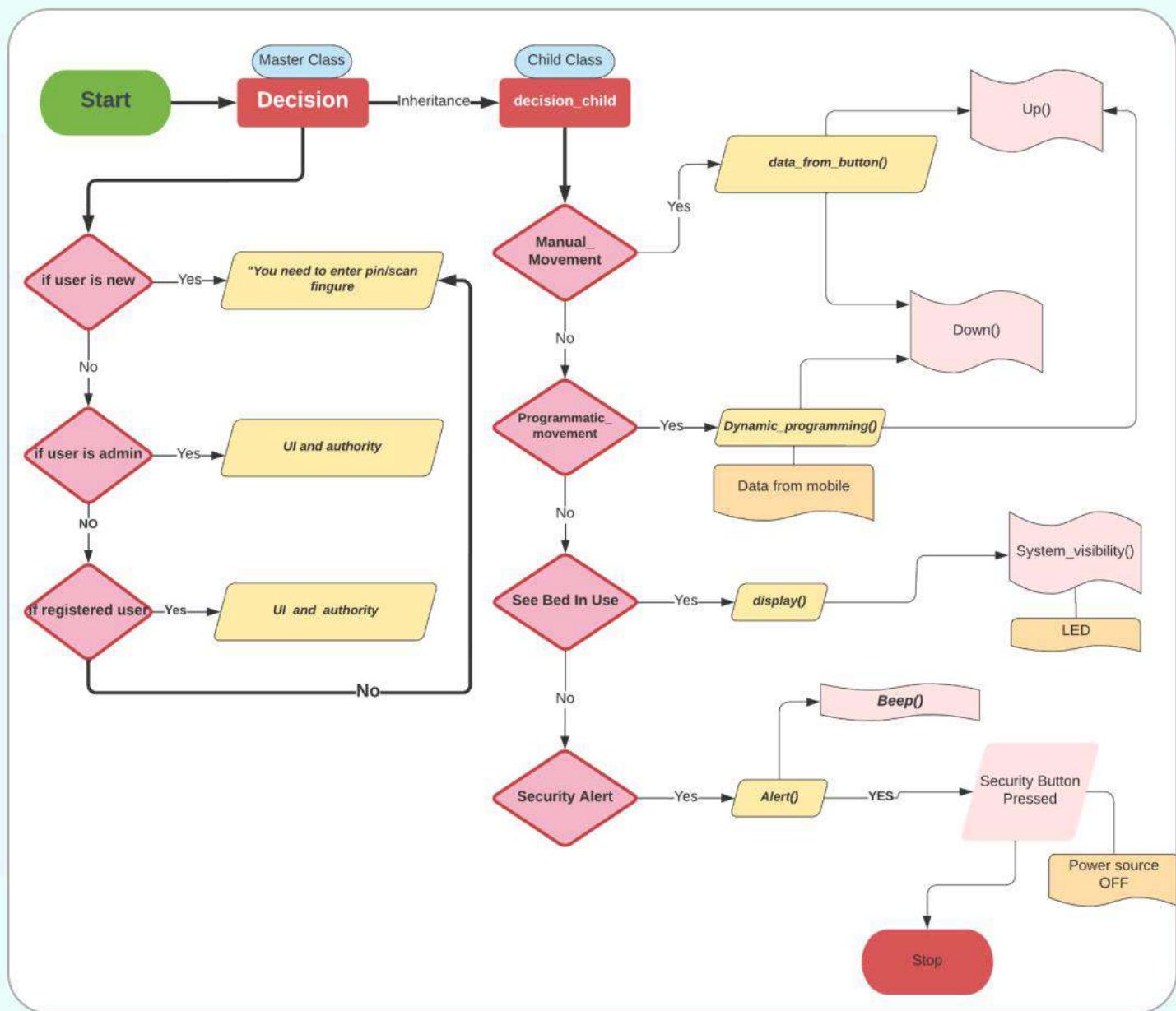


INFORMATION

In the above diagram of functional flow you can actually see that when a user feed the input in the form of user interface, feed goes to the microcontroller to give the command to activate the mechanism and activates the sensors as well to trigger at certain distance if any object identified as a security measure

Algorithm

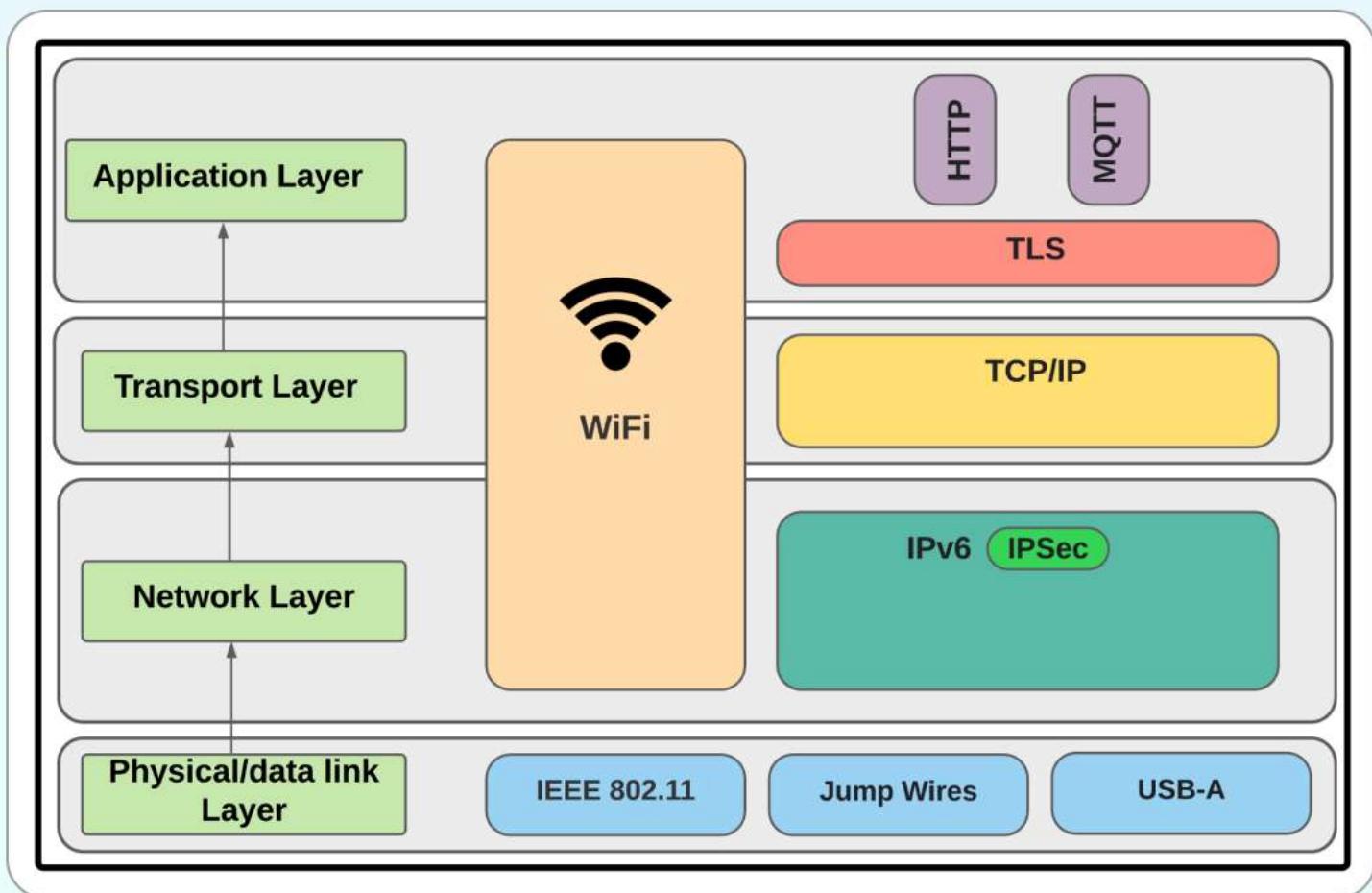
Just start writing. Headline and description will automatically expand.



NOTE

The algorithm of this mechanism working is shown in the above diagram which communicates the flow from user inputs to the outputs given by sensors and reactions of controllers upon their feedbacks and thus demonstrates the purpose

Communication Architecture



NOTE

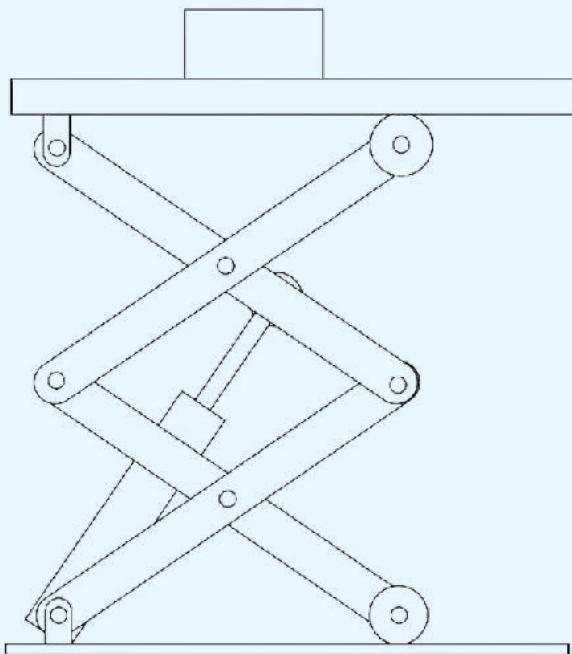
In the above communication architecture we can see that there are different layers used in Internet of things (IoT) from physical components to there interaction with microcontroller and working of them in background with different types of protocols and standards are shown in this diagram.

FINAL DESIGNS

3D modelling and calculations

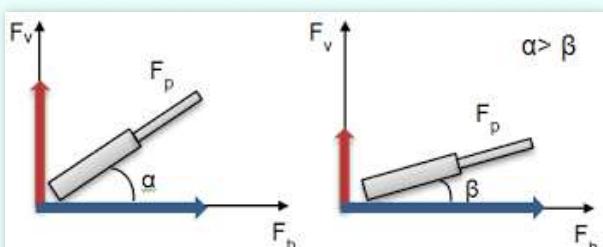


Sketch with actuator

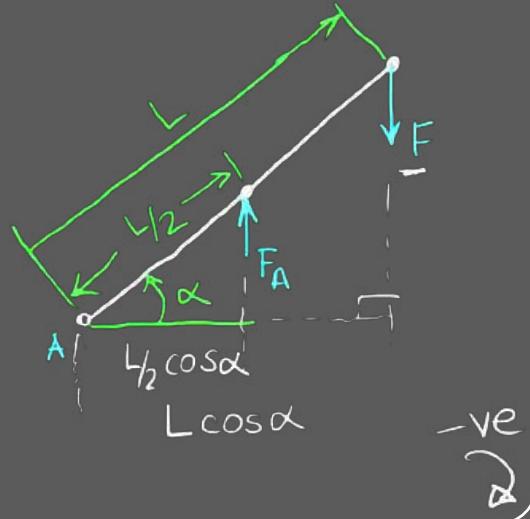
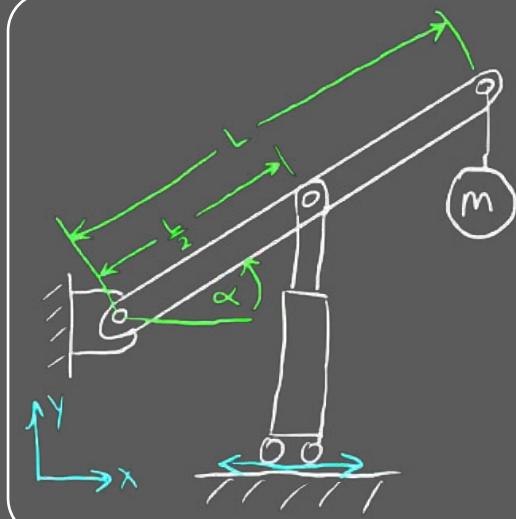


This is the geometrical, angular sketch with a linear actuator attached on it. Considering the conditions to be ideal we will now calculate the force exerted on the piston of actuator with the load capacity tolerance

Mechanix Calculations



We will consider a diagram of linear actuator where we will calculate the force exerted on the piston of the arm lever



$$+\underline{\underline{\Sigma M_A}} = F_A \left(\frac{L}{2} \cos \alpha \right) - F (L \cos \alpha) = 0$$

$$F_A = \frac{F(L \cos \alpha)}{\frac{L}{2} \cos \alpha} = 2F$$

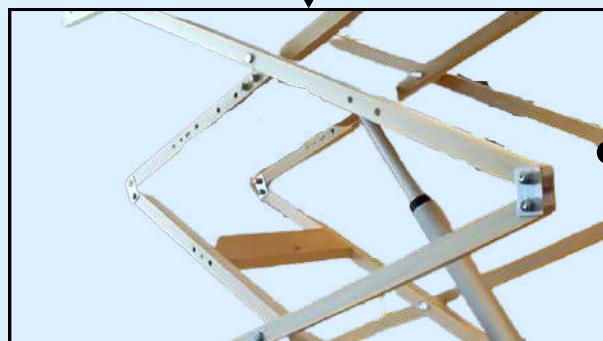
$$F_A = 2F$$



In this figure, the rod is connected to two pin joints implying two reaction forces acting horizontally and vertically on the rod at these points. However, since one of the joint is further connected to a roller joint as shown, the rollers are free to move in horizontal direction and hence no component of reaction force acts on the rod due to absence of any horizontal resistance. Hence the only component of force that remains is in the y direction which act on the rod at all the three points as shown in the FBD.

In the second figure, it's apparent that the vertical forces are acting at different points on the rod. Hence, we apply the concept of balancing the moment of these forces abt point A to get the desired relations. In addition to the moment balance, we need to do the force balance to solve and get the unknown two variables.

MECHANISM PROCESS ON MS FRAME STRUCTURE





3D Rendered Model

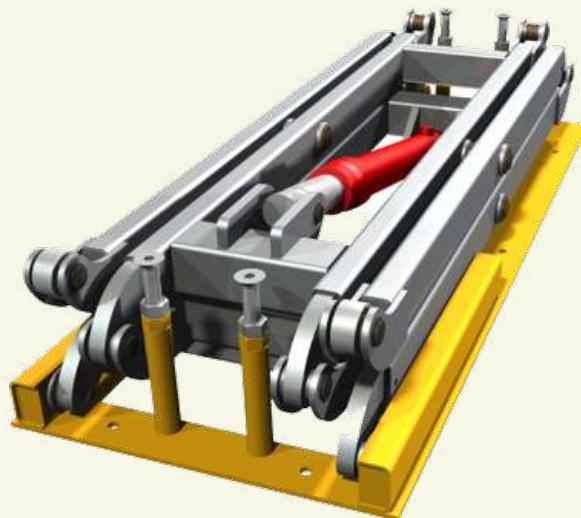


FIGURE A



FIGURE B

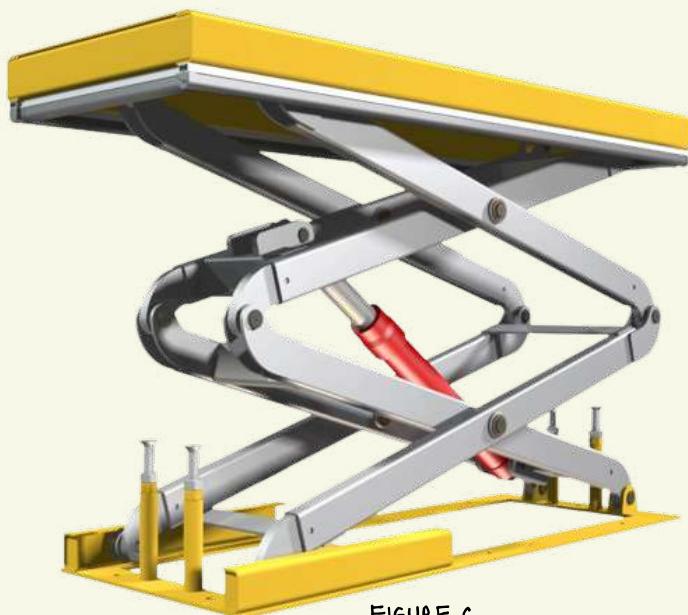


FIGURE C

Component Designs



Capacitive touch buttons programmable will be used with led color changeable lights to operate the bed mechanism with an enhanced UI

FURNISHED PRODUCT



Safety measures ensure the Cloud Bed always floats safely into the ceiling or to the ground.

How it works

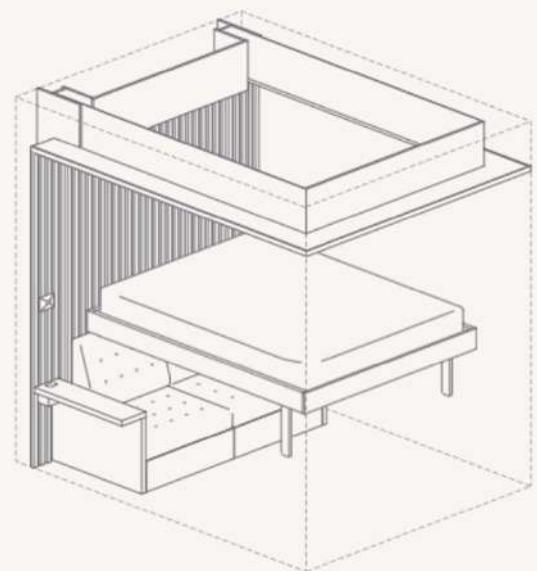
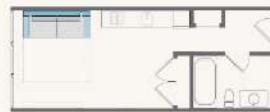
Control



Side



Top



Features



More room for rest

The luxury of a King or Queen bed, without losing living space.



Quick and quiet

An effortless transition from bedroom to living room (or vice versa) in 30 seconds.



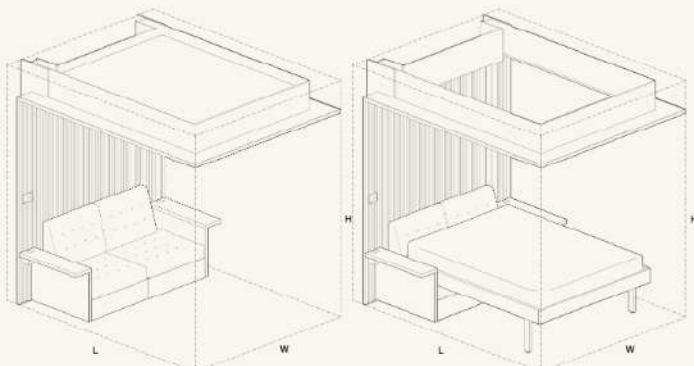
Lit from within

Hidden, dimmable LED lighting casts an ambient glow.



Outlets for all

With built-in outlets, it's easy to plug in and charge up.



Size	Queen
Length	103"
Width	69"-81"
Height	96", 102", or 108"
Weight	884 - 881 lbs.
Storage	11 cubic ft.

Delighters

Smart AI based automatic scheduled On/Off

Lighting LED ambient lighting with sensors and beeps

Control Amazon Alexa, Google Home

Design Limitations



Weight Tolerance

The capacity of lift is to hold the bed in cloud without person is 250kgs (approx)



Frequent Maintenance

Characteristics that place the business or project at a competitive disadvantage.



Failure Psychology

Risk of bed collapsing from roof creates the image in the mindset



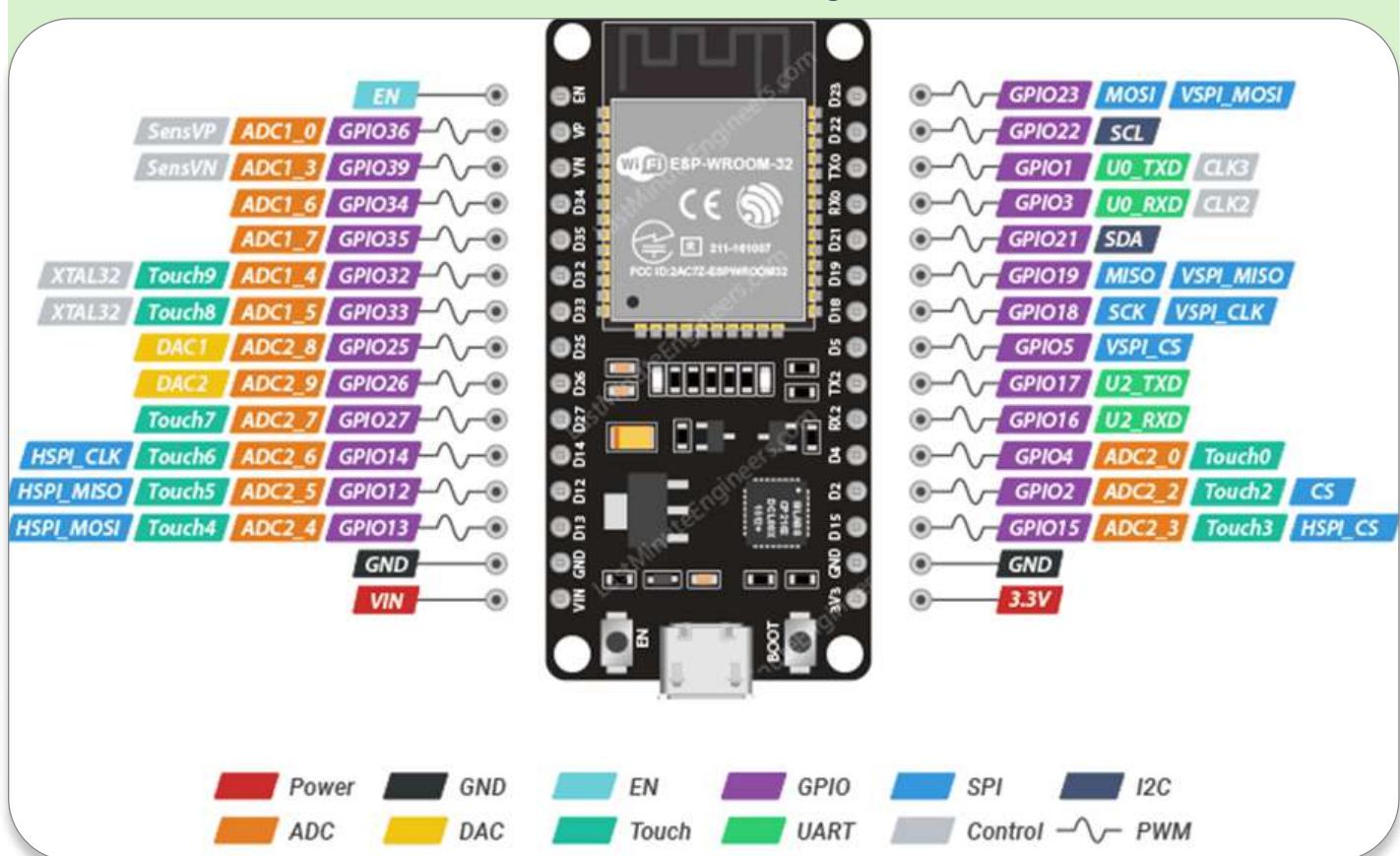
IMPLEMENTATION PHASE

- INTRODUCTION
- PROTOTYPING
- SOFTWARE CONFIGURATION
- CIRCUIT SCHEMATIC

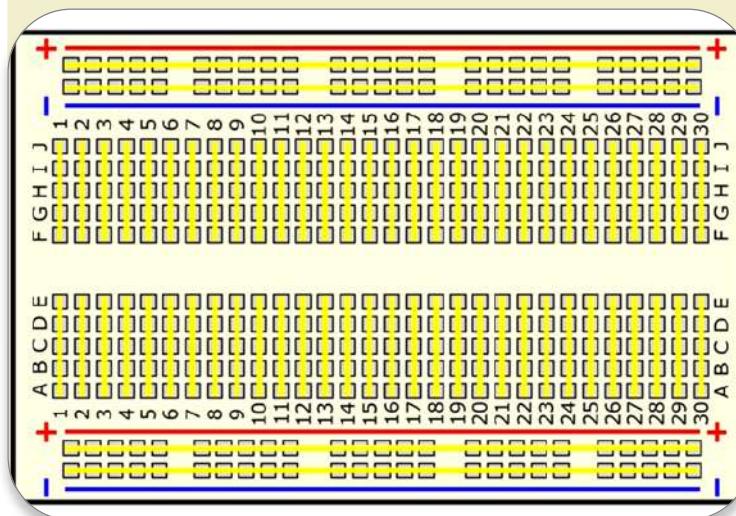
General Introduction

Integrate analysis, design, architecture, optimization, experiments and simulation to build our ADT project, subject to given constraints for a real-world application.

ESP32 Pinout Diagram



Breadboard diagram





Softwares - Apps - Online Services



Arduino IDE

Blynk Blynk: It is used for making mobile application



IFTTT Maker service: Used to connect with Google Assistant



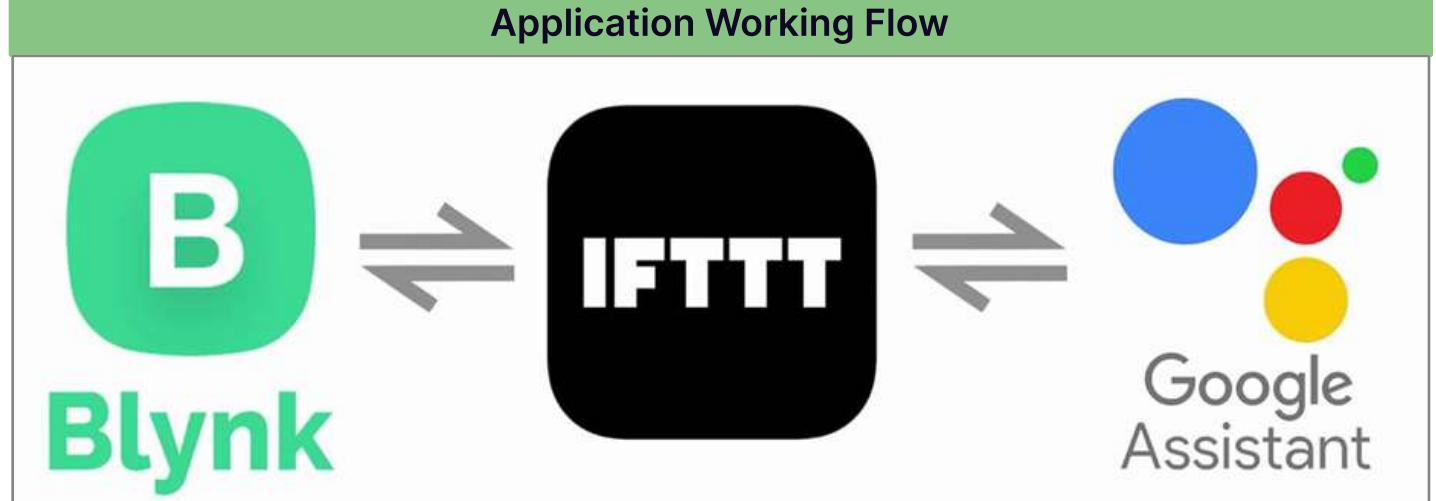
Google Assistant Service



Fritzing is used to draw the circuits

There are some of the machine learning features for scheduling the opening and closing of mechanism implemented in program.

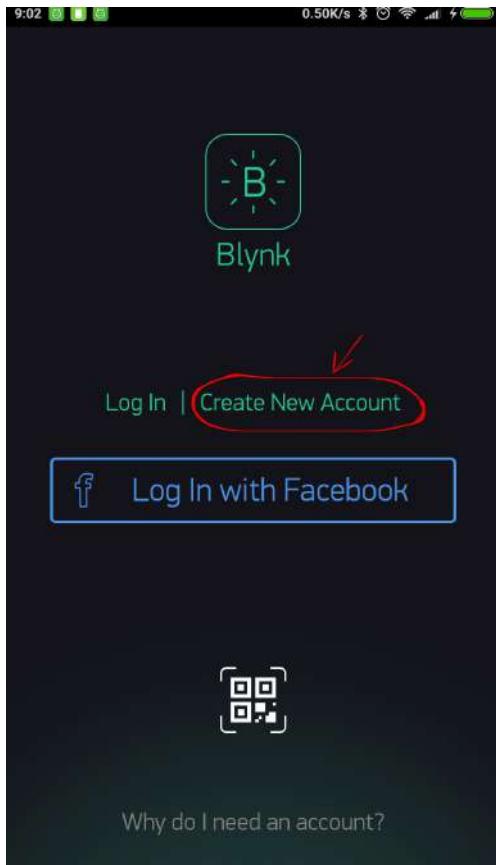
Application Working Flow



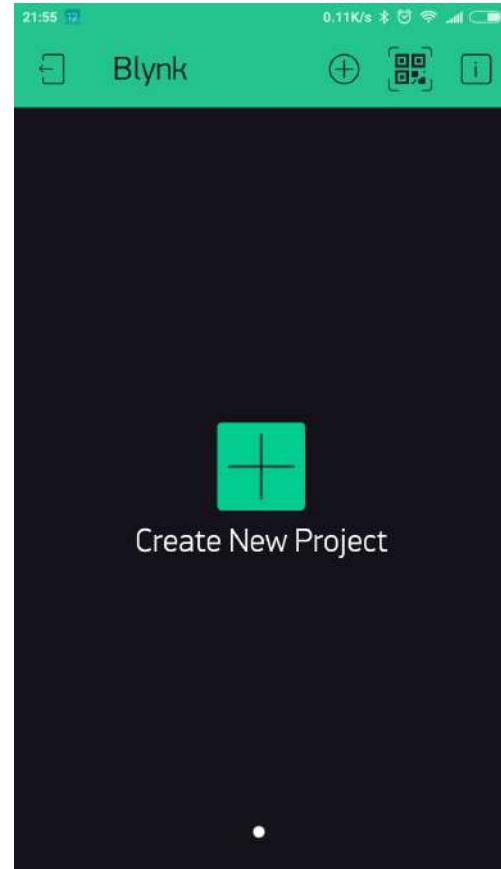
Setting up Apps



Setting up Blynk app



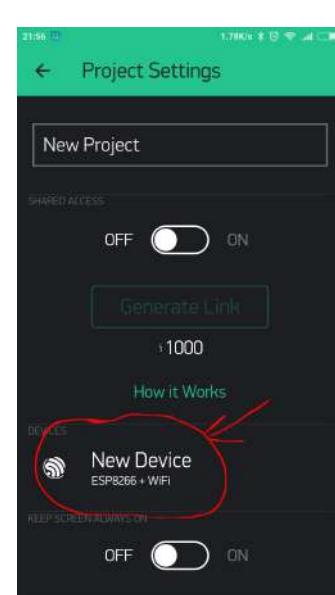
Create a Blynk account



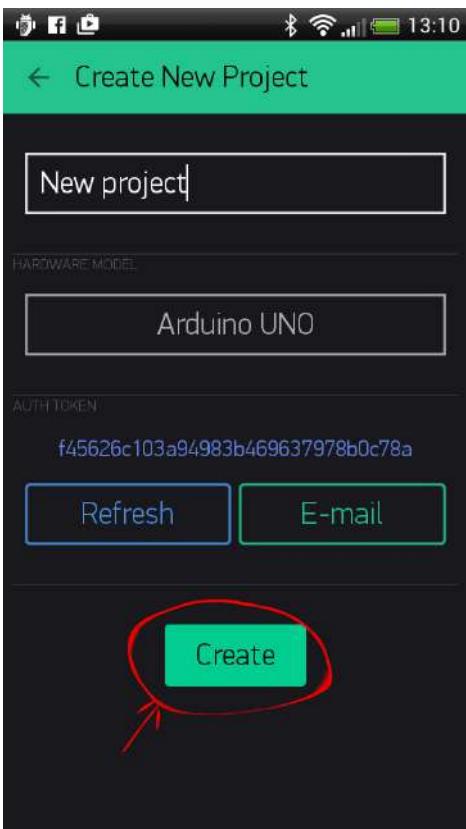
After you've successfully logged into your account, start by creating a new project.



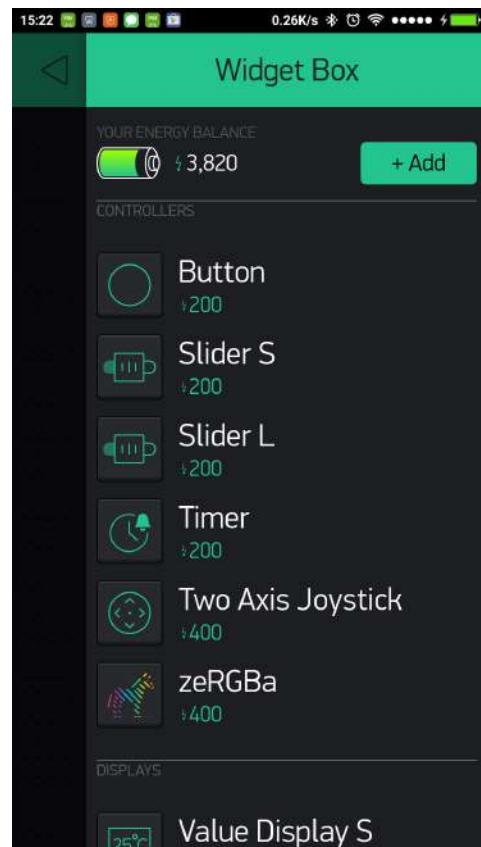
Select the hardware model as esp32



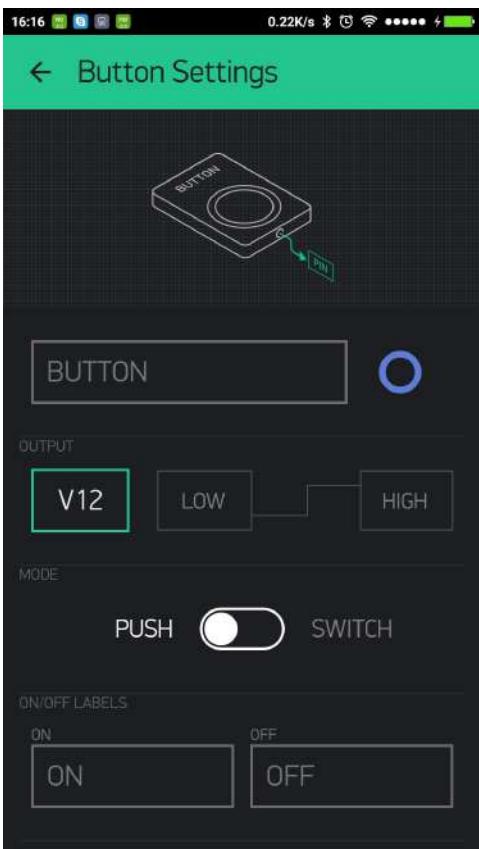
Auth Token is a unique identifier which is needed to connect your hardware to your smartphone.



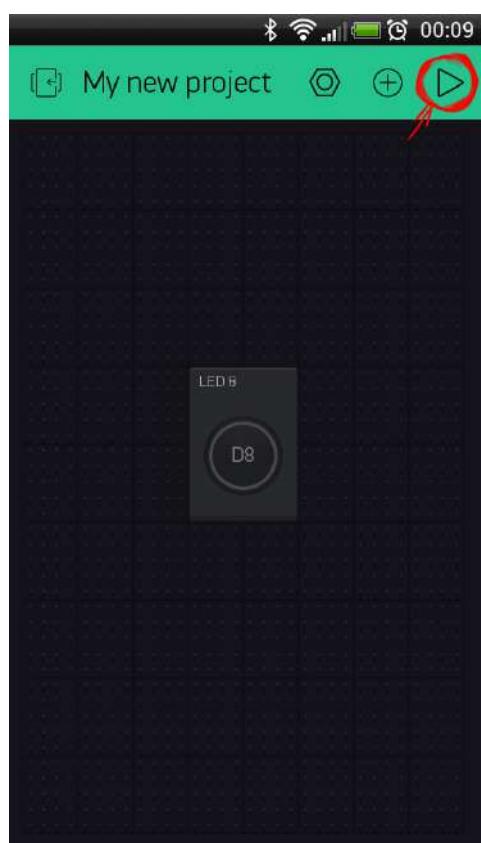
Hit on Create button to create the project



Tap anywhere on the canvas to open the widget box. Now pick a widget of choice.



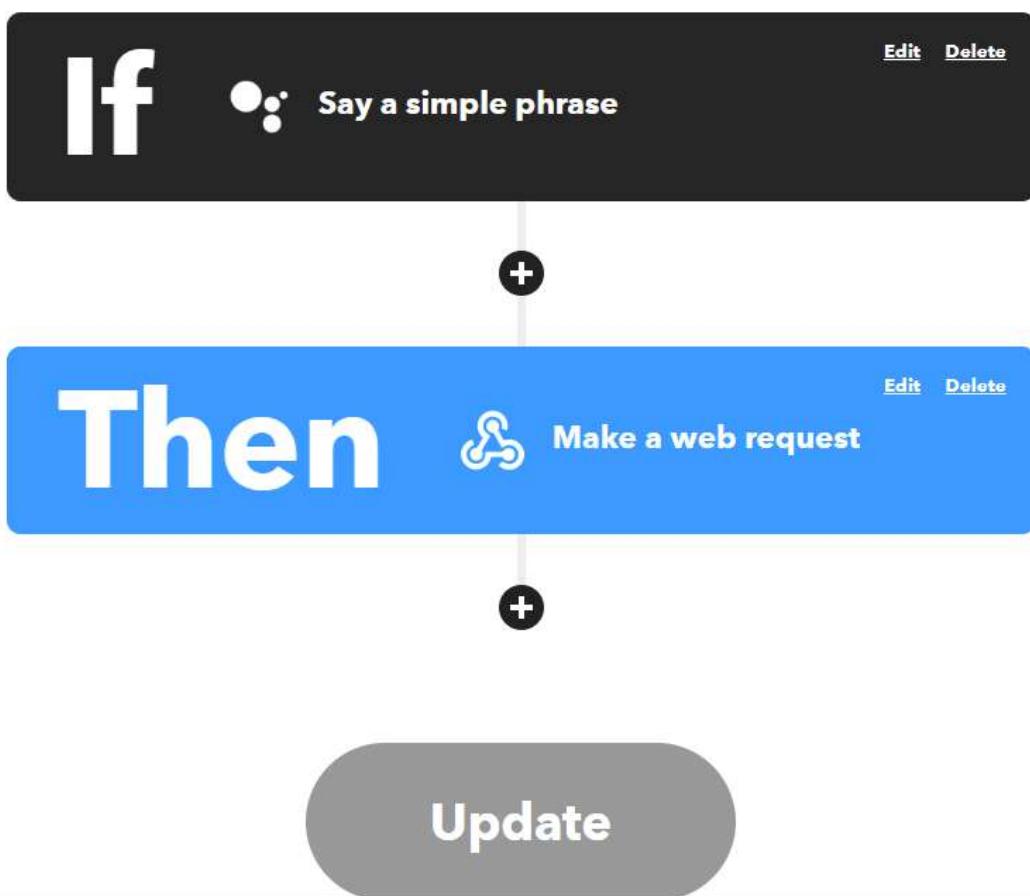
Assign the Pin to the widget you have chosen.



After assigning click on save and project is ready to run.

Edit Applet

Want to publish this Applet so anyone can use it? [Click here ↗](#)



Create an Account on IFTTT (it would be same as signed in with google as we need to integrate the google assistant with it). Go to my applets and click on + icon to start creating your own applet, by doing this you will get the above window of If this then that.



Say a simple phrase

What do you want to say?

open my bed

What's another way to say it? (optional)

open cloud bed

And another way? (optional)

palang nikaal

What do you want the Assistant to say in response?

opening bed

Language

English



Update trigger

In the If condition select assistant out of many options, you may have to search it and select it, doing so you will get the above window where you have to say the command or phrase through which action will be performed.



Make a web request

URL

```
https://blr1.blynk.cloud/external/api/update?
token=WOAEARmJs0ZsCaKfY2t8b
IhZXZdrj3-0&V0=1
```

Surround any text with <<< and >>> to escape the content. Surround any text with <<< and >>> to escape the content. See [FAQ](#) if using an IPv6 URL.

[Add ingredient](#)

Method

GET



The method of the request e.g. GET, POST, DELETE

In the Then part select Webhook request out of many options, on doing so you will get the above window. In the URL part copy the API from Blynk API docs for sending a request and past it here, also in the end mention the PIN no. you assigned to device and what output you want to give for eg.(pin V0 assigned to switch and output will be HIGH/1)

Repeat all three steps for closing output, in assitant part say phrase you want to close on and in webhook instead of HIGH give 0/LOW to pin rest cases are same

B cloud bed

Duplicate Edit

Info Metadata Datastreams Events Automations Web Dashboard Mobile Dashboard

This is how the device page will look like for actual devices.

Device name **online**

Device Owner Company Name

Tag

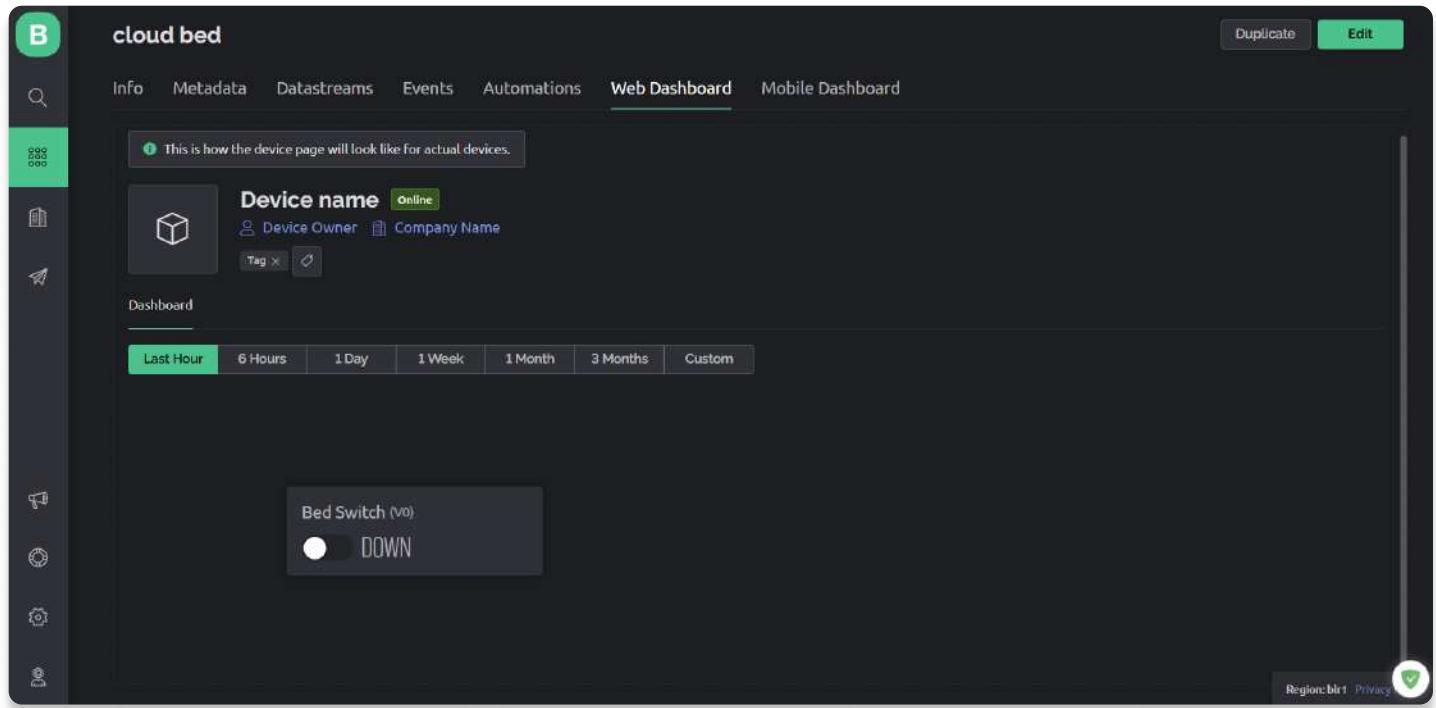
Dashboard

Last Hour 6 Hours 1 Day 1 Week 1 Month 3 Months Custom

Bed Switch (v0)

DOWN

Region: blr1 Privacy 

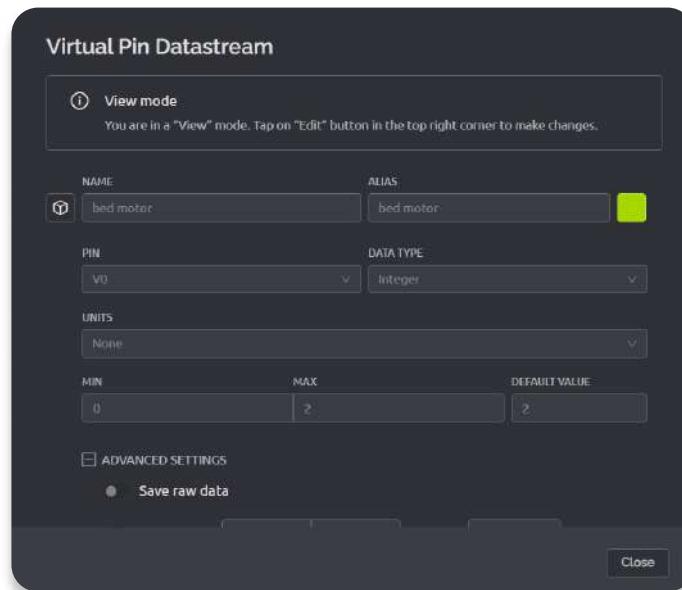


Virtual Pin Datastream

View mode
You are in a "View" mode. Tap on "Edit" button in the top right corner to make changes.

NAME	ALIAS	
<input type="text" value="bed motor"/>	<input type="text" value="bed motor"/> 	
PIN	DATA TYPE	
<input type="text" value="v0"/>	<input type="text" value="Integer"/>	
UNITS		
<input type="text" value="None"/>		
MIN	MAX	DEFAULT VALUE
<input type="text" value="0"/>	<input type="text" value="2"/>	<input type="text" value="2"/>

ADVANCED SETTINGS
 Save raw data



cloud bed

Bed Switch

DOWN

Button Settings

Bed Switch

TITLE ALIGNMENT 

DATASTREAM

OVERRIDE HIGH/LOW ON

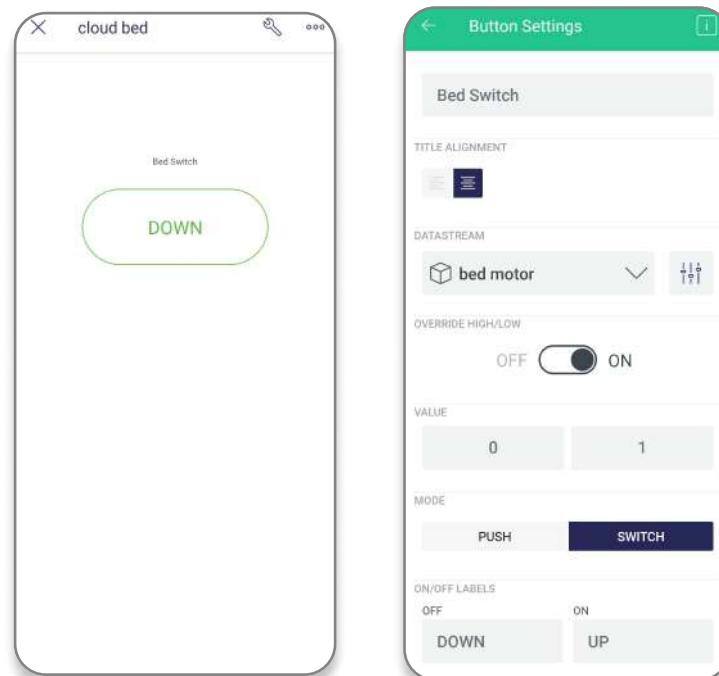
OFF ON

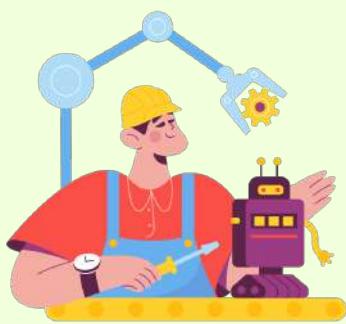
VALUE

MODE PUSH

ON/OFF LABELS

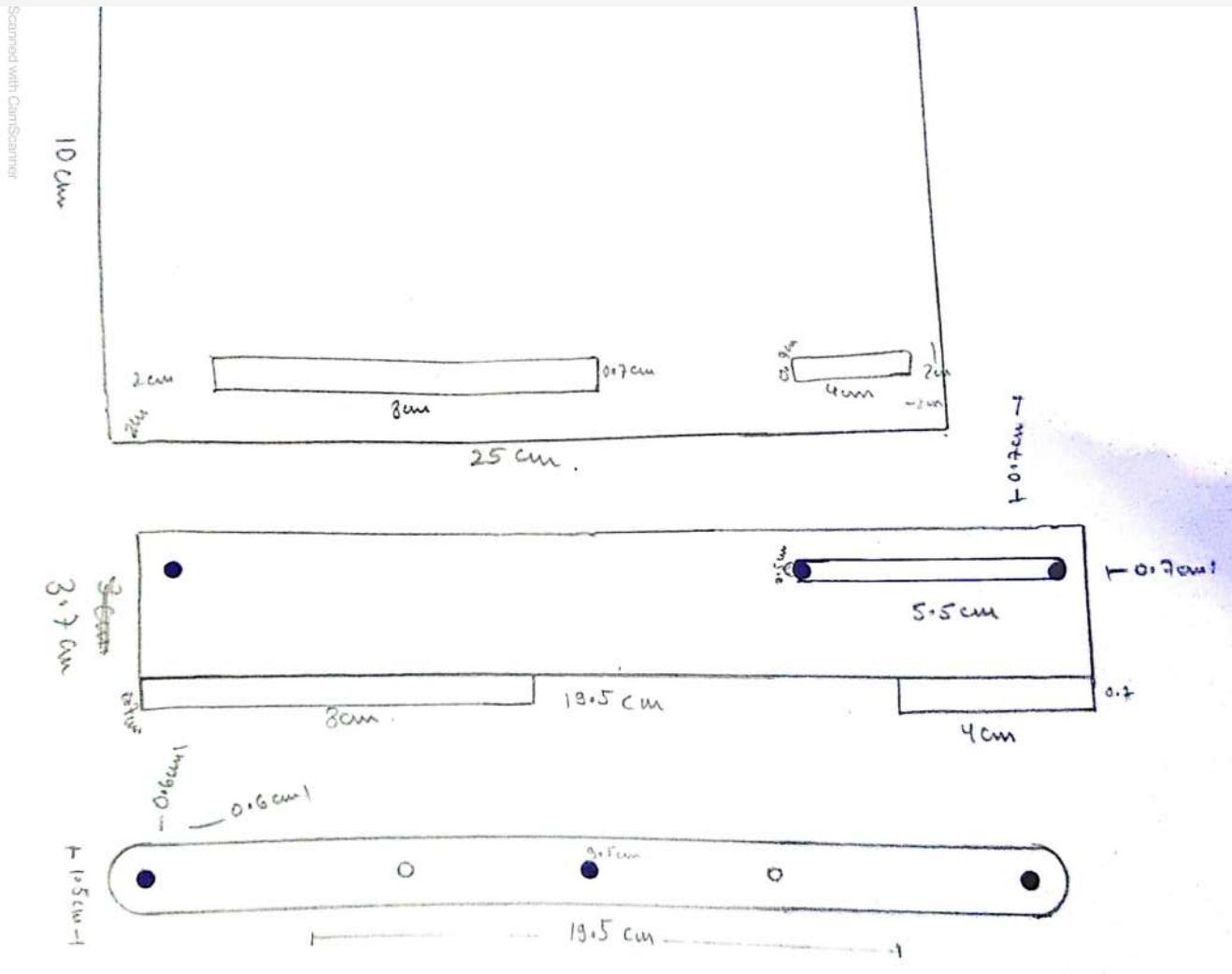
OFF	ON
DOWN	UP



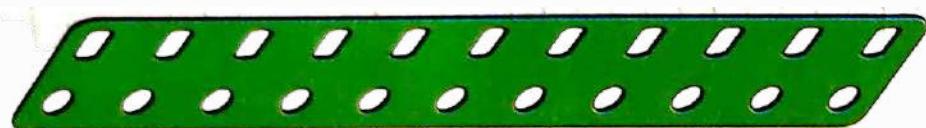


Prototype Construction

Geometrical Measurements

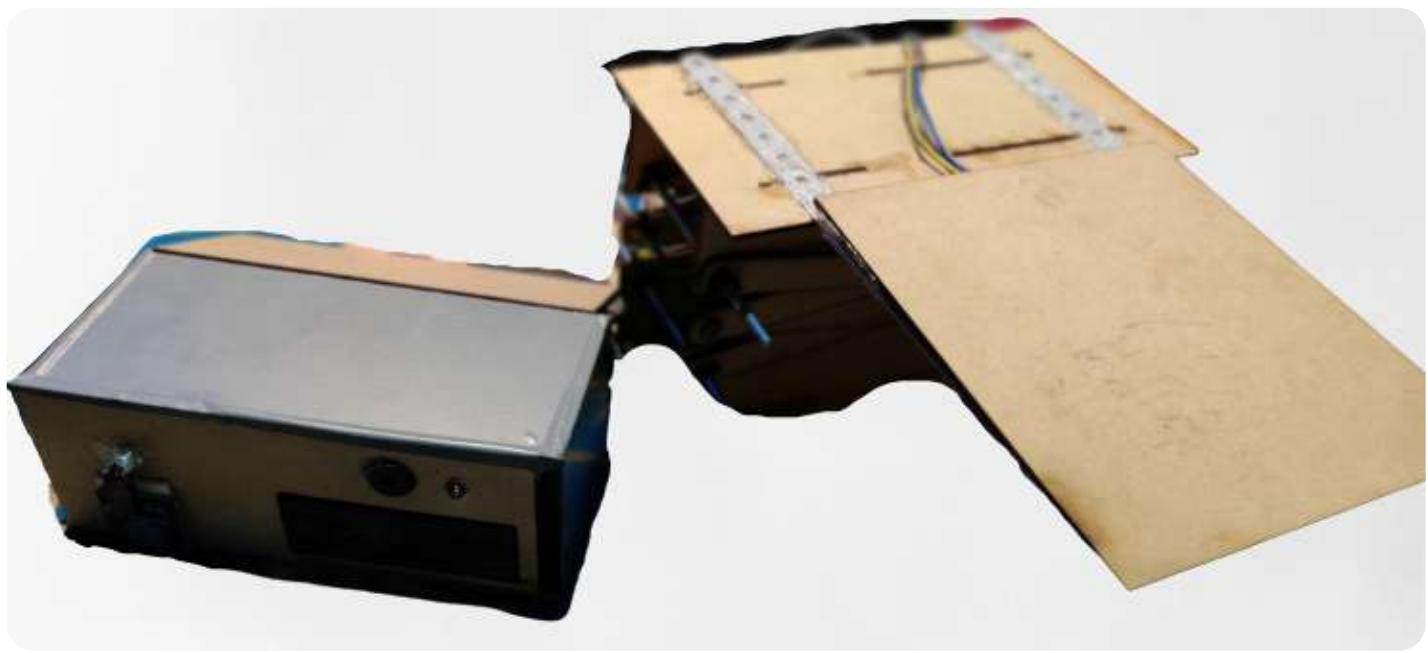


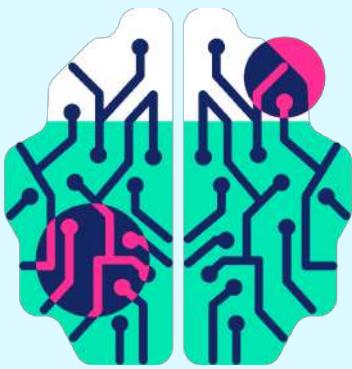
3D View



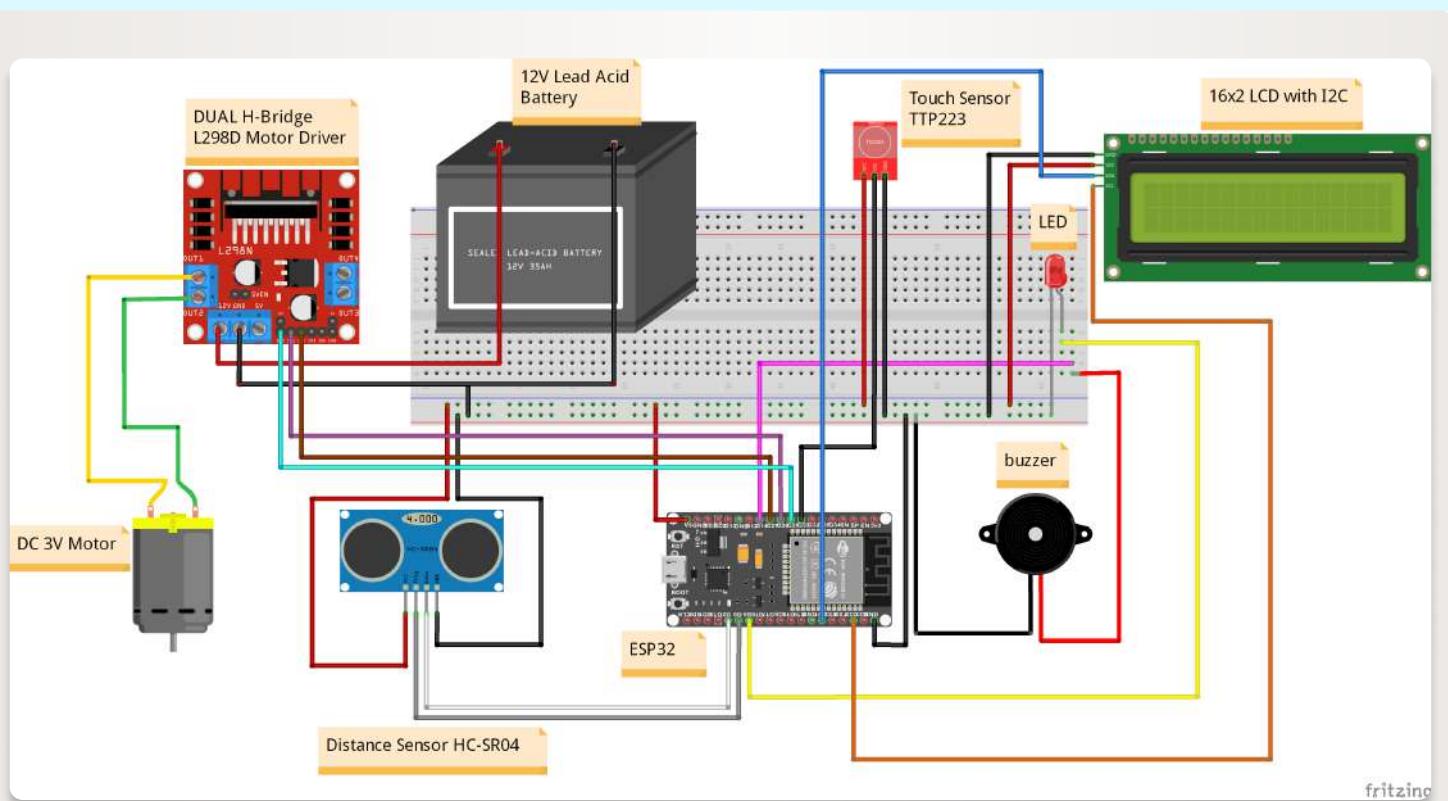
Furnished Prototype







Circuit Schematic and Connections



fritzing

Distance Sensor ESP32 Pinout	
Trig Pin	P0
Echo Pin	P2
VCC	5V
GND	GND

Motor Driver ESP32 Pinout	
ENA	P25
OUT1	P26
OUT2	P27
GND	GND

Touch Sensor ESP32 Pinout	
Signal	P16
VCC	5V
GND	GND

I2C Display ESP32 Pinout	
SDA	P21
SCL	P22
VCC	5V
GND	GND

LED ESP32 Pinout	
+Ve	P4
GND	GND

Buzzer ESP32 Pinout	
+Ve	P14
GND	GND



Code Implementation

```
#include <LiquidCrystal_I2C.h>
#include <SPI.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#include <SimpleTimer.h>
SimpleTimer timer;

//Constants
#define SS_PIN 5
#define RST_PIN 0

//initializing GPIO pins to sensors
const int trigPin = 0;
const int echoPin = 2;
const int motor_speed = 25;
const int motor_a = 26;
const int motor_b = 27;
const int buzz = 14;
const int led = 4;
//const int touch = 1;

unsigned long starttime;
unsigned long endtime = 0;

#define SOUND_SPEED 0.034

long duration;
float distance;

//int laststate=LOW;
//int currentstate;

/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial

/* Fill-in your Template ID (only if using Blynk.Cloud) */
#define BLYNK_TEMPLATE_ID "TMPLvhZs8pdW"

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "WOAEARmJs0zsCaKfY2t8blhZXZdrj3-0";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "KING NIPUN";
char pass[] = "King@1nipun";
```

```

BLYNK_CONNECTED() {
    Blynk.syncAll();
}

void opening() {
    MotorUP();
    display_open();
    timer.setTimer(1000, activity_on, 5);
    timer.setTimeout(6000, MotorOFF);
}

void closing() {
    MotorDOWN();
    display_close();
    timer.setTimer(1000, activity_on, 5);
    timer.setTimeout(6000, MotorOFF);
}

void MotorUP()
{
    digitalWrite(motor_a,LOW);
    digitalWrite(motor_b,HIGH);
    analogWrite(motor_speed,30);
}

void MotorDOWN()
{
    digitalWrite(motor_a,HIGH);
    digitalWrite(motor_b,LOW);
    analogWrite(motor_speed,30);
}

void MotorOFF()
{
    digitalWrite(motor_a, LOW);
    digitalWrite(motor_b, LOW);
    activity_off();
}

void plz_wait() {
    clean_display();
    lcd.setCursor(0,1);
    lcd.print("Please wait..!");
    timer.setTimeout(3000,clean_display);
}

void clean_display() {
    lcd.clear();
}

void display_open() {
    lcd.setCursor(5,0);
    lcd.print("OPENING");
    timer.setTimeout(2000,plz_wait);
}

void display_close() {
    lcd.setCursor(5,0);
    lcd.print("CLOSING");
    timer.setTimeout(2000,plz_wait);
}

void display_detection() {
}

```

```

lcd.setCursor(0,0);
lcd.print("Obstacle found:");
lcd.setCursor(0,1);
lcd.print(distance);
lcd.print(" cm");
timer.setTimeout(5000,clean_display);
}

void object() {
    digitalWrite(led,HIGH);
    digitalWrite(buzz,HIGH);
}

float obstacle_sensor() {
    digitalWrite(trigPin, LOW); // Clears the trigPin
    delayMicroseconds(2);
    // Sets the trigPin on HIGH state for 10
    micro seconds
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW); // Reads the echoPin, returns the sound wave
    travel time in microseconds
    duration = pulseIn(echoPin, HIGH); // Calculate the distance
    distance = duration * SOUND_SPEED/2;

    Serial.print("Distance (cm): ");
    Serial.println(distance);

    return distance;
}

void activity_on() {
    digitalWrite(led,HIGH);
    digitalWrite(buzz,HIGH);
    timer.setTimeout(500,activity_off);
}

void activity_off() {
    digitalWrite(led,LOW);
    digitalWrite(buzz,LOW);
}

BLYNK_WRITE(V0)
{
    int value = param.asInt();

    if(value==1) {
        opening();
    }

    if(value==0) {
        closing();
    }

    if(value==2) {
        MotorOFF();
    }
}

void setup()

```

```

}

Serial.begin(115200);
lcd.init();
lcd.backlight();
SPI.begin();

pinMode(trigPin, OUTPUT);
pinMode(4, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(motor_a,OUTPUT);
pinMode(motor_b,OUTPUT);
pinMode(motor_speed,OUTPUT);
pinMode(led,OUTPUT);
pinMode(buzz,OUTPUT);

Blynk.begin(auth, ssid, pass);
Blynk.virtualWrite(V0,2);
}

void loop() {
starttime=millis();

if(starttime-endtime>=500) {
endtime=starttime;
obstacle_sensor();
}

if(distance<=10) {

clean_display();
MotorOFF();
object();
display_detection();
delay(5000);
activity_off();
Blynk.virtualWrite(V0,1);
Blynk.syncVirtual(V0);

}
else{
Blynk.run();
timer.run();
}

}

```

Conclusion



Level of Completeness

Prototyping



Features



Delighters



TESTING & Deployment

STAGE-5

Submitted By:

Nipun Patel

AU19B1009

Submitted To:

Satyajit Pengaokar

Course Lead

Problem Statement

To test and deploy the ADT Application, the student must prepare a test plan with different test cases and execute the black box testing for different input values. This will lead to verifying the functionality of the system as per the user requirements.



We decided to test our application on 10 major test cases which could prove our application to be a efficient and sustainable solution in the world of Space saving furnitures.



12 Test Cases



Cloud Deployment

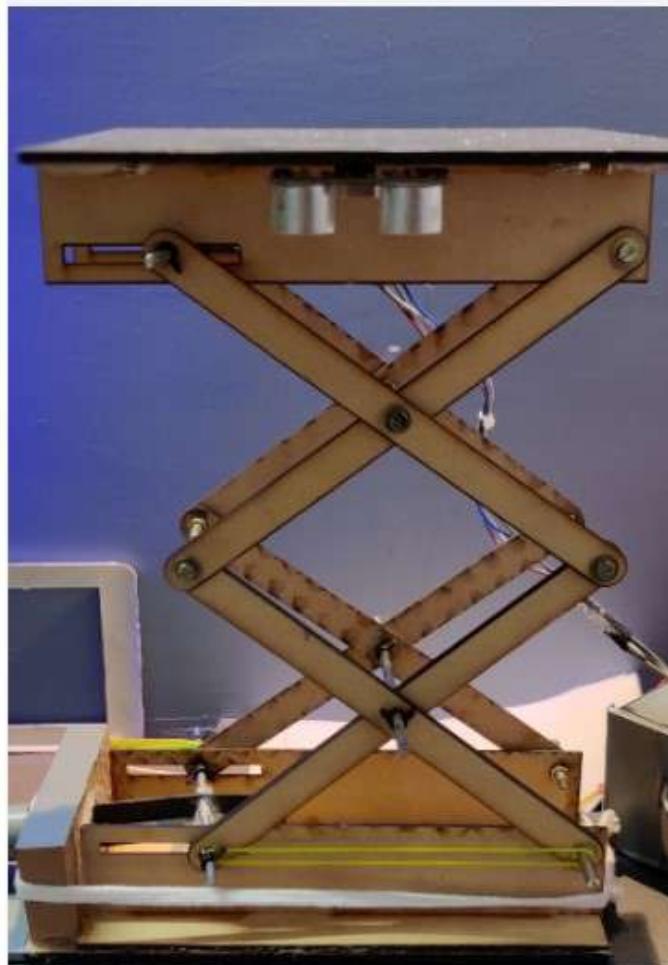


Black Box Testing

Test Case -1

Implementation is in Linear Motion

We made the use of a scissor lift and Linear actuator to make the movement linear so that our bed could move up & down in linear manner



STATUS *passed*



HOW DOES IT WORKS?



With Electricity



With Speech



Through Mobile Application



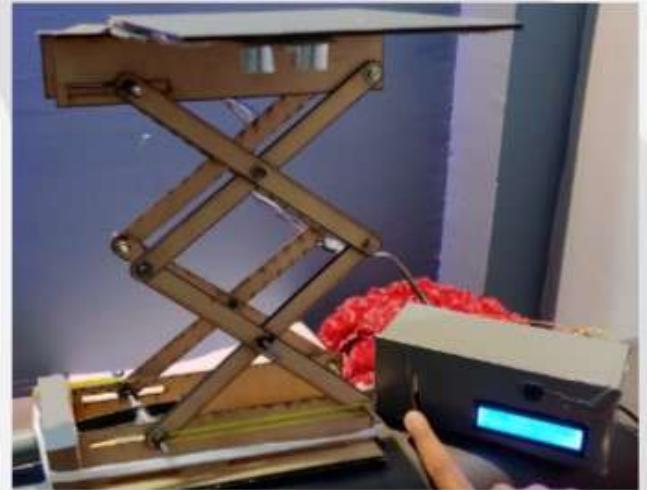
With a Manual Button too.

Test Case-2

Automatic Motion On Button Click

The User can interact with the system with just a single click of a Button. We have used Touch Buttons for it.

STATUS *passed*

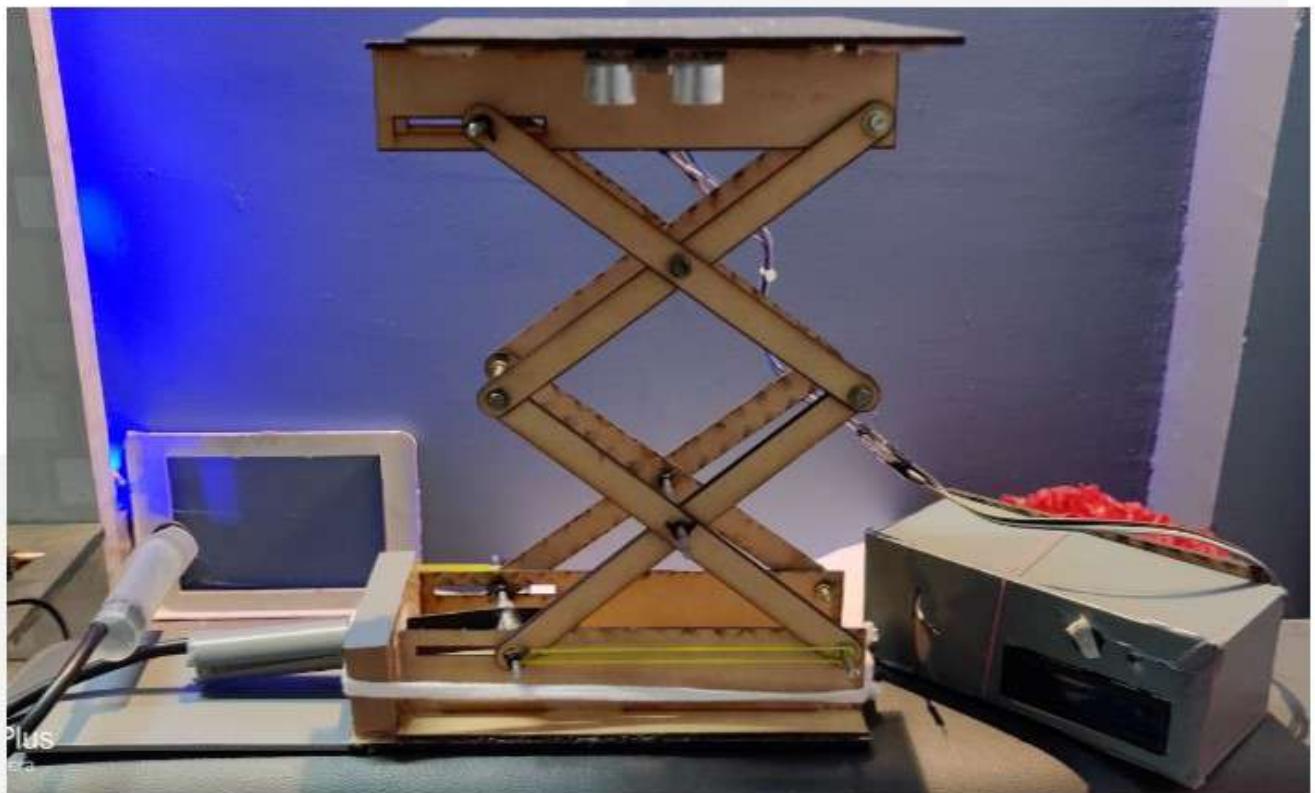


Test Case-3

The Solution is Easy to Install, Durable & Strong

STATUS *passed* 

The most important thing of any physical product/mechanism is its installation, Our products is easy to install, You just need to click buttons or use your voice

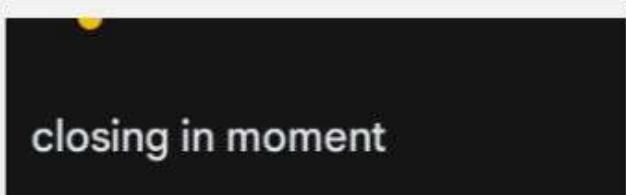
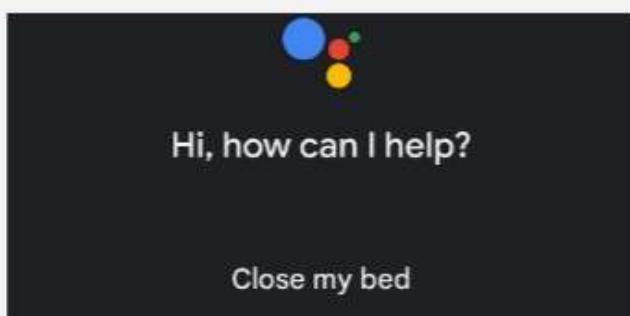
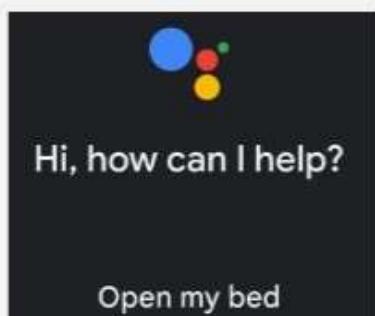


Test Case -4

Automatic Motion on Speech Recognition (Google Assistant & Alexa)

The product could detect the voice of the owner and with the help of speech commands via google assistant or Alexa the mechanism could be controlled

STATUS *passed*



HOW DOES IT WORKS?



Set Up Your Voice with Google Assistant



Through Mobile Application



Say the Phrase you choosed

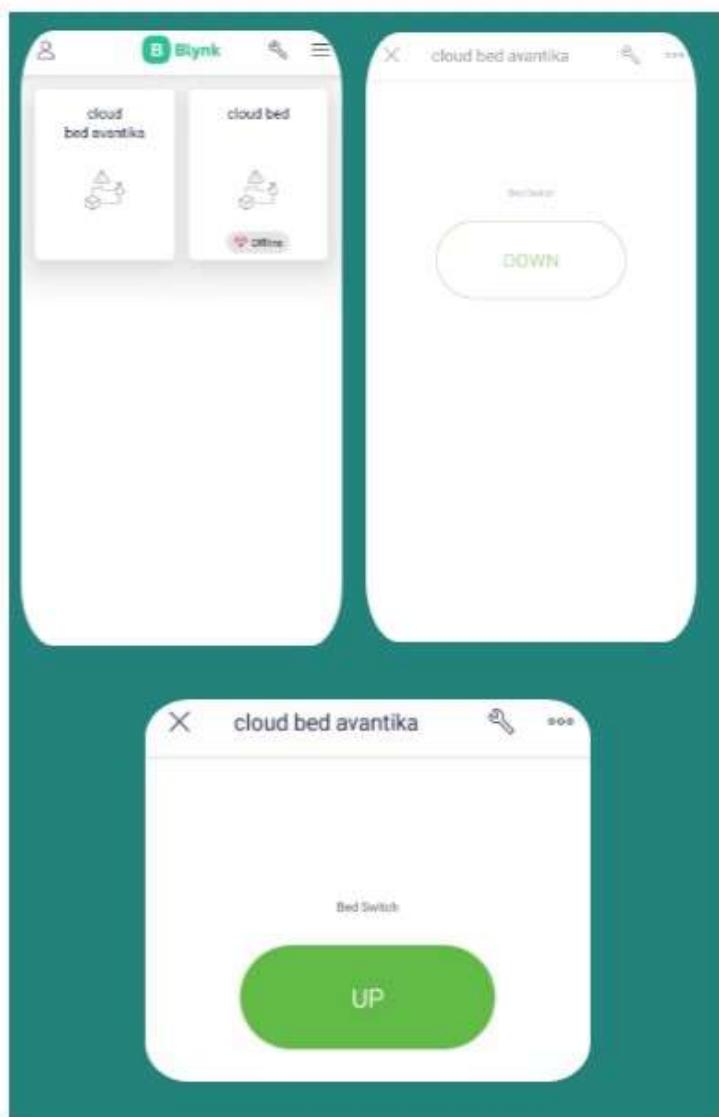


The Mechanism Starts

Test Case -5

Automatic Motion with the help of a User-Interface (Mobile Application)

The product could be accessed via a mobile application too which is having a very user-friendly and simple interface. You just need to have Blynk application



STATUS *passed*



HOW DOES IT WORKS?



Install Blynk Application



Or Use its web-Interface



Click The button



The Mechanism Starts

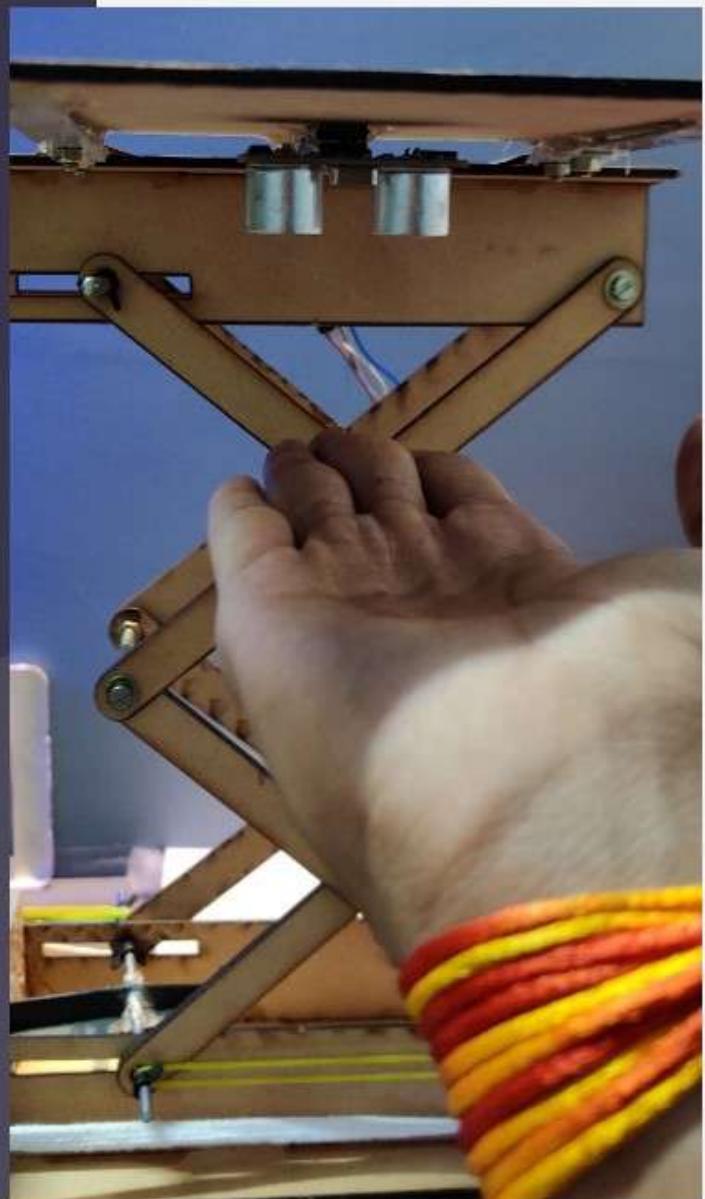
Test Case -6

Identification of any Object below it

The Security of the mechanism was our foremost goal so the architecture of our product is designed in such a way that whenever it's in the opening or closing phase it detects the object at a distance of 5 feet from it and gets automatically stopped. This is implemented to prevent any accidents.

After waiting for a minute it again check whether the object is there or not, if the object is not found it continues to operate else it alerts with a beep sound

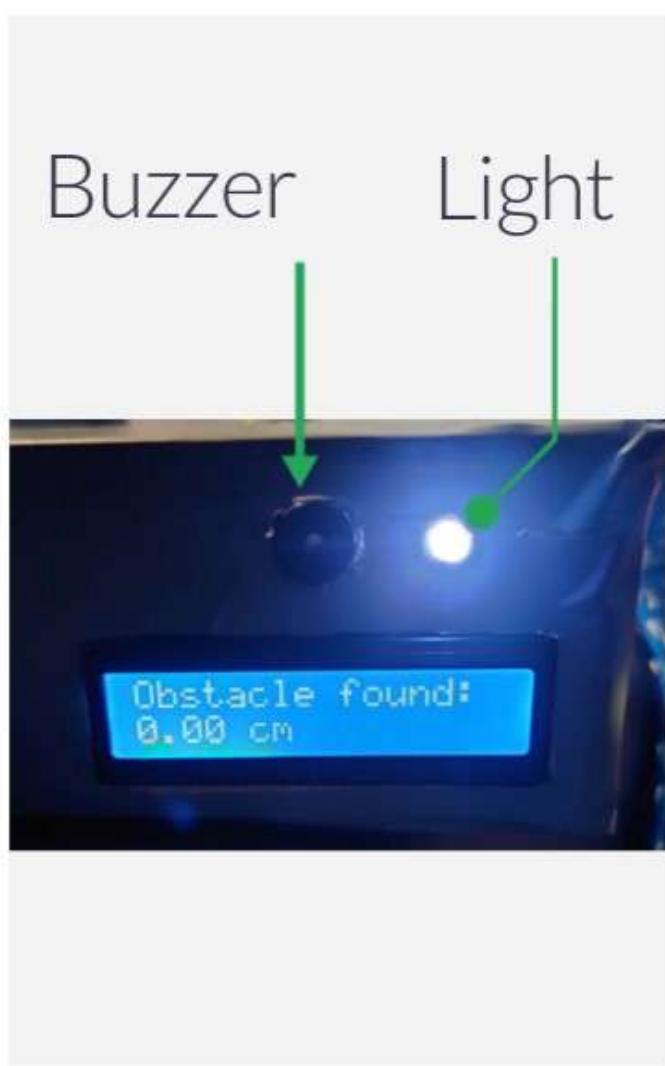
STATUS *passed*



Test Case -7

Alert Sound on Object Detection

In the opening or closing phase it detects the object at a distance of 5 feet from it and gets automatically stopped. This is implemented to prevent any accidents.



STATUS *passed*



HOW DOES IT WORKS?



Detects the Object



Alerts Via
Beeper



Waits for 5 sec



The Mechanism
Starts again

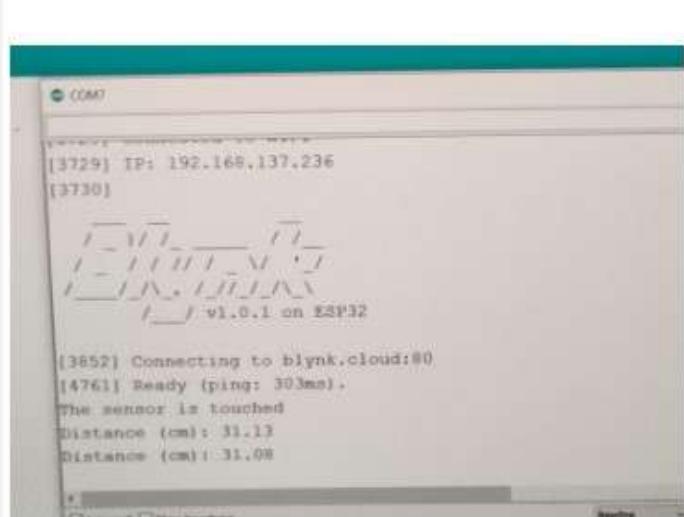
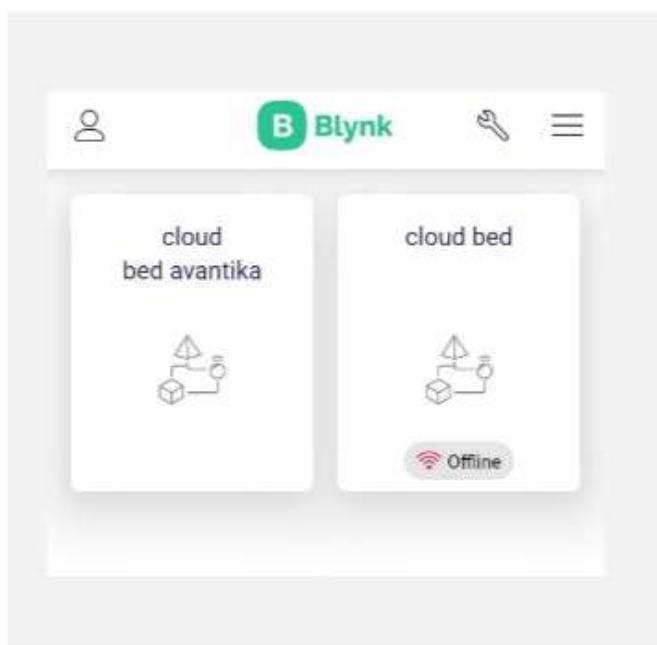
Test Case-8

Visibility of System Status

STATUS *passed*



The system was designed in such a way that it should inform or keep the user updated with all the background processes running inside it so that the user could act accordingly.

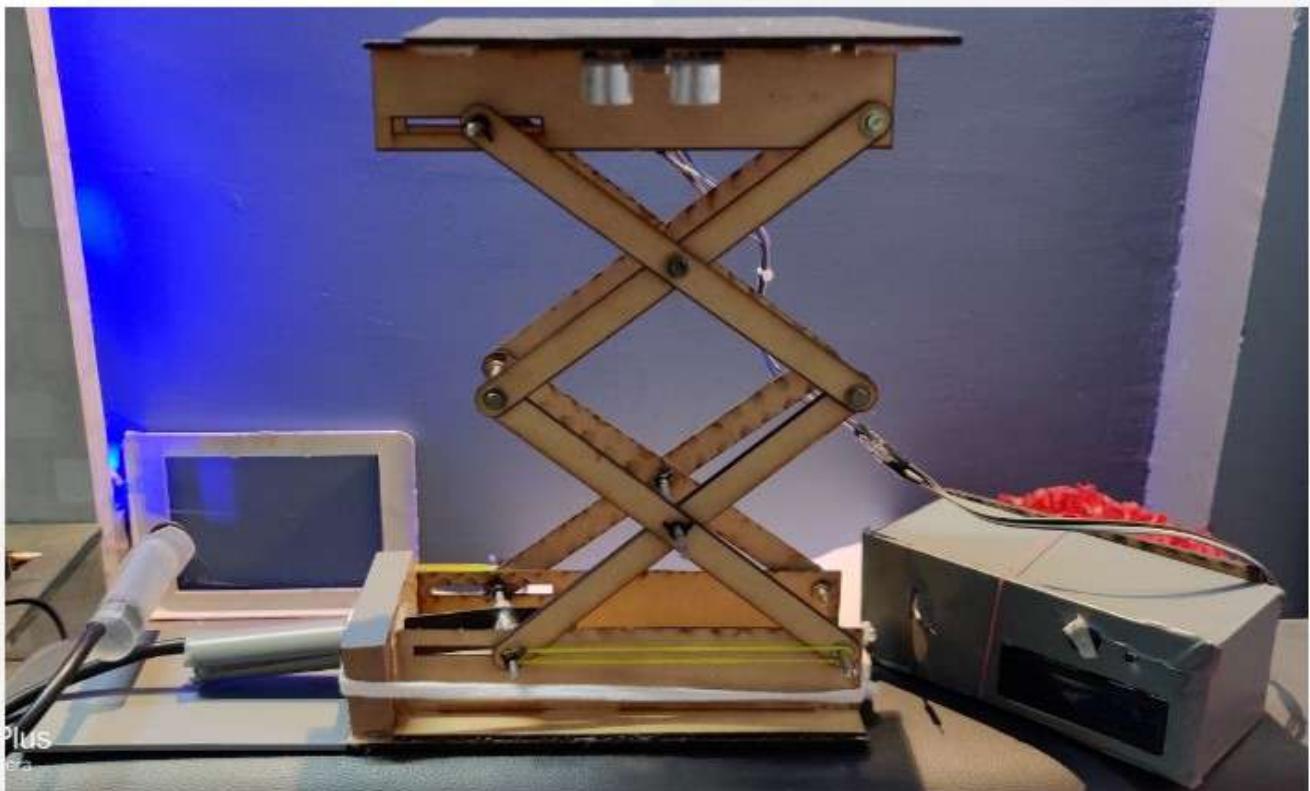


Test Case-9

Controlled & Smooth Motion

The system should operate smoothly without making much noise and should get lifted up and down in a smooth manner.

STATUS *passed*



Test Case-10

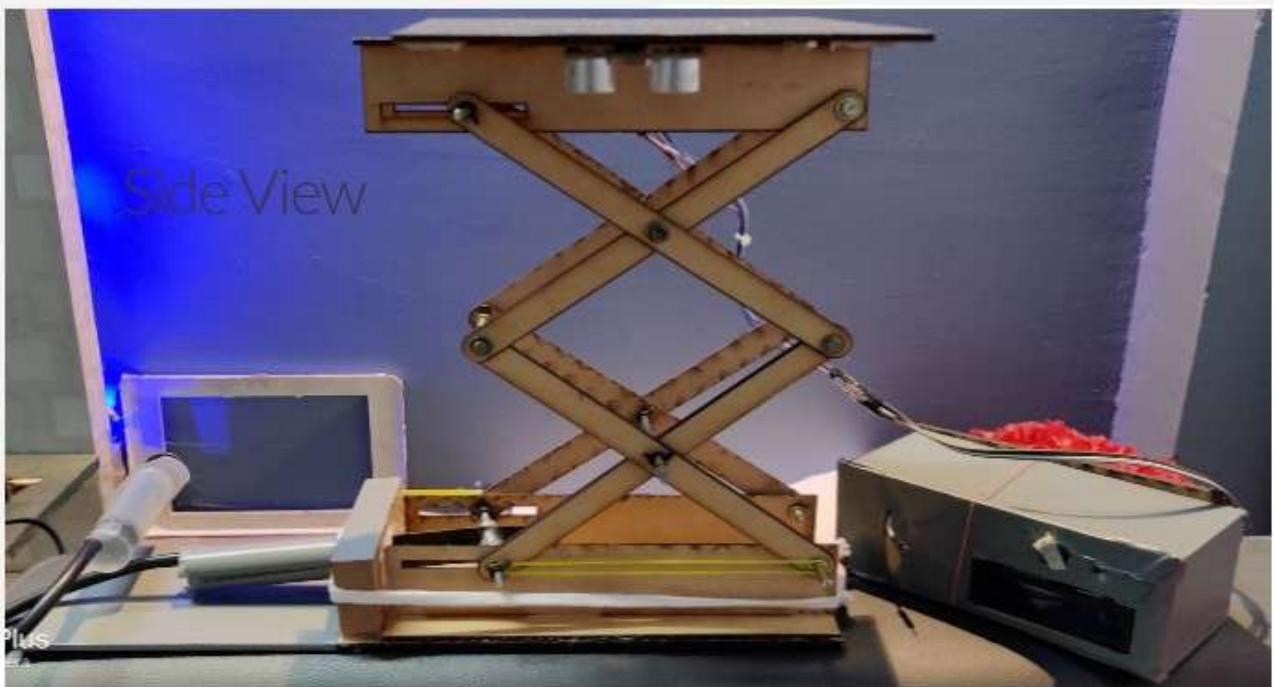
Aesthetics & Minimalist Design

The system should be appealing and minimalist in design taking less space for installation and giving a more appealing look.

STATUS *passed*



lateral-view

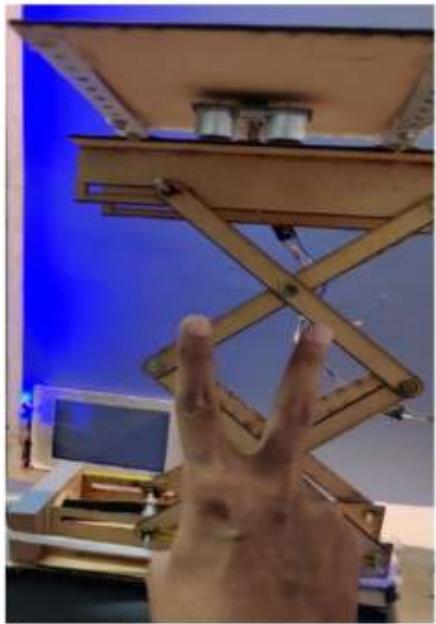
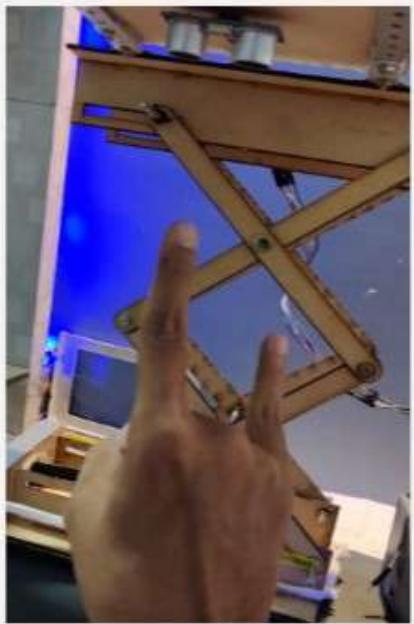


Test Case-11

Automatic motion with the help of gesture

The system is unable to move with the help of hand gestures.

STATUS *failed* ✗

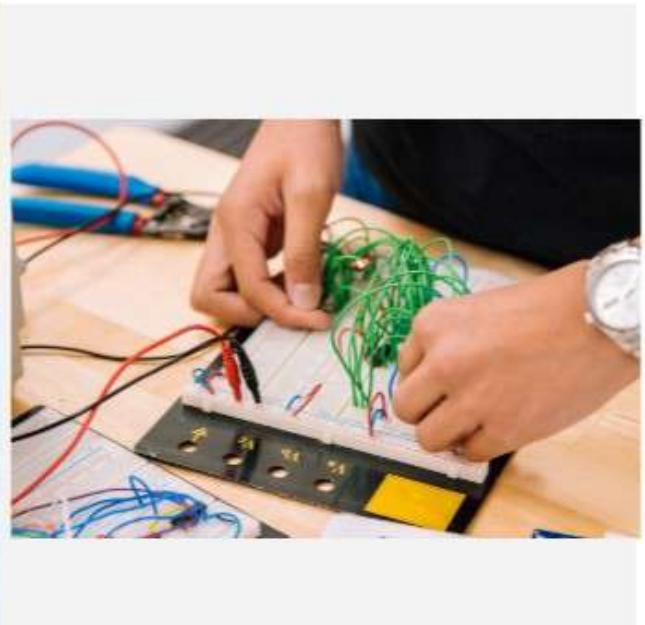
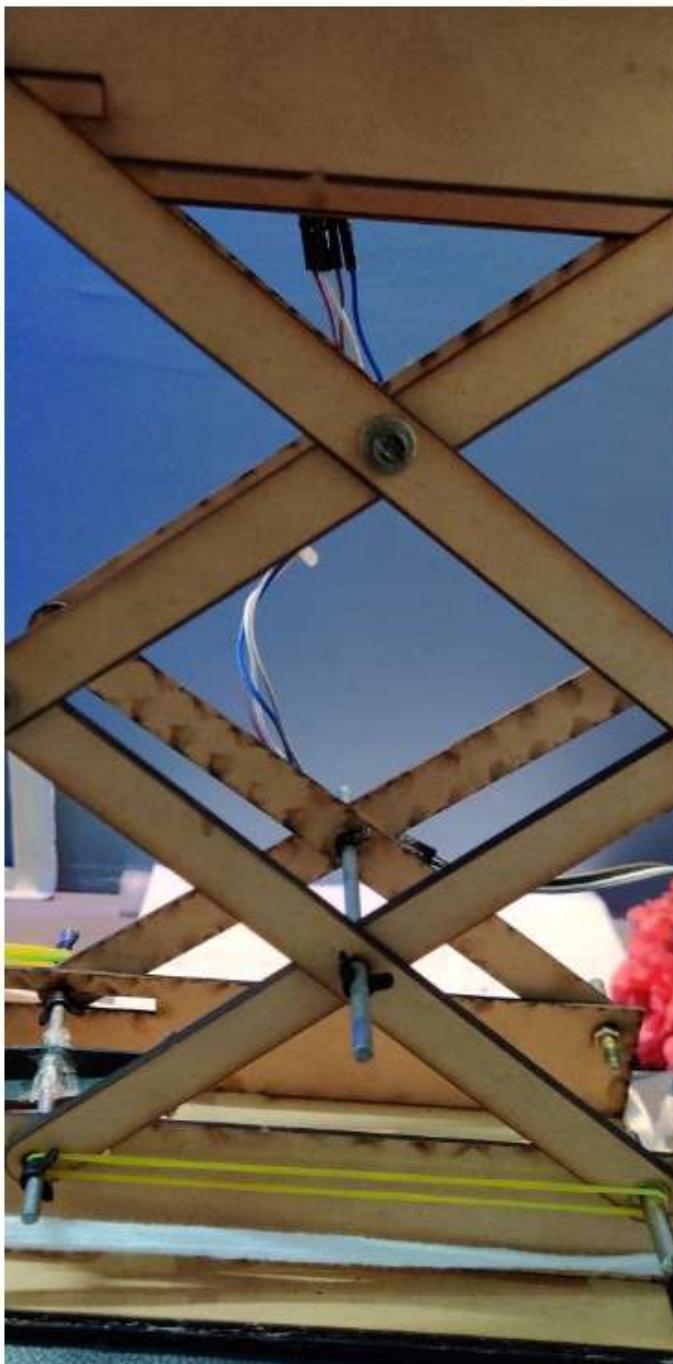


Test Case-12

Identifying opening time using deep learning

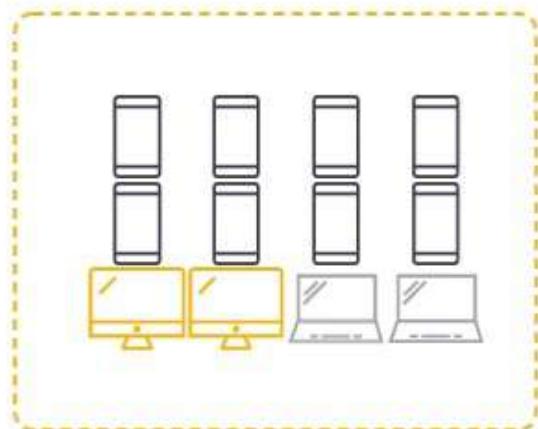
The system is unable to record the general time of its opening and closing.

STATUS *failed* 



```
wp_enqueue_style('lp-fotorama');  
wp_register_style('lp-styleSheet', get_stylesheet_directory_uri() . '/css/styleSheet.css');  
wp_enqueue_style('lp-styleSheet');  
  
//adding scripts file in the footer  
wp_deregister_script('jquery');  
wp_register_script('jquery', 'https://code.jquery.com/jquery-3.5.1.min.js');  
wp_enqueue_script('jquery');  
  
wp_register_script('lp-plugins', get_stylesheet_directory_uri() . '/js/plugins.js');  
wp_enqueue_script('lp-plugins');  
  
wp_register_script('lp-js', get_stylesheet_directory_uri() . '/js/main.js');  
wp_enqueue_script('lp-js');  
  
wp_register_script('lp-fotorama', 'http://malsup.github.com/jquery.fotorama.js');  
wp_enqueue_script('lp-fotorama');  
}  
function lp_setup() {  
add_theme_support('post-thumbnails');  
add_image_size('slider', 900, 426, true);  
add_image_size('banner', 900, 256, true);  
add_filter('image_size_names_choose', 'my_custom_size');  
}
```

Web Deployment



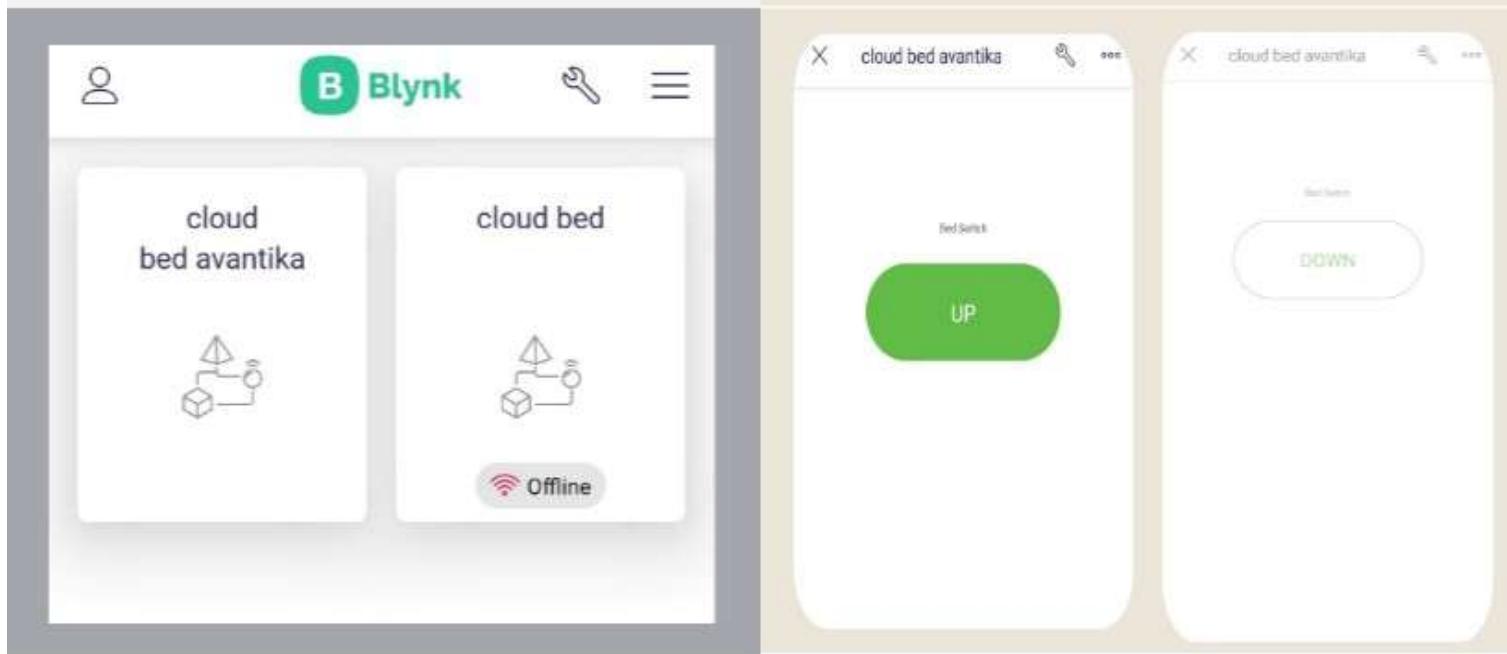
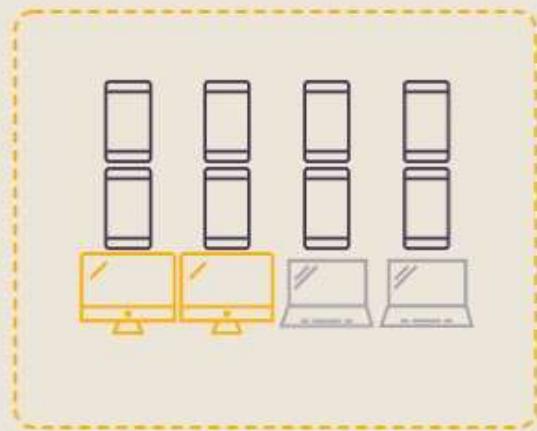
A screenshot of a web-based dashboard titled "cloud bed". The dashboard includes a header with tabs: Info, Metadata, Datastreams, Events, Automations, Web Dashboard (which is highlighted in pink), and Mobile Dashboard. Below the header, there is a section for "Device name" with a placeholder "cloud bed" and fields for "Device Owner" and "Company Name". A "Dashboard" section shows time filters from "Last Hour" to "Custom". At the bottom, there is a button labeled "Bed Switch (w)" with a toggle switch set to "UP". The footer of the browser window shows "Not on OnePlus" and "Powered by Triple Camera".

Here is the detailed number of days we dedicated to build this portion of project

ADT Project Planning
Nos of Days



mobile Deployment



Here is the detailed number of days we dedicated to build this portion of project

ADT Project Planning Nos of Days

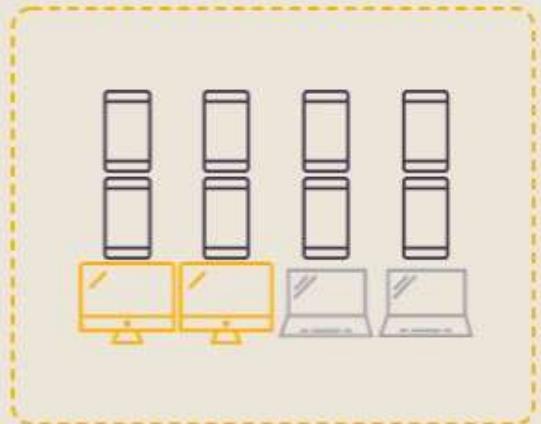


■ Mobile Deployment 4

■ Design 20

■ Development 15

physical Deployment



Here is the detailed number of days we dedicated to build this portion of project

ADT Project Planning
Nos of Days



■ Physical Deployment 3

■ Design 20

■ Development 15

Black-Box testing

Black Box Testing is a software testing method in which the functionalities of software applications are tested without having knowledge of internal code structure, implementation details, and internal paths. Black Box Testing mainly focuses on the input and output of software applications and it is entirely based on software requirements and specifications. It is also known as Behavioral Testing.



Black-Box Testing Points

S. Nos	Test Cases	Response Time	Usability	Reliability
1	Linear Implementation	Very Quick	95%	95%
2	Durability	-	80%	85%
3	Ease of Use	-	95%	95%
4	Movement with Button	Very Quick	95%	95%
5	Movement with Speech	Quick	95%	95%
6	Movement with UI	Very Quick	95%	95%
7	Object Identification	Very Quick	99%	99%
8	Alert Sound	Very Quick	95%	95%
9	System Visibility	Quick	80%	80%
10	Smooth Motion	-	80%	80%
14	Aesthetic & Minimalist	-	80%	80%

Conclusion

1

We have used Blynk Cloud for Websites

2

We have used Blynk app for Mobile Application

3

For the Integration of Voice we had used IFTT along with Google Assistant

4

We made the physical Model in Fab-lab

5

Hence we were able to successfully implement the all tasks given to us by industry person.

BUDGET

Based on the agreement with the industry person we have created 2 design implementation. The cost of each is:

Invoice #1

Testing Model (Prototype)

Up to **800** Rs ~

Invoice #2

Main Model (Physical)

Up to **15,000** Rs ~



I worked with one of my classmate on this project. All the work was done in a tracked and timely manner. Division of work was equally done between the group partners based on skillset and Knowledge.



"Helped and Guided us in building the mechanical prototype. Also helped us in proper documentation and overall efficiency of the model. We are very glad to have him as our mentor on this project because throughout the journey he kept a check on us and provided us with his precious inputs"

- Varun Tiwari



Always Supported and Helped. The Guidance at every stage played a key role and always motivated us to do extra.

-Satyajit Pengaokar

