

DESIGNING AND SIMULATION ANALYSIS OF ROBOTIC BEE MODEL *

BY

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ABSTRACT

Times are changing, and it's very omnipresent with the modernization encircling our life. Perhaps, this is a giant leap for humankind, although it has very derogator symptoms for our Environment, and as a result, the smaller creatures which are holding the pillar of our micro-environment are crippling. Bees are the topic in focus here, is vitality for our agriculture to nurture and stay potent. In our journal, we cover how Robotic bees can take up the task of pollination and end the era of pollination scarcity. Introducing a robot Bee, assembled with smart sensors designed compact and lightweight capable of performing many tasks under various environmental conditions. An outstanding bio-inspired micro aerial vehicle focusing on pollination & soil pH measurement.

To design and simulate the design, we used fusion 360. Software to model and carry out stress tests, such as tensile, crash tests, and how much maximum load it can carry out. Moreover, this thorough analysis gives us a perfect picture of how the miniature model will work in real-time. To avoid using any heavy software to control our robots, we will rely on machine-learning where electronic chips work to execute a task. Using IOT – internet of things gives us an edge over normal AI-controlled robot.

KEYWORDS

Robo-bee, Internet of things, Augmented reality, machine learning, Auto-desk 360.

I.INTRODUCTION

We all know the tiny bugs play a crucial role in the micro-environment by dusting the anther of a flower to another. This insignificant act is the reason why flora and fauna persist after millions of

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years. In this time of 50 million years, older than when the first flowers appeared. The bee's perseverance is necessary for agriculture. It is changing now; industrialization is a crucial factor in decimating their genetic generosity. Also, an undebatable amount number of research papers are showing how bees are entering the RED list. The RED list of animals, explains about animals hunted or poached and plants, logging, causing their numbers to decrease. Then they end up becoming extinct. An infamous example is the dodo bird, which was hunted on a large scale for its wings.

Large colonies collapsing in thin air, no clue, no proof, no justification of any precise cause. This is a cause of concern as bees do the majority of the pollination in the entire world, and we need to preserve this.

Inspiring from the problem of colony collapse disaster we had to generate ideas and solutions from scratch. On a micro-scale, small changes have a big effect on the model. Inspiring from the biology of Honey Bee we started quick step-by-step idea generation and development of a Micro Aerial Vehicle "FLORA-BOT". Applications of the Flora-Bot could possibly assistance with crop pollination, environmental monitoring, and search-and-rescue operations.

II. LITRATURE SURVEY

We also carried out a public survey and the data revealed a lot of relevant data to carry out this project. We conducted a public survey of how bees are declining. Three teams of farmers responded to this survey. The first team of farmers said that in 2000, there used to be about one beehive every two-acre land.

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The type of bees found were small Asian bees, they added. The second question regarding current beehives present, they said that one about every eight acres of land there is one beehive. When we asked for a reason, they said "it's like that, no one knows why also wild beehive bread is a delicacy." This means that humans are also a reason for beehives numbers decreasing.

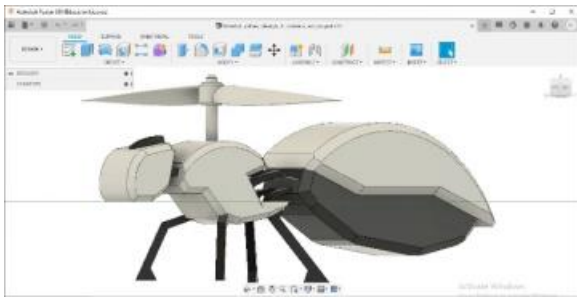
They also stated that the drop in beehives was gradual and that now wild plants are not very diverse. Many

old species just do not grow anymore, just our agricultural plantation grows.

The second team of farmers stated that in past there used to be a beehive every five acre-land and now it's about eight acre-land that a beehive is present. They said that the decrease in bees was nothing significant as it was so less it did not matter, adding that there was not much

change in trees present as there was plenty of water present. The team of second farmers did not go through a lot of change.

The third team of farmers noted that there used to be about three beehives every acre-land and over time they are gone, not a single beehive. They specified that it was a significant change as their rate just started dropping, and slowly but surely, they vanished. This did not affect the natural diversity of plants and not a lot of changes in plant numbers. There are multiple concepts for artificial pollination, but the concept that we have devised is much more precise and uses modern technology to control multiple Robo-bees with the help of augmented reality. Pollination is the process of the male germ fusing with the female gamete. This way new embryos are born and pollination occur.



III.MATERIAL DETAILS

The materials used for simulation: ABS plastic, Acrylonitrile butadiene styrene a thermoplastic polymer.it is widely used in 3D printing and building material for its rigidity. Moreover, it is highly resistance to corrosive chemicals and impacts; and stainless steel for the propellor rods to hold the propellor. It is rigid and is resistant to corrosion.

Table 1:properties of ABS plastic

Elongation at break	Elongation at yield	Strength at break (tensile)	Strength at yield (tensile)	Youngs modulus
10 – 50 %	1.7 – 6 %	29.8 - 43 MPa	29.6 – 48 MPa	1.79 – 3.2 GPa

IV.DESIGN

Developing robots with close resemblance to insects has been an area of interest for quite a decade. Along with mechanism and components, the design of the Robo-bee should be efficient

to take a controlled flight and should be much stable to perform tasks in an air pressured atmosphere.

We very rapidly build reliable prototypes, which allowed us to be more aggressive in how we test them, the team has gone through 4 prototypes in just the past four months.

Table 2: property of prototype model

Physical material	density	Ultimate Tensile Strength	Young's modulus	Yield strength	Thermal conductivity
Abs plastic	1.06E-06kg/mm ³	29.6MPa	2.24GPa	20MPa	1.6E-04W/(mm C)
Stainless steel	8E-06 kg/mm ³	505MPa	195GPa	215MPa	0.0162W/(mm C)_

However, there are two factors that are considered the weight of the robot and the maximum thrust that each wing can generate. Namely, we cannot guarantee the generation of sufficient thrust and moments to enable the robot to take off and stabilize itself until any experiments

The body of Robo-bee consists of three parts.

1 Head

The head of Robo-Bee has outlined considering factors like aerodynamics, Angle at which it will receive the oncoming air, the speed at which it moves, etc. The head consists of 3 components.

1.Eyes: We have used a 12MP camera for navigation and path control while an environment monitoring sensor.

2.Chin: Sticky plate with micro voids on the surface, enabling the pollen grains to stick on the plate from one plant for the transferring process. A vibration mechanism attached to the sticky plate helps to lose the pollen grains to other plants.

3.Antenna: The antenna of the Robo-Bee has been designed like a shark fin considering the air resistance and aerodynamics.

2 Thorax

Thorax is the middle part of the Robo-Bee and is the anchor point for four legs and the holding mechanism for the propeller.

3 Tail

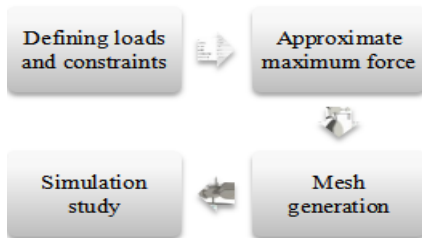
For our design tail is the powerhouse of the Robo-Bee. Battery, a centre of gravity adjusting mechanism and small storage for carrying plant seeds inside the tail



Figure 2: Robo-bee compared to floor tiles (rendered image Auto-desk fusion 360)

V.SIMULATION

To examine the performance of the robotic bee multiple simulations are carried out for distinct parts of the robotic bee using Autodesk Fusion 360. Designing a quality model without prototyping is a quite challenging task so we performed a static simulation to analyse the deformation and stress into the model from structural loads and constraints. Static simulation provides the required data to calculate the strength of the design. To calculate the structural loads and boundary conditions, we have performed modal frequencies study for distinct parts of the robotic bee.



flowchart 1: flow chart showing how we did our simulation study.

VI.MESHING

Meshing the model before analysis is very essential for more accurate results. Tetrahedral meshing with refinements is applied to the design. Initial and boundary conditions to the meshed model are applied which include fix and moving constraints as well as load conditions. For the meshing and analysis purpose, we used Autodesk fusion 360.

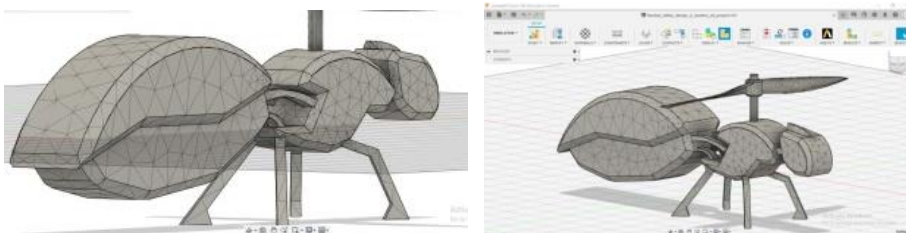


Figure 3,4: meshing in real time

1.Jacobian ratio

Jacobian ratio tells us about how much a body can bend or change shape without permanent changes. The bending is defined over a scale from -1 to 1 and our simulations study.

According to the meshing the Jacobian ratio for overall model is in the range of 0.4 to 1.0 while worst ratio is 1.31 on element 1148, 1.23 on element 1313, and 1.10 on element 2156.

2.Aspect ratio

It is ratio of the longest to the shortest side of element cell. For best result it should be near to 1 to get best result

VII.SIMULATION STUDY

Simulation results:

When the parts of the Robo-bee are applied with 1 N force, static simulation show that the Robo bee can withstand the applied amount of force, so we increased the amount of force and found that the bee can withstand a maximum of 5N force before it breaks

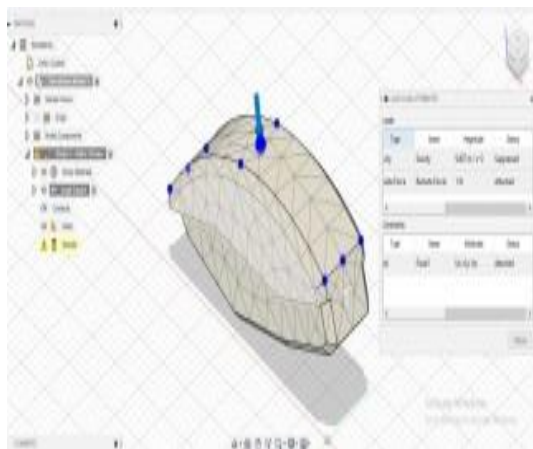


Figure 6a: first is reaction force, 2nd displacement, 3rd strain, 4th stress, so writ accordingly)

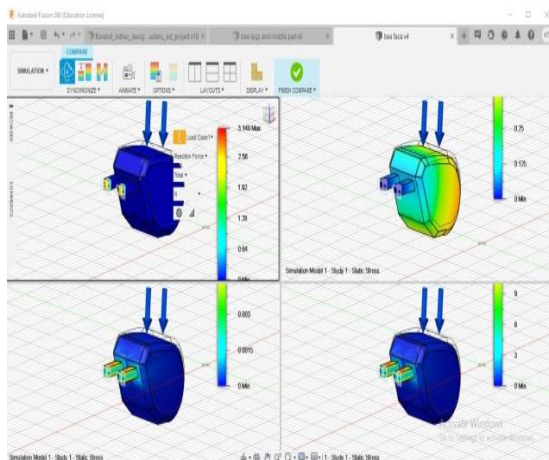
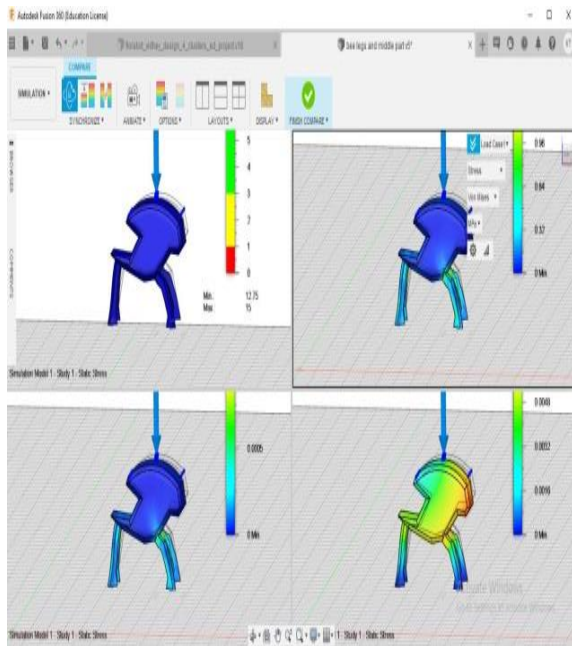


Figure5b: first is reaction force, 2nd displacement, 3rd strain, 4th stress, so writ accordingly



VIII.LIFT

After properly selecting parts for building a drone, the approximated weight is around 98 to 110 grams. To overcome the weight of 0.9 N and take off the lift force should be greater than the weight. Therefore, the lift required for the propeller is

$$L = 0.90 - 1.10 \text{ N}$$

With this considerable amount of force, the Robot-bee will hover. To accelerate the Robot-bee and proportionately increase its desired altitude, this lift force must be greater than 110N.

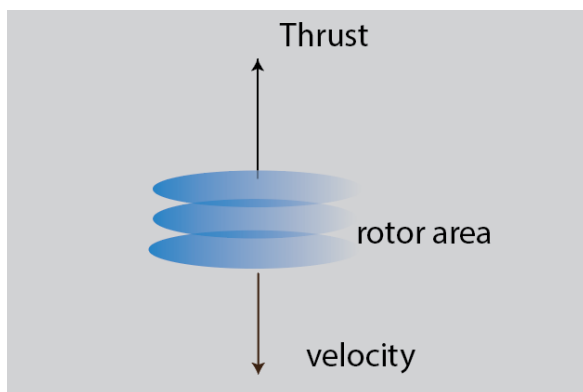


Figure 7: Lift from rotor thrust

IX.IMPLEMENTATION OF AR AND ML

How are we going to control or execute the pollination by the Robo-bee? The robot will be based on the principle of Augmented Reality, IOT and Machine Learning.



Use of Augmented Reality in the robot-bee:

- Using this we will be able to see the 3D view of the environment in AR which will act as a virtual robot so that we can see how the real robot is working.
- We will be able to track the robot-bee using the GPS system.
- For pollination there will be a

Use of Internet of Things (IOT) in the robot-bee:

- The eyes of the robot-bee will play the role of a small camera from which we will be able to see the video.
- The sensors which we are going to use are Micro collision detector, PH Sensor, Humidity Sensor.
- All the three sensors and the camera will be connected to a high speed WIFI network.



Use of Machine Learning in robot-bee:

- Machine learning will be the main part of the control system as it will act as the brain of the robot-bee.
- This will help the bee to execute its work as all the data will be stored in it so the bee will act and work accordingly.

- □The sensors will also be based on machine learning.

CONCLUSION

There may be countless ways for pollination, although our prototype and simulation are an autonomous and has a target operation. Making it efficient.

Studies in the field of flying drones include fixed and flapping wing vehicles. Deeply studied.

The classification includes various categories of drones, such as unmanned air vehicles (UAV), micro air vehicles (MAV), nano air vehicles (NAV), and Pico air vehicles (PAV). These capable drones can be operated to efficiently perform various civil and military operations which thoughtfully include crop pollination, soil ph & moisture sensing, search and rescue, environment protection, space exploration. Possible solutions for the possible challenges faced for design were carefully calculated and properly discussed. In addition to that, we performed static simulation and modal frequencies simulation. performing simulation is very important in case when you have no prototype for testing and methodology. form the simulation we concluded that the robot bee can bear minimum of 300-gram force after that the distortion of the body will gradually increase. The lift force for flight was also discussed.

In this project, we have used Fusion 360 software to develop the design and undergo the simulation part. All the data calculated with the properties is stored in it. From simulation study we come to know that the worst Jacobian ratios found are 1.31, 1.2, and 1.1 over some elements of mesh. Some elements also have worst aspect ratio which needs to be corrected. Now that we have this great platform, there are several tests we are planning to perform to test Flora-Bot in more rough conditions and do research on stable flight, control system and landing options, and to design more efficient and light weight.

The public survey carried out by the team members helped us a lot for our further research. The materials listed in the paper would support the model. The design making and simulation work were a bit challenging part as we had to develop a proper design which will actually look the same as honey bee. The simulation work done by our team member gave 100% result which was a boon to us. Through the simulation study we are sure that the model will be able to handle stress and the bee will be able to handle a maximum of Newton force. Applying Augmented Reality, Machine learning and IoT to the robot-bee will be best thing through which we will be able to control and see the Pollination work.

More – over we also plan on integrating this technology to an application. which improvements it is introduced to corresponding fields of robotics.

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