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Design and Fabrication of Multiple Type Fruit Picking Stick using Renewable Energy Source

M.Chandru, R.Gowthamvishal, Mr. M. KARLMARX M.E.,

S.Hariharansudarson*Assistant Professor,*

Department of Mechanical Engineering, K.L.N College of Engineering, Sivagangai, (India)

ABSTRACT

This paper presents the realize of shape adaptability and stable grasping for fruit mechanical picking. As such, the fruits are being imported and their price on the local market has increased. As part of a solution, this work looked at presenting a mechanical fruit picking device which could assist in the reaping process. Requirements for the device were gathered from local farmers and the device was designed, built and tested for various fruit like mango,guava, orange, pomegranate. The design calculation for the fabrication is done by using ANSYS software. The picking stick should be lightweight, low cost, high efficiency, convenient operation and easy maintenance.

Keywords: Mechanical fruit picking, Shape Adaptability, Stable Grasping.

I. INTRODUCTION

In day-to-days life fruit damage is the vital problem facing by farmer's. It occurs in various ways while picking, by using sharp edge material like scissors, blade, knife etc., by picking manually the fruits get damaged by falling down that's a permanent damage or the labour can fell down in case of shrubs or tall trees. Current forms of harvesting include shaking the trees by hand, climbing the trees and using ad-hoc pickers made out of scrap material. To ensure the fruit is not damaged during picking, fruit picker was designed. Now days the manual picking is more complex during high height, they get damaged easily. Hence it contributes to decrease in production of fruit and thus the fruit cost is increased in market. Therefore, the consumer need to pay more to buy a fruit. To overcome this problem the fruit picking stick is designed. Depending upon the type of fruit tree, their growth is maximum up to 15-18feet. So, we need to design the stick for 14 feet. During the lifting by human their height also need to include it. Average height of the human is 5 feet. Human can maximum lift the stick up to his shoulder that height is 4 feet, include the stick height with it, so totally we obtain 18 feet. We also need concentrate on basket rather than height to obtain without damage fruit. The basket should be mounted in top the stick. The basket should with stand the weight of the fruit and gravitational force. The gripper is needed to provide a necessary cutting force. The stipping cutter is used to cut the fruit. Selection of stipping cutter because of high strength to cut any type of fruit steam. Here we use one of the new type mechanism for extending the pipe like telescopic model. The device should be convenient operation and easy maintenance.

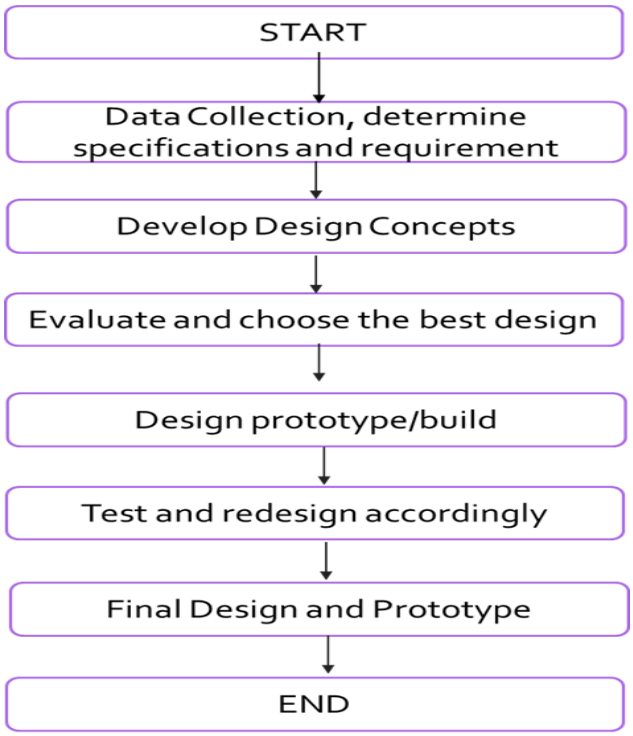
PROBLEM DESCRIPTION:

- Fruit get damaged while manual picking.
- Labour shortage and High incentive problem.
- Problems in handling equipment due to illiteracy and not in affordable prices.
- Not sophisticated to use by women and children due to heavy weight.

OBJECTIVE:

To pick the fruit without damage, with safe condition. Efficiency of picker should have the ability to pick the fruits in a specified period of time. Cost should be affordable. The fruit picker ought to be light weight. Simplicity of operation can be easy to handle.

II. METHODOLOGY



We start our data collection from field export. In this field, the export people are farmer's. our data collection is how much height is needed,how to cut the fruit and prevent the fruit from damage. We get answers for all the questions. The required height is 14 feet, by using the gripper to cut and place the basket on top of the stick, below the gripper. A detailed description of the design and materials used to make picking stick can be get from specification. The dimension of stick, volume of basket, type of gripper motor used can be find. The requirement for the project is Telescopic Pole, DC motor, Gripper, 12v Battery, Solar Panel, Basket, thread rod and sleeve.

The design concept was developed in solid works. The design was fully developed with accurate dimension.

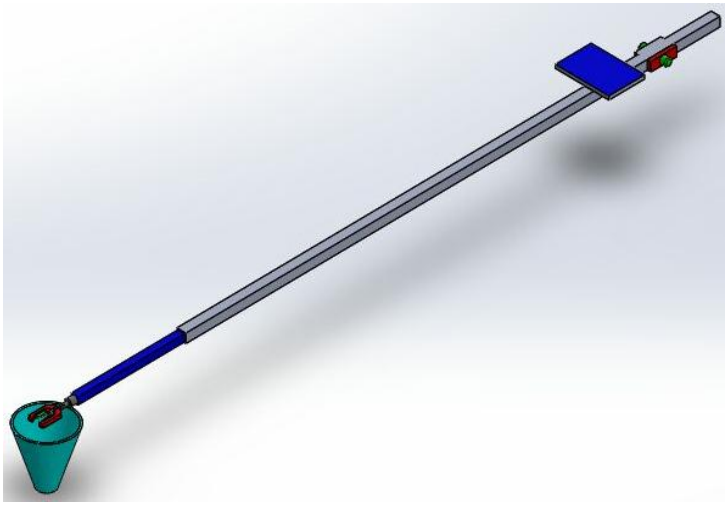


Fig 1 Design Development in Solid Works.

Dimension for Design:

For below stick:

Square shape width:25mm

Length:6 feet

Thickness:1.5mm

For above stick:

Square shape width:19mm

Total Length:8feet-2feet=6feet

Thickness:1.5mm

The basket diameter is 24.5cm

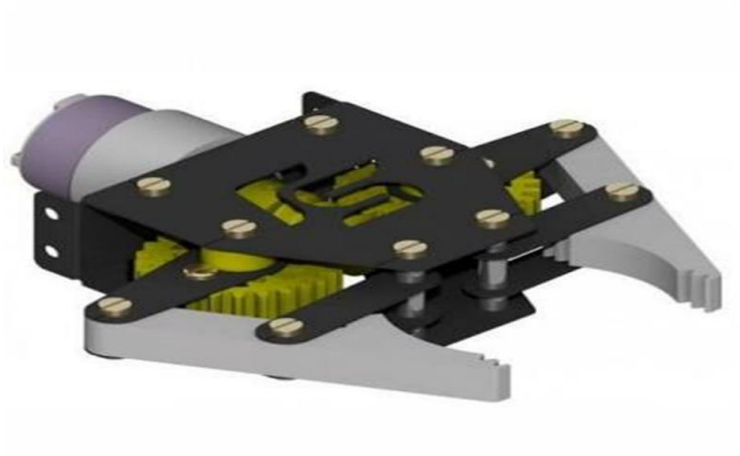


Fig.2 Gripper diagram

The gripper contains 2spur gear and 1 worm gear

Diameter of spur is 3cm

Teeth of spur gear is 25 teeth.

Worm gear height is 3 cm.

Supporting plate length 4cm.

Analysis Result:

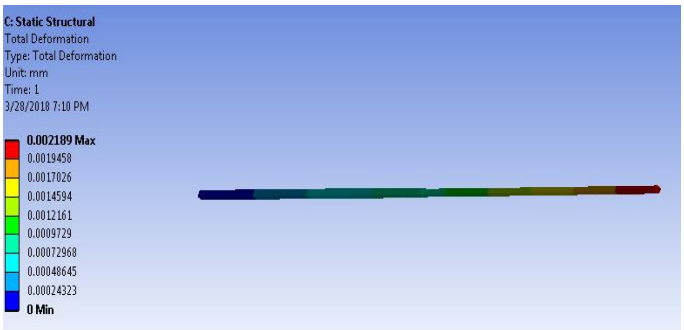


Fig.3Deflection of stick.

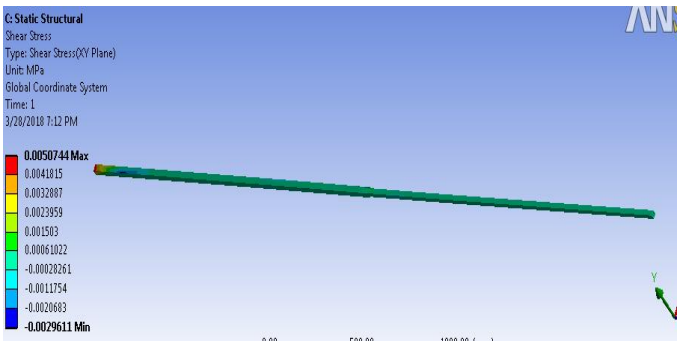


Fig.4 shear stress.

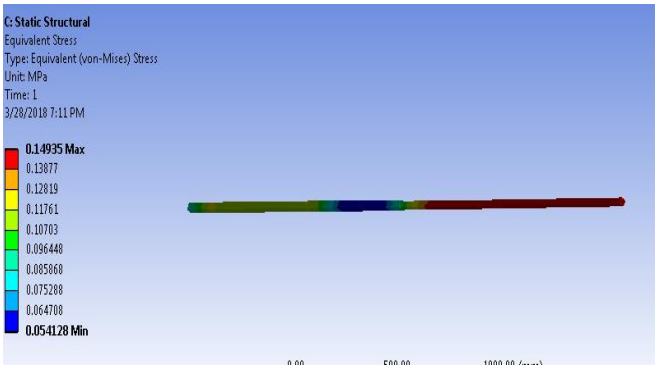


Fig.5 Equivalent stress.

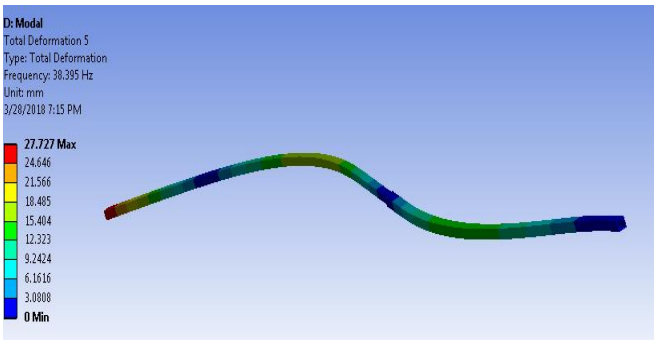


Fig.6 Frequency of deformation.

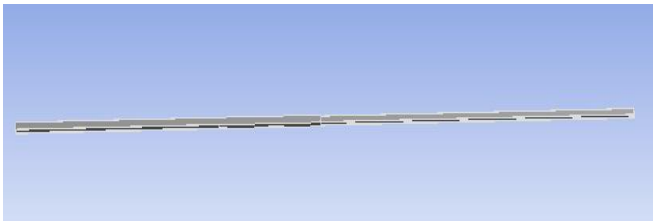
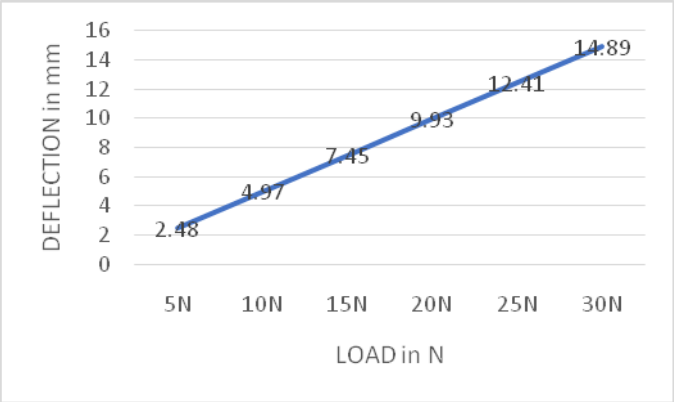
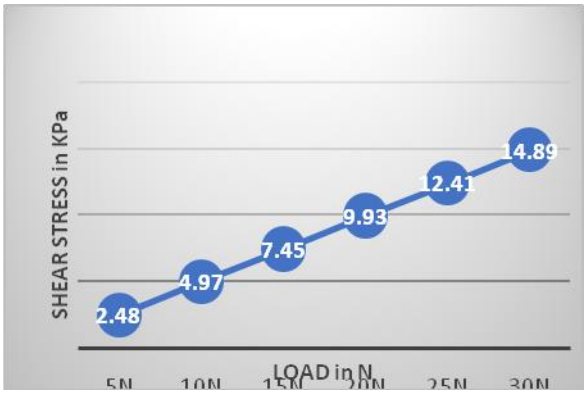


Fig.7 Ultimate load.

Graph:

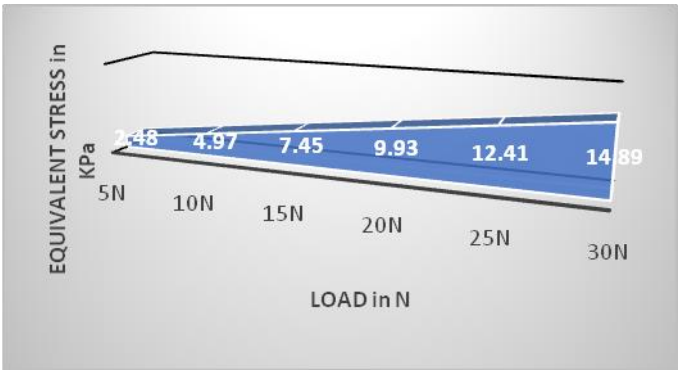


This graph describes about deflection of aluminium square pipe depending up on the load.Hence maximum load withstand by the stick is 30N.



This graph shows load Vs shear stress

Hence maximum shear stress can withstand in stick is about 5.07 KPa.



This graph shows load Vs Equivalent stress.

The maximum equivalent stress for this graph is 14.89 KPa.

Above calculation are made for maximum amount. This Deflection, shear and stress are derived from the ANSYS software. Here we derive the frequency of vibration for purpose of finding vibration when the fruit fall on the basket this frequency is transfer to pipe. When fruit fall on basket again another fruit fall by process continuous so that vibration factor must be included maximum vibration is 38.395 Hz.

The elastic tension for the stick is 7.4772e-7 mm is maximum.

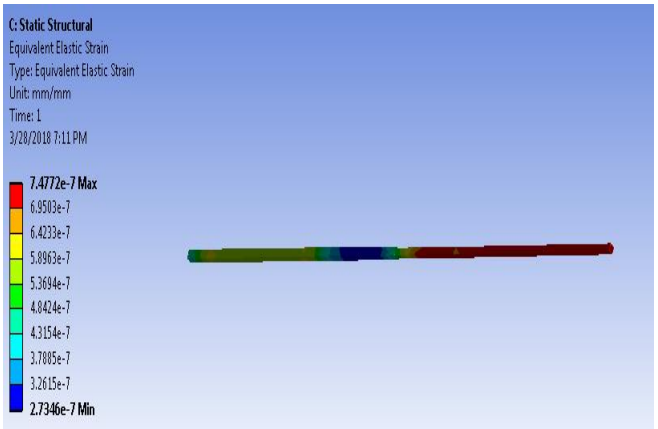


Fig:8 Elastic tension.

Design Result:

To determine Deflection, shear, stress, Elastic tension, Ultimate load and Frequency of deformation the serious test was conducted. The result obtained for this taken down and generate the graph for the following properties:

1. Load Vs Deflection.
2. Load Vs Shear stress.
3. Load Vs Equivalent stress.

The basket ring is made up of steel hence the steel can withstand more strength than aluminium. But the steel is hinged with aluminium. The typical alloying elements are magnesium, copper, tin, manganese, zinc, and silicon. So high strength to low weight ratio.

There is friction between two metals, hence there is friction loss in it. The necessary torque motor is used overcome the friction loss to increase height of the stick. The cutting force need to be calculated, for that we must select the cutting material and stack size need to be calculated. Hence after hardware development we discuss about this.

Above result can say that the maximum 30N or 3Kg or 6.61lbs of fruit can be pick for one time, after that we must relief the load that mean get the stick and take the fruit and empty the basket then the process continuous. Although the result is compare with design data book, obtain result is comparatively equal.

Hence the design is safe.

III. HARDWARE DEVELOPMENT

Material Selection:

Here we use aluminium—6061 grade alloy. Because high strength to low weight ratio. This grade is available for cheaper, for consideration low cost.

why we choose aluminium square size?

Because it is easy to hold and have embracing. The fruit picking stick is a model of telescopic pole, the outer pipe is of 6 feet and its dimension is 25mm and the inner pipe is of 6 feet and its dimension is 19 mm. The overall height of the stick is 12 feet. Actually, the original height of the inner pipe is 8 feet but 2feet is rigid inside the 25mm pipe just for avoid bending.

Working of telescopic of rod:

Here we used 6m long and 6mm diameter thread rod, due to comfortable extension. It is fastened with the outer pipe and it is linked with high speed DC motor. At the end of the inner pipe we placed a nut with 6mm diameter associated with sleeve, why because the size of the thread rod is bantam. Hence it behaves as guide. When the motor rotates, the thread rod also rotates. So that the inner pipe elevates up to 6 feet.

Robotic End Effector:

In robotics, end effector is a device at the end of robotic arm which is designed to interact with the environment. The apt nature of the device based on robotic application. They are typically based on different physical effect used to stable grasping between the object and gripper. The end effector that can be used as tool to serve various purpose, they are spray painting where uniform coating is essential and spot welding in an assembly were the working circumstance are grievous for human being.

End Effector Uses:

End Effector is mainly used for gripping purpose. Due to my convenient purpose, I changed the mechanism of gripper from holding to cutting down. By fixing stripping cutter at the end of the end effector, we convert its functions. Here we do not use sharp edge material so it does not make any harmful to fruit. The cutter just cut the stem of the fruit, after identifying. At once stem was cut the fruit was fell into the basket. And our picking purpose continues.

Function of Gripper:

Assembled gripper module with stipping cutter. Working with two spur gears and one worm gear actuated by a DC helical gear moto. The motor shaft is connected with worm gear. The worm gear is meshed between two spur gears. In spite of worm gear rotates by the 12vDC motor, the spur gear rotates. Each spur gear contains 25 teeth. The side plate is attached on both side above the spur gear, the cutter is fixed at the other end of the side plate. Hence the gear moves the cutting operation occur.

Basket:

The frame of the basket is made up of steel and it contains same height and diameter of 25.4 centimetre. The lower part of the basket is remains normal size net and that was covered by tiny holes net. So that very small fruits can be hold easily inside the basket and can avoid interactions with leaves and branches while picking fruits. The total volume of the basket is 4288-centimetre cube.

DC Motor:

In this fruit picking stick, we used two DC motor namely, 12v DC motor 1 Ampere with 100 RPM and 12v DC motor 2Ampere with 1800 RPM. This 100 RPM motor is fixed in gripper and it is used for cutting force. The 1800 RPM motor is fixed in bottom of the outer pipe and used for the extension of the pole.

DPDT switch:

Fig:9 DPDT Schematic Symbol.

A Double Pole Double Throw toggle switch acts exactly like two separate SPDT switches connected to the same switch bat. It has two separate common terminals and each of those is connected to one or the other of the other two terminals on the same side of the switch. The dotted line in the picture is to illustrate that the switch is actually two SPDT switches in one package with one switch bat. The switch can have adjusted to fix on any height.

SOLAR PANEL:

- 12V 2-Watt Solar Panel.
- High Conversion Rate & Efficiency Output.
- Ideal for Charging Small DC Batteries.

The 2-Watt Solar Battery Maintainer offers an ideal way to maintain the batteries. This unit is completely maintenance free and easy to install. Made with durable ABS plastic and amorphous solar cells, this solar panel charges in all daylight conditions, even on cloudy days!

The size of solar panel is

- Length=13.5 cm
- Breath=12.5 cm
- Width=1.5 cm

The capacity of lead acid battery is about 50% stated capacity. They also have a lower charge efficiency than lithium ion.

Panel Power (in Watts) / Battery Capacity (in Watt hours) X 2

A 12V 2-Watt solar panel charging a 12V 7.5 Amp hour Lead Acid Battery (90 Wh) from 50% full to Full – Time=45/2*2=45 hours.

Battery:

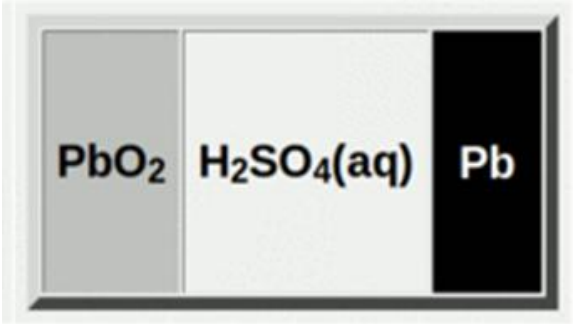


Fig10: Lead Acid battery.

It is type of Led acid battery and sealed rechargeable battery. It contains 12v and 7.5 Ampere.

In the fully charged state, the negative plate consists of lead, and the positive plate lead dioxide, with the electrolyte of concentrated sulfuric acid.

Overcharging with high charging voltages generates oxygen and hydrogen gas by electrolysis of water, which is lost to the cell. The design of some types of lead-acid battery allow the electrolyte level to be inspected and topped up with any water that has been lost.

Due to the freezing-point depression of the electrolyte, as the battery discharges and the concentration of sulfuric acid decreases, the electrolyte is more likely to freeze during winter weather when discharged.

Cutting force required:

If we want to cut the cut the fruit, before we must know the size of stalks need to measured.

Specimen	Sample	Size of stalks(cm)	Force required to cut(N)
Mango	S1	0.7	34.26
	S2	1.0	37.85
	S3	0.8	35.28
	S4	0.6	32.41
	S5	0.7	34.22

Guava	S1	0.35	23.315
	S2	0.5	31.45
	S3	0.4	30.96
	S4	0.3	28.517
	S5	0.35	29.315
Orange	S1	0.8	35.26
	S2	0.9	36.47
	S3	1.1	38.67
	S4	0.7	34.23
	S5	0.8	35.11
Pomegranate	S1	1.2	39.77
	S2	1.14	38.98
	S3	1.32	40.28
	S4	1.5	43.44
	S5	1.6	45.747

IV. RESULT AND DISCUSSION

After the design was built series of vigorous testing to determine if it met the design specifications/requirements. The total weight of the prototype is 2.60 Kg. The battery and solar panel weight is 2.20 Kg. All parts can not be fixed in stick, so battery is alone separated from it. The allowable weight of the basket is 30 KN. The design and prototype reading are nearly equal. The maximum height of stick is extended up to 12 feet. The inclined angle to be used to cut the fruit. There is no wear in sharing capacity of the blade. In real time the fruit picking should occur in harsh condition like rainy and sunshine, the material should with stand in that condition. During compression of stick it noisy due thread and nut rotate in anticlockwise direction. But the bending moment, stress, strain and deflection of stick are meet specification.

The device showed good initial testing results and gives the basis for further development of the design.

V. CONCLUSION

After the prototype was designed the various test were conducted. During these tests the load and its adjustment of rod is noted corresponding deflection is also noted. The bending is directly proportional to length of the stick. During lifting of stickthe weight of stick is act on user due to inertia and bending moment. After picking of fruit, the weight of fruit is act with gravitational force, hence the weight is double time it can overcome by user. The time required to pick the fruit is depend upon the user. This is one type smart process to pick the fruit with short time. Hence, I fix the title as “smart fruit picking stick”

The framers are capable to use this stick. It is light weight. The operation used here is very simple like "ON and OFF". The owner need not depend on the labour, he can itself self-study the process and can operate the device. This device can be used pick fruit up to 12 feet. It can have compressedup to 8 feet, so that we can easily transport it.

To generate own electricity the solar panel is used to charge the battery. By this we overcome all the problem description mentioned above. Using this we can pick all the fruits.

VI. FUTURE WORK

This device can be further improved to operate by robot. Here semi-automatic process carries over. But in future we make it fully automatized process. The stick itself moving to pick and carry over the process. Other parameters can also be changed like gripper can changed to use the Underactuated End-effector. We can use template matching mechanism and image sensing process. For automatized process we use obstacle deduction and path planning using robot operating system. This one the society facing problem on increasing cost of fruit on local market. So far in all over the world, damaging of fruits is occur. All can say only five or four fruit damage during picking of hundred fruits. Our aim is solving all the fruits without damage. Further we can say picking nature of fruit, in high hills the nutrient fruits are grow in that place, we can use camera correctly pick the fruit. By collecting all the fruits above the basket, there is no time waste for get to picking fruit again from ground. Hence it very from dirt and dust.

VII. ACKNOWLEDGMENT

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