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RESEARCH ARTICLE

DEVELOPMENT OF DRONE WITH CUTTING ARM AND CROP DUSTER.

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Abstract

To design a robotic cutting arm, for a quad copter which identifies and suppress the pests in horticultural crops like coconut, mango, banana, guava etc., using IR camera, sensors & pesticide tank attached to it. Atmospheric conditions of the field such as temperature differences and gases present over an area are sensed by the respective sensors attached to the quad copter. In addition to that the images of the tree are captured by IR camera. These images are examined using image processor and the graphical analysis of these data are done by matlab which will give us an idea, whether the affected parts should be cured by the pesticides or to be removed from the crop. The affected part, to be manipulated is spotted by using a camera. The robotic arm consists of the cutting unit as well as the pesticide sprayer. It possess three degrees of freedom operated by a remote controller. This facilitates the appropriate movement of the arm and locates it nearer to the specified area. The command is given to cut or spray according to the analysis done earlier.

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Introduction:-

Unmanned airborne vehicles have gotten to be less expensive because many control capacities can be actualized in programming rather than depending on costly hardware. This even allows multiple UAVs to be utilized for a solitary application. In this case, the UAVs must have correspondence offices so they can speak with each other. This can easily be accomplished by furnishing a UAV with a remote cross section node. In this situation, the UAV swarm can be thought to be a highly portable remote lattice network. In this paper we propose an engineering in light of unmanned aerial vehicles (UAVs) that can be utilized to implement a control circle for agrarian applications where UAVs are in charge of splashing chemicals on yields and cutting the weed. The process of applying the chemicals is controlled by means of the criticism from the remote sensors system conveyed at ground level on the product field. The point of this arrangement is to bolster short defers in the control circle so that the UAVs praying can prepare the data from the sensors. Further more, we assess a calculation to alter the UAV route under changes in the wind (power and course) and the impact identified with the quantity of messages traded between the UAV and the WSN. The data recovered by the WSN permits the UAV to Confine its showering of chemicals to strictly assigned territories. Since there are sudden and frequent changes in natural conditions the control circle must be able to respond as fast as would be prudent. After spraying the chemicals there.

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Design And Analysis Of Quad Copter:-

The basic base design is done using software catia v5 and analyzed in the ansys v16.2.

A. Structural Analysis on Frame

Structural analysis carried in ANSYS V16.2 version. Here we performed tetrahedral mesh on the frame. Material is used for the frame is aluminum 6061-T6 which is low weight. Frame consists of arm, middle portion, landing legs. 2 MPa load is applied on the frame. There is deformation of 0.22mm on the frame when total deformation load is applied. 0.000606mm deformation when equivalent elastic strain is applied.

Table I:-Properties Of Aluminium

Density	2712 kg/m ³
Modulus of Elasticity	68947.57 MPa
Poisson's Ratio	0.33
Yield stress	275.79MPa



Fig 1:- Isometric view

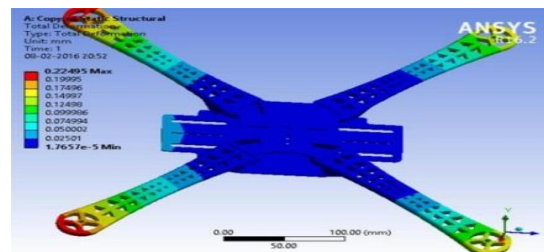


Fig 2:- Frame on workbench

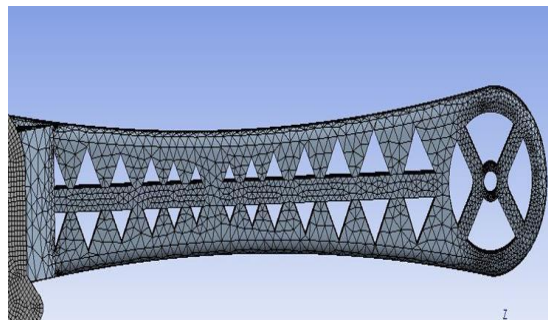
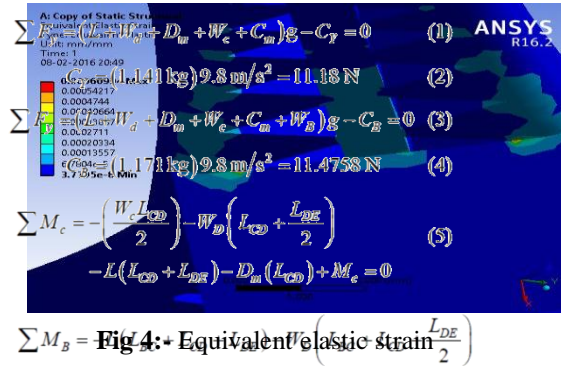


Fig 3:-Tetrahedral mesh on arm



ROBOTIC ARM:-

The mechanical outline of the robot arm depends on a robot controller with comparative capacities to a human arm. The connections of such a controller are associated by joints permitting rotational movement and the connections of the controller is considered to shape a kinematic chain. The business end of the kinematic chain of the controller is known as the end effector or end-of-arm-tooling and it is practically equivalent to the human hand. Figure demonstrates the Free Body Diagram for mechanical configuration of the automated arm. As appeared, the end effector is excluded in the configuration in light of the fact that an economically accessible gripper is utilized. This is on account of that the end effector is a standout amongst the most complex parts of the framework and, thusly, it is much less demanding and practical to utilize a business one than fabricate it.

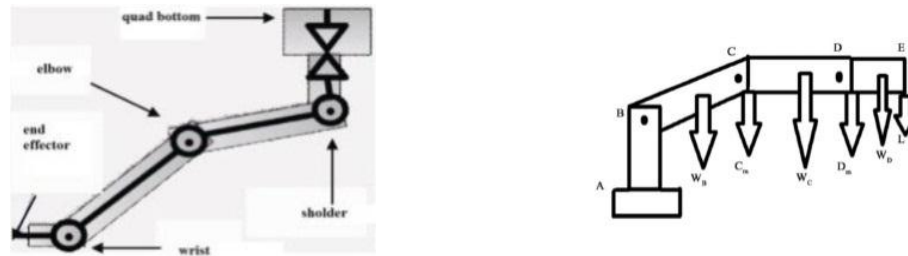


Fig 5:- Load on arm

ROBOT ARM INVERSE KINEMATICS:-

The values used for the torque calculations:

$W_d = 0.011$ kg (weight of link DE)

$W_c = 0.030$ kg (weight of link CD)

$W_b = 0.030$ kg (weight of link CB)

$L = 1$ kg (load)

$C_m = D_m = 0.050$ kg (weight of motor)

$L_{BC} = 0.14$ m (length(L) of link BC)

$L_{CD} = 0.14$ m (length(L) of link CD)

$L_{DE} = 0.05$ m (length(L) of link DE)

Performing the sum of forces in the Y axis, using the loads as shown in Figure , and solving for C_Y and C_B , see Equations (1)-(4). Similarly, performing the sum of moments around point C, Equation (5), and point B, Equation (6), to obtain the torque in C and B, Equations (7) and (8) respectively.

$$\theta_2 = 180^\circ - \arccos\left(\frac{LAB^2 + LBC^2 - x^2 - z^2}{2 \times LAB \times LBC}\right) \quad (9)$$

$$\theta_1 = \arctan\left(\frac{z}{x}\right) + \arccos\left(\frac{LAB^2 - LBC^2 + x^2 + z^2}{2 \times LAB \times \sqrt{x^2 + z^2}}\right) \quad (10)$$

$$\theta_0 = \arctan\left(\frac{y}{x}\right) \quad (11)$$

The servo motor that was selected, based on the calculations, is the Hextronik HX12K, which has a torque of 1.968Nm. The motor B is going to use θ_1 and the motor C is going to use θ_2 . The angle for the motor A is calculated.

ROBOT ARM CONTROL:-

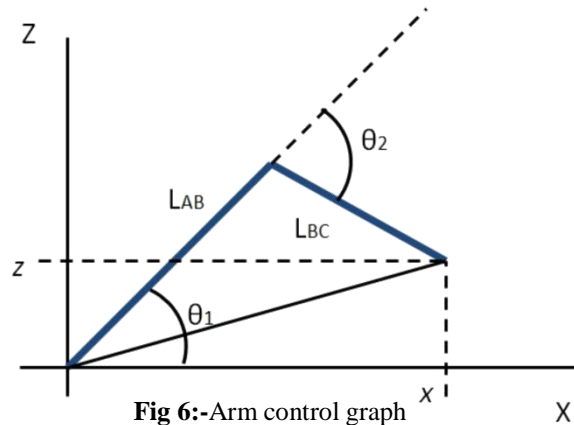


Fig 6:-Arm control graph

The control for the exhibited robot arm comprises fundamentally of three levels: a microcontroller, a driver, and a PC based UI. This framework has novel attributes that permit adaptability in programming and controlling strategy, which was actualized utilizing reverse kinematics; other than it could likewise be executed in a full manual mode. The microcontroller utilized is an Atmega 368 which accompanies an improvement/programming board named —ArduinoI. The programming dialect is fundamentally the same as C yet incorporates a few libraries that assistance in the control of the I/O ports, clocks, and serial correspondence. This microcontroller was picked on the grounds that it has a low value, it is anything but difficult to reinvent, the programming dialect is basic, and hinders are

accessible for this specific chip. The driver utilized is a six-channel Micro Maestro servo controller board. It undergoes three control strategies: USB for direct association with a PC, TTL serial for use with inserted frameworks, for example, the Arduino microcontroller, and inward scripting for independent and host free controller applications. This controller, as appeared in Figure, incorporates a $0.25\ \mu\text{s}$ determination for position and implicit velocity and quickening control.

Servo Motors Movement Range:-

The limits of the servo motors were obtained since specification of this type of motors contains that it has less than a 180 degree span. The real range for all motors was found to be in the range 125 - 142 degrees, as shown in **Table 2**. This clearly demonstrated that real operation of robot arm is different from the stander case.

Table ii:-Robotic Arm Angles

Motor	Angle Range
Motor A	130°
Motor B	135°
Motor C	142°
Motor Attack Angle	125°

Component And Specifications:-

A. *Flight controller board pixhawk flight controller px4*

TABLE III:-BLDC MOTORS

Kv	800
Max Current	20A
Max Power	222w
Idle Current	0.5A
Resistance	0.169
Shaft	3mm
Suggested ESC	Afro 20A
Cel Count	2-3S Lipo
Bolt Hole Spacing	16mm & 19mm
Connector	3.5mm Bullet

Table 4:-Multi Rotor Motor Speed Controller

Current Draw	20A Continuous
Voltage Range	2-4s Lipoly
BEC	0.5A Linear
Input Freq	1KHz
Firmware	afro_nfet.hex
Discharge wire/plugs	18AWG/Male 2mm
Motor wire/plugs	18AWG/Female 2mm
Weight	11.3g (Included wire, plug, heat shrink)

TABLE 5:-PROPELLER AND BATTER SPECIFICATIONS

Diameter	10ins
Pitch	4.5ins
Root Thickness	3mm
Mounting Hole	3mm
Color	black
Weight	4g each blade
Battery	
Lipo Battery	11 v

B. Servo motors

TowerPro MG996R - Standard Servo

Basic Information	
Modulation:	Analog
Torque:	4.8V: 130.5 oz-in (9.40 kg-cm) 6.0V: 152.8 oz-in (11.00 kg-cm)
Speed:	4.8V: 0.17 sec/60° 6.0V: 0.14 sec/60°
Weight:	1.94 oz (55.0 g)
Dimensions:	Length: 1.60 in (40.6 mm) Width: 0.78 in (19.8 mm) Height: 1.69 in (42.9 mm)
Motor Type:	? (add)
Gear Type:	Metal
Rotation/Support:	Dual Bearings
Additional Specifications	
Rotational Range:	? (add)
Pulse Cycle:	? (add)
Pulse Width:	? (add)
Connector Type:	? (add)

Fig 7:-Towerpro Mg996r-Standard servo

C. Crop-duster

Aerial farm robot speed: 20 km/hour

Spray coverage band: 0.5 m

Aerial farm robot payload: 1000 g

Spray Volume: 20 l/ha

IR CAMERA:-

A IR Camera is installed in drone to analyze and monitor the spray .Drones can provide farmers with three types of detailed views. First, seeing a crop from the air can reveal patterns that expose everything from irrigation problems to soil variation and even pest and fungal infestations that aren't apparent at eye level. Second, airborne cameras can take multispectral images, capturing data from the infrared as well as the visual spectrum, which can be combined to create a view of the crop that highlights differences between healthy and distressed plants in a way that can't be seen with the naked eye. Finally, a drone can survey a crop every week, every day, or even every hour. Joined to create the time-series animation, that imagery can show changes in the crop, revealing trouble spots or options for better crop management.

CONCLUSION:-

The core intention of this project is to make a robust design, development and implementation of robot arm, which has the talent to accomplish simple tasks, such as light material handling. The robot arm was designed and built from aluminum (Al) material where servo motors were used to perform links between arms and execute arm movements. The servo motors include encoder so that no controller was implemented; however, the rotation range of the motor is less than 180° span, which greatly decreases the region reached by the arm and the possible positions. The design of the robot arm was limited to three degrees of freedom since this design allows most of the necessary movements and keeps the costs and the complexity of the robot competitively. The end effector is not included in the design because a commercially available gripper is used since it is much easier and economical to use a commercial one than build it several tests were carried out to validate the robot arm where the testes covered both the particular elements and the overall system; results at different operating conditions show trustful of the robot arm presented.

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