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Design and Analysis of Multi-Funtional Helmet for the Industries (An Ergonomics way)

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ABSTRACT--The problem with the olden days engineering helmets was that engineers had to struggle a lot about the lighting system and moreover they had to work a lot to communicate to external work whatever they wanted to at work.but an initiative had been taken to build a helmet which could be a remedy to many of the problems faced by these engineers and ofcourse could be helpful in focussing the light wherever they want and whenever they want at the less effort and a continuous capturing and recording device is also attached to the helmet so that there is no extra effort required to be put in while at work.This project has been tested at the laboratory level and had been accomplished with the Pro-E and Ansys softwares .This works on the programming.Infact a model had been produced over here which could remove all the demerits of the modern days helmet and all the new features could be impregnated to modernize the olden helmets .

Keywords **–**Designing,Manufacturing,Analysis, programming,

I INTRODUCTION

Safety helmets with attached lights are used in various industries particularly science,technology,engineering and medical etc. In the olden days light was attached to the helmets but could not be adjustable from the user's point of view for the sake of convenience and safety also. In many areas of an science,technology,engineering and medical , it is desirable to have a helmet with an adjustable lighting system and camera to capture the running images apart from the normal focusing of the light alone .If the light could be focused onto some particular/specified area simultaneously the images/videos should be captured which could be retrieved online/offline for certain purposes is the main cause of thinking about this kind of project. Earlier in order to quickly change the desired focus of the light, user had to move his head to focus the light on the desired location and he had to had a camera separately to also capture the images . but always this is not good atall from the comfort and workmanship point of view and the society never accepts any poor ergonomic condition like that.Therefore a model had been developed taking into account, the positive and the negative aspects of the present day helmets. Here the task was to DESIGN and suggest for a working model of a helmet with an attachable light and a camera system , in which position of the light and simultaneously the camera could be very well controlled by a remote controller . The designing of the parts was done in Pro/E, a 3D CAD software and control of remote was developed using the PLC programming, programmed in assembler/compiler which was later dumped into 8051 microprocessor. The motor considered for the movement was a stepper motor whose details are discussed in the later part of the literature . The camera for this purpose had been taken up as the standard ones available in the markets that are being used for the lap-tops or the cell phones. Finally the assembling of every sub components was done using Pro/E and the simulation of the model was also tested using pro/E. Meshing was done in HYPERMESH, a software which is used for precise meshing of components and finally analysis is carried out in ANSYS, and the results were depicted later.

I INTRODUCTION

The overall purpose of the work is to develop a model of the helmet with an attachable lighting system and a camera system which could be controlled using a remote control for ease and convenience of the user who can also capture the images/videos or even send the same to the needed at any time and any place .

In this work, a light as well as small camera embedded in the torch and powered by a battery packwhich could be worn by the user as a waist belt or as a backpack on the backwas developed. After the charge of the battery goes off, just the battery could be removed from the pack and could be recharged easily . The power of the battery is dependent upon the capacity of the camera and the light system used.

In the prior art, when the light was clipped to the helmet, light gets fixed to the helmet but position could not be adjusted. Change in area illuminated by the light could be accomplished only by the user moving his head position

and if the pictures were to be taken required both the involvement of the hands and a camera which becomes a tough role in most of the times. . A circuit for operating (on/off) the camera or the lighting system or both simultaneously was also provided.

This development was done to cater to the needs of the "STEM" fields. S: SCIENCE T: TECHNOLOGY E: ENGINEERING M: MEDICINE.

In SCIENCE this concept could be applied in labs, research works etc. This work can be also used in dark room chemical testing, etc or wherever desired to focus the light onto a particular area and simultaneously to send the pictures either online or offline.

In TECHNOLOGY this product could be implemented in various areas such as trekking and climbing where helmets are highly/deadly essential . This development will provide satisfaction for users of caving as it serves in two ways such as, gives protection from falling rocks and bumps and to shine light on a required area as well as gives the videos and images which would be so exciting. This development finds perfect application in military as it is ideal for work such as navigation in night, loading gear and repairing equipment in the field where there is no light, could also be used to communicate as a web cam whenever necessary. It could also be used in SWAT purposes. It is apt in close quarters work such as map readings and document readings as it can also be used without power supply. Helmet with adjustable light and camera could also be applied in areas such as search and rescue operations such as fire rescue operations, which could be covered with live videos to make the job simple. This could also be used in search operations such as under lifts and collapsed buildings as well as volcanic and earthquake prone areas apart from the swimming and diving activities.. Helmets with lights embedded with camera can also find applications in archeology where exploration is done in dark space or no electricity areas .

In ENGINEERING field this helmet with an adjustable light embedded with a camera could be implemented in areas such as welding works where high intensity lights could assists the user to focus on the welded joints, which can be used for live study or tutorials. This helmet with light and camera could find application in construction works such as site works at night or in the villages having poor electricity connection for the site workers , with web coordination these improved versions of the helmets could benefit the society to the maximum extent possible. This concept could also be applied in engineering works such as painting where light is to be focused on some particular part. In workshed/Locosheds repair works such as under chassis repairs could be performedwith this product , and low light underneath could also be overcome by using helmet with light and camer system arrangement. This could also be used in underwater constructions ,Tunneling, flyover constructions, pipeline constructions ,blasting operations, heavy engineering works, steel industries, chemical process industries, nuclear operations, etc. and with the videos and images which could be captured could also act as a database for the next generation of users also.

In MEDICINE, some tasks such as dark room operations or military operations requiring complex surgeries and facilities could also be make use of this as advanced laser lighting system attachments .. This concept of helmet with an adjustable light and camera could also be implemented in pharmacology and other related areas.

II DESCRIPTION OF COMPONENTS

Table-1 Details of the Project-Components

Sl No.	Name of the part	Description of the Part	Materials Used
1	HELMET	Helmet is the major component used for safety and also holds the motor, connector for motor and torch and torch.	Helmet is made of High-density polyethylene (HDPE) or polyethylene high-density (PEHD), which is a polyethylene thermoplastic made from petroleum.
2	GUIDE	Guide is attached to the helmet and it supports the motor to move in it. Guide contains teeth on which the motor teeth meshes and makes movement.	Guide is made up of Low-density polyethylene (LDPE), which is a thermoplastic made from petroleum.
3	• GEAR SYSTEM GEAR SYSTEM : HELICAL GEAR • ANGLE : 2^0		

	• PITCH : 2 mm • NO. OF TEETH : 356 • HEIGHT : 0.85 mm • LAND : 1 mm		
4	MOTOR	Motor rotates inside the guide, in which movement of motor is made by the meshing of motor teeth with guide gear teeth. Other end of the motor will be connected to another component named as stem 1. Both will be screwed for attaching. Motor is readily available in market, hence the dimensions are taken from a real motor. Torque : 1kg Voltage : 12v – 24v	
5	STEM 1	Stem 1 is designed to give support for another component, stem 2 and other end is to be fitted to motor. There are slots which are provided for stem 1 so that it could be screwed to motor by some screws. There is a ball joint on the end of stem 1, so that stem 2 would be fitted and provided a spherical movement.	NYLON OR STEEL Nylon can be preferred as it is easy to manufacture. Nylon is a thermoplastic silky material. It is made of repeating units linked by amide bonds and is frequently referred to as *polyamide* (PA).
6	STEM 2	Stem 2 is a cylindrical pipe, which fits on the ball joint of stem 1. This makes the stem 2 to move in spherical direction. Other end has internal thread for which torch is screwed. Hence due to this total setup, orientation of the torch could be adjusted and a hole is provided, so that wire from the torch could be incorporated. .	Same NYLON can be used for manufacturing of stem 2.Polypropylene (PP) can also be used for the ease of manufacturing
7	TORCH EMBEDDED WITH CAMERA	Torch is the last component and the design of torch is taken from the Mathematical concept of "PARABOLA" i.e SINGLE FOCAL	

		POINT (F). Internal surface was designed in a way that all the rays would be focused on only one point. This modification was done to enhance the light intensity . In internal design for every 10^0 ,surface was made flatten so as to increase the reflection. End of the torch will have a thread for which it sets in the stem 2 and other end of torch will have a glass. Top surface contains a hole in which camera can be installed and wiring can be given to remote along with the torch wiring.	
8	TORCH		Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications. Most commercial polypropylene is isotactic and has an intermediate level of crystallinity between that of low-density polyethylene (LDPE) and high-density polyethylene (HDPE). Commercial isotactic PP has a melting point that ranges from 160 to 166 °C (320 to 331 °F), depending on atactic material and crystallinity.

III DESIGNING Details

The software used over here is PRO-E.The following table depicts the details about the Commands used and the usage of the commands .

Table-2 List of the Design Commands used

SL No.	Name of the Component	List of the Design commands Used	Usuage Procedure
1	HELMET	BOUNDARY BLEND SURFACE PROTRUSION EXTRUDE MIRROR	At start, open sketch so that 2D sections can be drawn. Draw half of the base part and using MIRROR command total base can be obtained. Using sketch draw the outlines of the helmet including height, length and width.

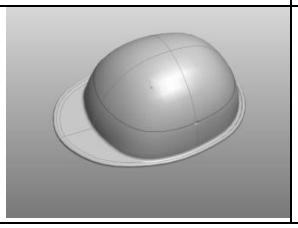
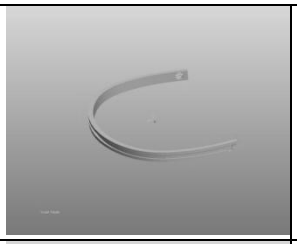
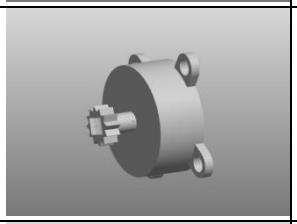
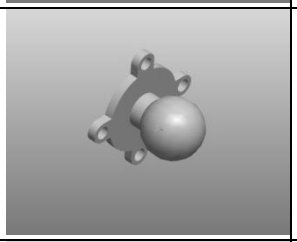
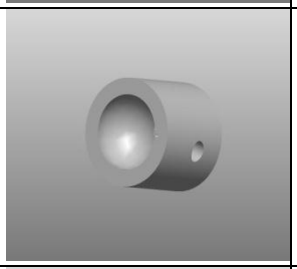
			Using BOUNDARY BLEND command, fill the surface of the head portion carefully without any un-uniformity. Using SURFACE command, the front extended part and surrounded part for head can be produced with a surface layer. Using PROTRUSION command, piping for the helmet can be created. Using EXTRUDE command, a hole of required thickness for guide can be created.
2	GUIDE	PROTRUSION EXTRUSION PATTERNOF PROTRUSION MIRROR	As this is top down approach, take the plane of helmet on which the guide is to fitted. In sketches, draw the shape of the guide and take another plane as reference draw the length of guide. Now using PROTRUSION command, selecting the shape and length we can form the outer shape of the guide. Using EXTRUDE command, make a hole which fits a screw for holding to helmet. In sketch draw the internal shape of guide which looks like a teeth of required dimension. In sketch take another plane for the length of the teeth i.e length of the guide. Using PATTERN OF PROTRUSION command, selecting the shape and length we can produce the internal teeth. Using MIRROR command, form the teeth throughout the guide.

3	MOTOR	EXTRUDE PATTERNOF EXTRUDE	Taking the plane of guide as the reference plane for motor, start the drawing. In sketch, draw the base of the motor which is a circle. Using EXTRUDE command, increase the thickness of the base by selecting the sketch. In sketch, draw a circle of small length which acts as connector for base and motor tip. Using EXTRUDE command, increase the thickness up to required dimension. Using sketch, draw a star using "16 star" tip option. Using EXTRUDE command, selecting the star can make the star into a solid object of required thickness. Using PATTERN OF EXTRUDE command, draw the shape on base of motor which holds the screws, and extrude the pattern of required thickness.
4	STEM 1	EXTRUDE REVOLVE	Taking motor plane as the reference plane, start the stem 1 drawing. In sketch, draw the shape of the base of stem 1 in required dimensions. Using EXTRUDE COMMAND, increase the thickness of the base up to required thickness. In sketch, draw the half shape of ball joint with respect to some reference axis. Using REVOLVE command, selecting the object and selecting the axis, object can be revolved and made in ball shape.
5	STEM 2	EXTRUDE REVOLVE	In sketch, draw half shape of

			the stem 2 any give reference axis. Using REVOLVE command, selecting the sketch as object and selecting the axis for reference, shape of stem 2 will be formed which looks like a cylinder. Using EXTRUDE command, make a hole of required dimensions and select up to the surface so that hole will be formed throughout the solid.				In sketch, taking a reference axis draw a parabola according to calculated dimension on one half of the solid. Using REVOLVE command, select the object drawn in sketch and selecting the reference axis, make a hollow surface which creates the internal surface of the torch. In sketch, mark the points on internal surface where we want to flatten the surface. Now draw the lines connecting these points, and using PATTERN
6	TORCH	REVOLVE PATTERN EXTRUDE	In sketch, draw half of the shape of the torch and draw an axis for reference. Using REVOLVE command, selecting the object and axis as the reference a solid object of torch shape is formed.				

			command, create the lines at uniform distance according to the dimensions and internal surface will be flattened uniformly which enhances the reflection. In sketch draw a hole in size of camera and with extrude, make a hole by picking upto the surface.

3.1 Images of the Components

Sl No.	Figure	Name of the Component
1		HELMET
2		GUIDE
3		MOTOR
4		STEM 1
5		STEM 2
6		TORCH

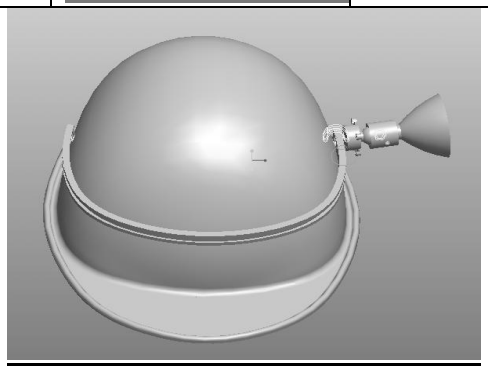


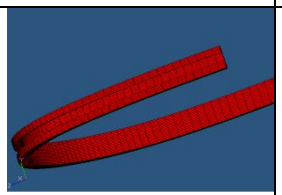
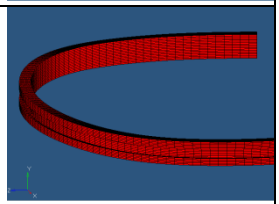
Image of the Assembled product

IV Manufacturing Details

Sl No.	Name of the Component	Material
1	GUIDE	MOULD BASE: EN28 INSERTS: high chromium steel like stavax
2	TORCH	MOULD BASE: EN28 after we can harden up to 48 HRc INSERTS: high chromium steel like ramax(Cr <13%) which gives mirror finishing to the surface .
3	STEM 1	MOULD BASE: EN28 INSERTS: high chromium steel like OHNS
4	STEM 2	MOULD BASE: EN28 INSERTS: high chromium steel like stavax
5	HELMET	MOULD BASE: P20 INSERTS: No inserts. We use plate itself as inserts

The manufacturing planning included the sizing of the material,Grinding to the size, Roughing the mould base (guide holes, insert pockets, slots etc. .), Finishing the mould base (boring, EDM for guide ways etc.), Roughing the inserts (0.3mm to 0.5mm stock), Hardening the inserts , Finishing the inserts (removing the stock), and Assembling the mould base.

V Analysis Details and Observations

Sl No.	Images	Details
1		NO. OF ELEMENTS: 9600 NO. OF NODES: 14443
2		

5.1 Material properties

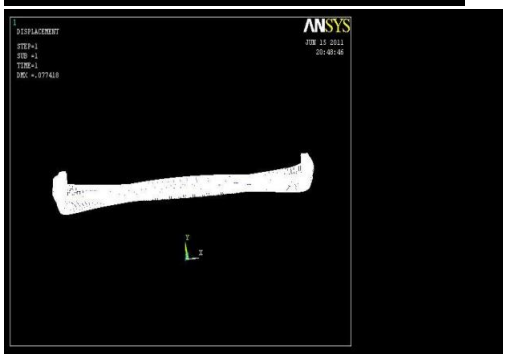
Sl No.	Material Property	Range /specification
1	YOUNG'S MODULUS	200-400 Mpa
2	SHEAR MODULUS	100-350 Mpa
3	TENSILE STRENGTH	8-12 Mpa
4	BENDING STRENGTH	10-40 Mpa
5	YIELD STRENGTH	15-20 Mpa
6	DENSITY	0.910-0.940 g/cm^3

From the material properties we came to know that yield strength of the LDPE is 15-20 Mpa. To know the maximum force the guide can withstand, we should know the force for which the maximum stress should not cross the yield strength of the material i.e. the maximum stress should be less than yield strength.

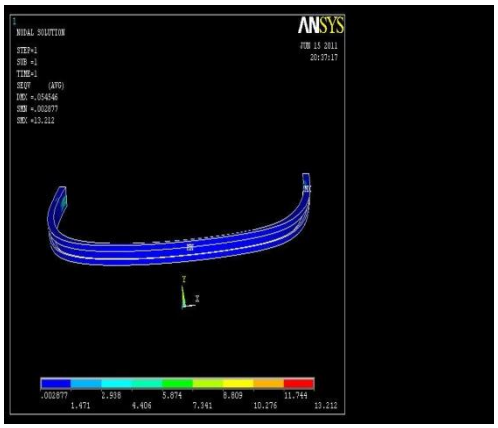
When 5N (500gm) is applied, maximum stress is around $13N/mm^2$.

When 10N (1000gm) is applied, maximum stress is around $27N/mm^2$.

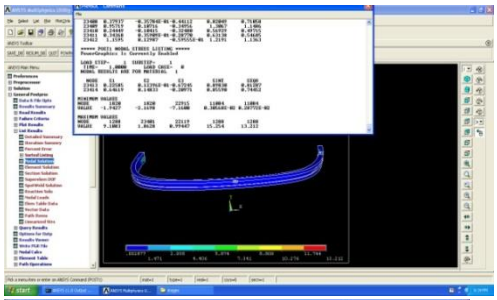
From analysis, it could be observed that upto half kilogram (5N) this material can withstand and when going on increasing to 10N, fracture occurs.

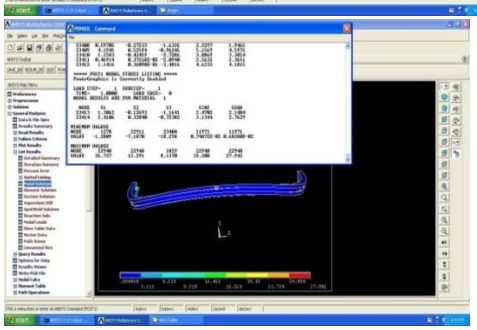


DEFORMATION WHEN 5N IS APPLIED
DEFORMATION WHEN 10N IS APPLIED



VON MISES STRESSES WHEN 5N IS APPLIED VON MISES STRESSES WHEN 10N IS APPLIED





MAXIMUM AND MINIMUM STRESSES

VI Programming Details

NAME : DUMPER
SOFTWARE : HANDYPRO
PROGRAM FOR 8051 MICROCONTROLLER

```
MOV P1, #0FFH
S1: JB P1.0, S2
ACALL FORWARD
S2: JB P1.1, S1
ACALL BACKWARD
LJMP S1
FORWARD: MOV A, #88H
MOV R0, #4
BACK1: MOV P2, A
ACALL DELAY
RR A
DJNZ R0, BACK1
RET
BACKWARD: MOV A, #88H
MOV R1, #4
BACK2: MOV P2, A
ACALL DELAY
RL A
DJNZ R1, BACK2
RET
DELAY: MOV 20H, #100
LOOP1: MOV 21H, #50
LOOP2: NOP
DJNZ 21H, LOOP2
DJNZ 20H, LOOP1
RET
```

STEP ANGLE:

Step angle of the stepper motor is defined as the angle traversed by the motor in one step. To calculate step angle, simply divide 360 by number of steps a motor takes to complete one revolution. As we have seen that in half mode, the number of steps taken by the motor to complete one revolution gets doubled, so step angle reduces to half. As in above examples, Stepper Motor rotating in full mode takes 4 steps to complete a revolution, So step angle can be calculated as...

Step Angle ø = 360° / 4 = 90°

and in case of half mode step angle gets half so 45°.

In our case, motor rotates 24 steps to complete one revolution. Hence step angle can be calculated by

$$Ø = 360^0 / 24 = 15^0$$

Hence step angle of our motor is 15^0.

VII Discussion

A helmet with lighting system and in future with a camera system for enhancing the usability of the designed helmet. The safety helmet with a lighting and camera system could be expensive for manufacturing with the techniques available but the advent of the development of the materials technology could be available, accessible for the most of the other purposes also. These kind of helmets could be made usable for the traffic and other rescue action purposes also. Also finds use in Media, mining and marine. A light means for emitting a light is mounted to the helmet and positioned in the channel. A power supply is operationally coupled to the light means. The present invention relates to helmet devices and more particularly pertains to a new safety helmet with a lighting system for enhancing the usability in terms of the multi purposive in regards to the STEM concept and an embedded camera for providing knowledge about work.

Swing can be provided.Can be employed to Bullet proof helmets and given for military or police.Can be used for sports such as bicycling at night.Continuous color changing can be employed for identification purposeCan be used as tool for surgical activities for complex tasks.

With the addition of secret camera system, spying purpose can also be achieved.Motion pictures can also be taken up with the audio and video technology and also it can be made to capture the picture continuously by connecting the same to the satellite connection. (CCTV Technology).

VIII Results /Conclusion

These kinds of helmets when provided and build with the composite materials could serve lots of purposes including the engineers involved in the search operations can also use the same.Almost all the people from the diverse areas of science ,technology,engineering and medical could benefit a lot from this product .

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