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Fire Fighting Vehicle: Constructional Design

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Abstract
The paper helps to generate interests as well as innovations in the fields of robotics while working towards a practical and obtainable solution to save lives and mitigate the risk of property damage. Fire fighters face risky situations when extinguishing fires and rescuing victims, it is an inevitable part of being a fire fighter. In contrast, a robot can function by itself or be controlled from a distance, which means that firefighting and rescue activities could be words; robots decrease the need for fire fighters to get into dangerous situations. This robot provides fire protection when there is a fire in a tunnel or in an industry by using automatic control of robot by the use of microcontroller in order to reduced loss of life and property damage.

Keywords—fire fighters, rescuing, dangerous situations, microcontroller.

I. Introduction

Robot:

Robot is a machine that looks like a human being and performs various complex tasks. Now, let's have a good look at existing firefighting robots. Virtual Reality Simulation of Fire Fighting Robot (Indonesia) is a virtual adaptation of competition robot that took part in PanitiaKontes Robot Cerdas Indonesia competition in 2006. This system was developed in MATLAB/ Simulink with the help of Virtual Reality Toolbox» plug-in. It is oriented for initial testing of controlling algorithms. It's important to notice, that even the robot itself doesn't have enough level of functionality, because of low-detailed formalization of environment. The robot could operate only in corridor-room environment, without strange objects. Only one fire source is meant and there are auxiliary marks on floor that mean for example room entrance. Pokey the Fire-Fighting Robot (USA) is the firefighting robot that made its way out of competitions, and became more "serious" than other systems. In there are detailed description of used equipment and basic algorithms of operating. Robots operating environment is a building, so the robot is equipped with necessary sensors, for example, with a line sensor, that could be unusual in conditions of dense smoke. The main advantages of robot are:

• using of two types of fire sensors, working in different ways;

• using of complex firefighting tool;

Firefighting:

Firefighting is the act of extinguishing fires. A firefighter suppresses and extinguishes fires to protect lives and to prevent the destruction of property and of the environment. Firefighters may provide other valuable services to their communities, including services. Firefighting demands a professional approach. Many firefighters achieve a high degree of technical skill as a result of years of training in both general firefighting techniques and developing specialist expertise in particular fire and rescue operations such as aircraft/airport rescue, wilderness fire suppression, and rescue. One of the major hazards associated with firefighting operations is the toxic environment created by combustible materials; the four major risks are smoke, oxygen deficiency, elevated temperatures, and poisonous atmospheres. Additional hazards include falls and structural collapse that can exacerbate the problems entailed in a toxic environment. To combat some of these risks, firefighters carry equipment. The first step in a firefighting operation is reconnaissance to search for the origin of the fire, to identify the specific risks, and to locate possible casualties.

II. DESIGN

DISCUSSION FOR DESIGNING:

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy &efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts; 1.System design 2.Mechanical Design.System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely, 1. Designed Parts 2.Parts to be purchased

DESIGN OF COMPONENTS:

Design of components is very important because set up must sustain against the fluctuating load. So that every component have sufficient strength rigidity. Design procedure for those components and basis for designing is mentioned below.

1) Base

Function:

- It gives firm support to the test set up
- It provides proper space for motor & rest of all the things consisting in the set up.

It balances the system while the rig is in testing condition.

We consider the load is simply supported we design the frame.

$P \quad = 40$ Kg

$\quad = 40 \times 9.81$

$\quad = 392$N

Consider 3 times static load so the load is P

$P \quad = 3 \times 392$

$\quad = 1177.2$ N

FOR SIMPLY SUPPORTED BEAM,

$R_A = R_B$

$R_A + R_B = W$

$W = 2\, R_A$

$R_A \quad = W/2$

$\quad = 1172.2/2$

$\quad = 588.6$N

$R_A = R_B = 588.6$N

Moment at point c is

$M_c \quad = R_A \text{ X } l/2$

$\quad = W/2 \times L/2$

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$$= \frac{W}{4}$$

$$= \frac{1 \quad .2\,X5}{4}$$

M =17583

For square pipe

$$I = \frac{bd^3}{12}$$

b = d

$$I = \frac{d^4}{12}$$

$$y = \frac{d}{2}$$

Flexural Formula

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$\frac{M}{I} = \frac{\sigma}{y}$$

$$\frac{175830}{\frac{d^4}{1}} = \frac{\sigma}{\frac{d}{2}}$$

We want to check our pipe is safe or not.

We take the pipe of dimension 25mm x 25mm

So we find out the stress

σ =67.51 N/mm^2

Mechanical Properties of Metals

Material	Type	Density (kg/m3)	Ultimate Tension (MPa)	Ultimate Compression (MPa)	Ultimate Shear (MPa)	Yield Tension (MPa)	Yield Shear (MPa)	Elastic Modulus (GPa)	Shear Modulus (GPa)	Thermal Expansion (10e-6 m/m/C)	Ductility % Elongation for 50 mm.
Aluminum	Alloy 1100-H14 (99% Al)	2713	110		69	97	55	70	26	23.6	20
Aluminum	Alloy 2014-T6 (4.4% Cu)	2796	483		290	414	221	73	27	23.0	13
Aluminum	Alloy 2024-T3	2796	483			345		73		22.7	18
Aluminum	Alloy 6061-T6 (1% Mg)	2713	310		186	276	138	69	26	23.6	12
Brass	Cast	8553	166	207	248			62			
Bronze	Gun metal	8885	103	83				69			
Cast Iron	Gray 4.5%C (ASTM A-48)	7197	172	655	241			69	28	12.1	0.5
Cast Iron	Malleable (ASTM A-47)	7308	345	621	331	228		166	64	12.1	10
Copper	Pure	8941	172	276	207	62		117		16.6	40
Gold	Pure	19293						74		14.4	30
Lead	Pure	11321	18					14		52.7	
Magnesium Alloy	8.5% Al	1799	379		166	276		45		26.1	7
Monel Alloy	Annealed 400 (Ni-Cu)	8830	552			221	124	179		13.9	46
Monel Alloy	Cold-worked 400 (Ni-Cu)	8830	676			586	345	179		13.9	22
Nickel	Pure	8913						221		13.0	
Phosphor Bronze	Cold-rolled (510)	8858	559			517	276	110	41	17.8	10
Phosphor Bronze	Spring temper (524)	8775	841					110		18.4	4
Platinum	Pure	21424	152					147		9.0	
Silver	Pure	10518	124			55		72		19.8	48
Steel	High-strength-low-alloy	7861	483			345	207	200	79	11.7	21
Steel	Quenched / tempered alloy	7861	828			690	379	200	79	11.7	18
Steel	Stainless (302) Annealed	7916	621			276	152	193	73	17.3	50
Steel	Stainless (302) Cold-rolled	7916	862			517		193	73	17.3	12
Steel	Structural (ASTM-A36)	7861	400			248	145	200	79	11.7	23
Tin	Cast	7308	24	41				28		22.3	
Titanium Alloy	6% Al 4% V	4456	897			828		114		9.5	10
Tungsten	Pure	19321						345		4.5	2
Yellow Brass	Annealed (65% Cu 35% Zn)	8470	331			103	62	103	39	20.3	62
Yellow Brass	Cold-rolled (65% Cu 35% Zn)	8470	538			434	248	103		20.3	8
Zinc	Cast	7141	34	138				90		39.4	

Table No.1 Mechanical Properties of Metal

Yield tensile strength = 248 N/mm^2

Allowable bending strength = 0.6 X 248 = 148.8 N/mm^2

Applied σ (67.51 N/mm^2) < Allowable bending strength (148.8 N/mm^2)

Hence, design is safe.

2) Design of shaft:

We use the motor having speed is 30 rpm and power is 25 watt

$$P = \frac{2\pi}{6}$$

$$25 = \frac{2\pi \quad 3 \quad X}{6}$$

Shear stress t= $\frac{ul \qquad st}{fa \qquad o\ s}$

$t=700/4=175 N/mm^2$

$$T = \frac{\pi}{1} x\ d^3 x\ t$$

$$= \frac{\pi}{1} x\ d^3 x\ 175$$

d = 6.14 mm

Normally we use shaft of diameter 12 mm.

12 > 6.14 so that our design is safe.

3) Design for water tank:

Measurements of water tank-

1. Height of water tank = 20 cm
2. Width of water tank = 16 cm
3. Length of water tank = 16 cm

- Area of water tank

Formula = width x length
= 16 x 16
= 256 cm^2

- Volume of water tank

Formula = area x height
= 256 x 20
= 5120 cm^3

- Capacity of water tank = 5120 / 1000
= 5.12 liters

III. SYSTEM DESIGN:

In system design we mainly concentrated on the following parameters:

1. System Selection Based on Physical Constraints:

While selecting any machine it must be checked whether it is going to be used in a large-scale industry or a small-scale industry. In our case it is to be used by a small-scale industry. So space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room.

2. Arrangement of Various Components:

Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. More over every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements.

3. Chances of Failure:

The losses incurred by owner in case of any failure are important criteria of design. Factor safety while doing mechanical design is kept high so that there are less chances of failure. Moreover periodic maintenance is required to keep unit healthy.

4. Weight of Machine:

The total weight depends upon the selection of material components as well as the dimension of components. A higher weighted machine is difficult in transportation & in case of major breakdown; it is difficult to take it to workshop because of more weight.

IV. Conclusion and Future Scope:

The fire fighting vehicle we can extinguish the fire. By using the remote control we reduce human efforts. This paper work has provided us an excellent opportunity and experience, to use our limited knowledge. Fire accidents can be controlled to a great extent in places such as forests, homes, colleges, industries, trains and some other public places.Fire accidents leads to death of people by using this technique we can save those lives easily. Camera and video transmission can be added. Improve the weight capacity of robot.

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