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FIRE FIGHTING ROBOT

Sahil S.Shah[1], Vaibhav K.Shah[2], Prithvish Mamtora[3] and Mohit Hapani[4]

[1,2,3,4]D.J.Sanghvi College of Engineering,
Vile Parle – West, Mumbai, India

Abstract: ***There are many possibilities a fire can start in an industry or in any remote area. For example, in cotton mills, garments, fuel storages, etc., electric leakages can lead to huge damage. Also it's a worst-case scenario, causing heavy losses not only financially but also destroying areas surrounding it. Robotics is the emerging solution to protect human lives and their wealth and surroundings. The aim here is to design a FIRE FIGHTING ROBOT using embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal case and as a fire extinguisher in emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The project will help 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.***

Keywords: Comparator, Mono-stable NE555, Fan Driver

1. INTRODUCTION

Our task as Electrical Engineers was to design and build a prototype system that could autonomously detect and extinguish a fire. Also aims at minimizing air pollution. It is the Robot that can move through a model structure, find a lit candle and then extinguish it with help of a blowing technique. Our research paper describes the design of a small autonomous Fire Fighting Robot. We have worked on the same project at our college presenting a synopsis showing its basic construction and working. The Fire Fighting Robot is designed to search for a fire in a small floor plan of a house of the specific dimensions, extinguish the fire with the help of the front fan of a toy hovercraft, and then return to the front of the house. The fire detection to be put into use is relatively free of false alarms, it is anticipated that it will not overreact in non-fire simulations. This mission is divided into smaller tasks, and each task is implemented in the most efficient manner such as self autonomous start of the robot, navigation of the robot in every room step by step, finds the fire in a specific room, approaches the fire at a very fixed distance, extinguishes it and finally returning to the front of the house.

2. BLOCK DIAGRAM

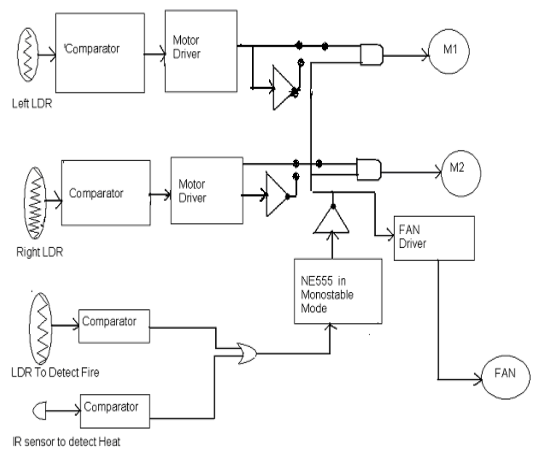


Fig 1 Block Diagram

3. SYSTEM WORKING

The circuit implemented consists mainly of two different sub-circuits.

The first part comprises of making the robot follow a black strip. This was done using a comparator circuit using the LDR whose reference voltage was fixed using the potentiometer. This was based on the phenomenon that the resistance of the LDR decreases as the intensity of light falling on it increases. In our case, the light reflected from the white surface is more than that from the black surface. Therefore, the voltage in positive terminal of the comparator remains high as long as the robot is moving on white surface. If the black surface come under one of the two LDR's the motor corresponding to that LDR stops, the other making it move away from the black line. But as the other LDR crosses the black line, its motor stops, the other forcing it in other direction, resulting in its following the black line. Thus, the output voltage of the Op-Amp has been varied according to the need, but the current flowing through the output of Op-Amp is in some mA .Thus there was need for current amplification. The Darlington –pair was used for the same. The resistance of the motor was 5-10ohms, thus source follower circuit was used.

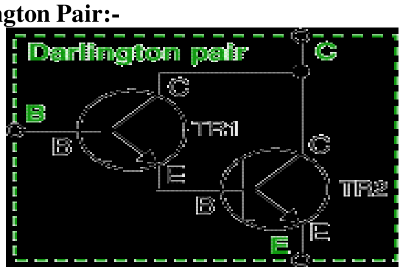
The second part comprised of using LDR's and IR-receivers to detect flame .The dual Op-Amp LM358 was used for the same. The two comparator circuits were used .For LDR, the working was same, but for IR receiver the voltage and not the resistance vary according to the intensity of light. Thus the two ends of IR-receiver were connected to ground and positive terminal of the comparator .The output of these two were ORed and given to a mono-stable 555 timer with time period of 4 sec.555 was used because when the robot sees the fire ,the fan starts and the motors stop but when fan starts the intensity of light decreases and hence the two motors start again and there is a chance that the motor starts before the fire is extinguished .The 555 helps in generating a high pulse of about 4 seconds which will remain high and will not depend on the intensity of light for the same duration .Thus, this will make sure that the fire is extinguished before moving ahead. Once the fire is extinguished it will retain its original motion.

4. COMPONENT DETAILS

1. COMPARATOR CIRCUIT:-

When Vin rises above or falls below Vref the output changes polarity (+ becomes -). Vout is high for Vin greater than Vref and is low for Vin less than V ref.

2. Darlington Pair:-



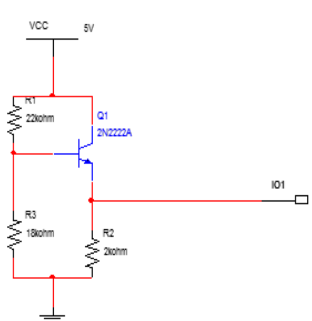
A Darlington pair is like a set of feeders with a high current gain (approximately the product of the gains of the two transistors). A general relation between the compound current gain and the individual gains is given by:

$$\beta_{\text{Darlington}} = \beta_1 \cdot \beta_2 + \beta_1 + \beta_2$$

If β_1 and β_2 are high enough (hundreds), this relation can be approximated with:

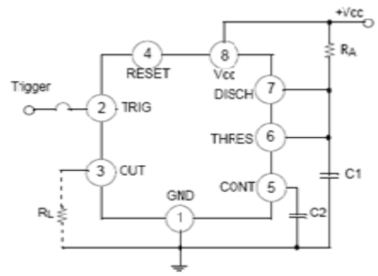
$$\beta_{\text{Darlington}} \approx \beta_1 \cdot \beta_2$$

3. Source Follower:-



The source follower is used to avoid voltage drop due to low output impedance. It supplies the same amount of voltage and current but can drive low resistance devices.

4. Mono-stable NE555:-

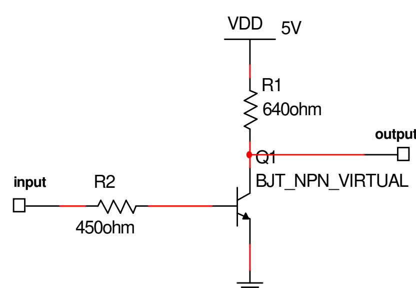


Here the popular 555 timing IC, is wired as a mono stable. The timing period is precise and equivalent to:-

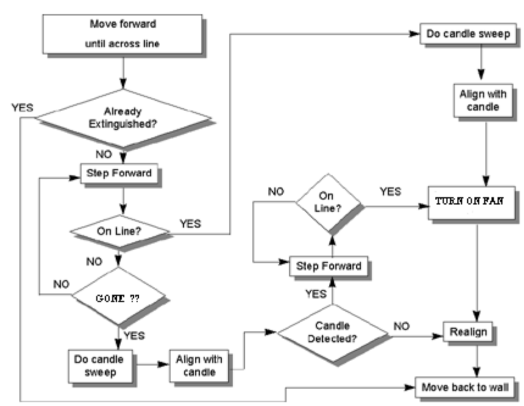
$$W=1.1 \times R_1 \times C_1$$

With component values shown this works out at approximately 1.1msec.The output duration is independent of the input trigger pulse, and the output from the 555 is buffered and can directly interface to CMOS or TTL IC's, providing that the supply voltages match that of the logic family.

5. NOT using NPN transistor:-



5. ALGORITHM



6. DIFFICULTIES FACED AND STEPS TAKEN

1. IC 741 was used for the comparator circuit but the output of the comparator was around 4.5V when high and 1.8 V when low. The AND IC used considered this as a logic high and hence the circuit did not work according to the logic. LM 358 was used to overcome

the difficulty. Its logic high is 3.8V and logic low is 0V.

2. The output of the comparator gives very less output current which does not drive the motor. Thus, the Darlington pair was used to increase the current.
3. The current gain of different SL100 transistors used varied from 100 to 750 .Thus number of transistors used in the Darlington circuit were 3 on one side and four on the other.
4. The output impedance of the motor is few ohms. Thus to run the motor one required a source follower circuit.
5. Though the line follower began to work, the current flowing through SL100 of the source follower circuit exceeded the maximum limit. Thus, SL100 had to be replaced by 32C.
6. The fire extinguishing part of the robot also faced the problem. The robot used the fan to extinguish the fire. The intensity of light and heat governed the speed of the fan. But as the fan tried to extinguish the fire, the intensity of light decreased and hence the robot started to move without extinguishing the fire. The mono-stable 555 was used to solve this problem .It made the fan to rotate for a fixed duration without depending on intensity of light for a fixed duration after which it continued on its path.
7. The main problem which could not be overcome was that it could not be driven by batteries. The power requirement of the circuit could not be received using the batteries.
8. Selecting the best chassis was a time consuming process.

7. FUTURE SCOPE

This project has been motivated by the desire to design a system that can detect fires and intervention. In the present condition it can extinguish fire only in the way and not in all the rooms. It can be extended to a real fire extinguisher by replacing the fan by a carbon-di-oxide carrier and by making it to extinguish fires of all the room using microprogramming. This provides us the opportunity to pass on to robots tasks that traditionally humans had to do but were inherently life threatening. Fire-fighting is an obvious candidate for such automation. Given the number of lives lost regularly in firefighting, the system we envision is crying for adoption. Of course, this project has only scratched the surface. As in the design simplifications and the implementation constraints in suggest, our project is very much a proof-of-concept. In particular, a practical autonomous fire-fighting system must include a collection of robots, communicating and cooperating in the mission; furthermore, such a system requires facilities for going through obstacles in the presence of fire, and ability to receive instructions on-the-fly during an operation. All such concerns were outside the scope of this project. However, there has been research on many of these pieces in different contexts, e.g., coordination among mobile agents, techniques for detecting and avoiding obstacles, on-the-fly communication between humans and mobile agents, etc. It will be both interesting and challenging to put all this together into a practical, autonomous fire-fighting service.

8. APPLICATIONS

1. The robot can be used to guide the visitors from the entrance to the main office .
2. It can help doctors to carry medicines from one ward to another .
3. The main purpose is to rescue the people by extinguishing fire in a building.
4. Can be used in record maintaining rooms where fire can cause lose of valuable data.
5. Can be used in Server rooms for immediate action in case of fire.
6. The potential application of the multifunctional firefighting system has been defined as a group that includes the chemical and oil industry, nuclear plants, military storage facilities, as well as mine fields and dangerous substance transport.

9. CONCLUSION

This paper has presented a unique vision of the concepts which are used in this particular field. It aims to promote technology innovation to achieve a reliable and efficient outcome from the various instruments. Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. With a common digitalized platform, these latest instruments will enable increased flexibility in control, operation, and expansion; allow for embedded intelligence, essentially foster the resilience of the instruments; and eventually benefit the customers with improved services, reliability and increased convenience. The day is not far when this technology will push its way into your house hold, making you more lazy. This paper presents the major features and functions of the various concepts that could be used in this field in detail through various categories. Since this initial work cannot address everything within the proposed framework and vision, more research and development efforts are needed to fully implement the proposed framework through a joint effort of various entities.

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