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Aims and Scope

The Journal of Electronic Engineering and Communication Engineering is a peer reviewed journal . It is intended to serve as a forum for researchers, practitioners, and developers to exchange ideas and results for the relevant engineering issues on electronics and communication. Suitable topics include, but are not limited to: Advanced power semiconductor devices, Modelling, simulation, analysis, design and implementations of the application of power circuit components (power semiconductors, inductors, high frequency transformers, capacitors), Control algorithms and techniques applied to power electronics, Applications in motor drives, wind energy systems, solar, battery chargers, UPS and hybrid systems.

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Contents

PROPOSED PATH FORMATION AND MAINTENANCE ALGORITHM FOR BETTER EFFICIENCY IN AODV

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ABSTRACT

MANETs workspace was initiated by a simple protocol of AODV that tries to find out the path to destination node dynamically, using circuit switching procedure. After the circuit of nodes for data transfer become known to source, transmission of data through it starts. Since MANETs have the inherent property of nodes moving here and there, this circuit breaks very often during data transfers. Here some resolutions are provided for these limitations that will provide a way to harness the attributes in an efficient way. The initial working scenario of AODV is deeply analyzed and optimizations were made in it to solve the problems of path breaking by making multiple paths towards destination, either from the source or from middle nodes, without incurring much overhead. Beside this, some local maintenance from nodes are also offered to cater the link loss problems.

KEYWORDS: MANET, AODV, Path Break, Local Recovery, Multi Path, Path Recovery.

INTRODUCTION

MANETS [1] are characterized by the property of moving nodes, with fast moving topologies and nodes entering and leaving the network anytime. For routing the packets various algorithms have been designed which are categorized according to the essence they depend on. Current research work is heavily oriented towards designing better algorithms, as well as removing the limitations of the previous ones. Such works always remove some sort of problems but help develop other limitations as side effect. According to the platform on which they are developed, routing algorithms can be categorized as:

1. Pro-active.
2. Reactive.
3. Hybrid

Proactive [3] routing algorithms need that the routing table of the nodes should have data path being inserted before they were being inserted in the network. Manually we have to find the path from source to the destination which is then inserted in node's routing table [4]. We can also create conditions where one node is always forced to transmit data to only given specific nodes. Such algorithms work well only in the conditions where knowledge exist at hand which nodes are permanent in network, as well as if there is very little mobility in the network. If the network is highly dynamic, then it is cumbersome for the MANET admin to insert the new nodes at given places with routing table updates for the nearby

nodes. Examples of this type include DSDV [5], WRP [6].

On the other hand, Reactive [7] protocols do not require initial routing table to work for. Their routing tables are initialized to no routes. When a node finds data to send to other node, it dynamically looks for connectivity to the destination node. Due to this feature, this protocol becomes highly adaptive to ever changing topologies and location changes of the nodes in MANETs. If the path breaks before the completion of data transaction, such protocols make use of remedial methods to overcome the problems. Example of this type includes DSR, AODV [2][5] and ABR [6]. Hybrid [7] protocols are mixture of proactive as well as reactive protocols. They try to acquire the best features of both the protocols. The better attributes of each protocol, depending on the scenarios of the network, are chosen and applied, so that the overall burden on the resources of the MANETs is limited. Example of this type includes TORA [6], ZRP [8].

AODV ROUTING

Adhoc Ondemand Distance Vector routing is a reactive protocol that is a mixture of DSR and DSDV protocols. The route discovery procedure as well as route maintenance phases are similar to DSR protocol while the hop to hop data transfers as well as route updating phases are similar to DSDV protocols. AODV offers quick adaptation to dynamic link conditions, lower processing needs and memory overhead, lower network utilization, and determines unicast routes to destinations. It uses destination sequence numbers to ensure loop freedom at all times, avoiding problems associated with classical distance vector protocols. It enables dynamic, self-starting, multi-hop routing between participating mobile nodes wishing to set up and maintain an ad hoc network. AODV allows mobile nodes to obtain new routes speedily for new destinations. AODV offers quick convergence even in the case of path breakage. When paths breaks, all the nodes which are on the side of the source are conveyed message that path breaks has occurred and delete the related entries from the routing table. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the packet types utilized by AODV. UDP is used to transfer such packets and normal IP header processing applies. For broadcast, the IP limited broadcast address (255.255.255.255) is used. Before starting the data transfer, the source generates a RREQ packet that is broadcasted to the nearby stations. Such a RREQ packet contains RREQ, id reserved bit, destination IP address, destination sequence number, source IP address and source sequence number. It also consists of some other fields also. This packet when received by a node is checked in the routing table of the node. The destination sequence number is compared from packet to that of routing table. If the packet sequence number is greater than the one in the node routing table, packet is forwarded to establish a new route. If this is not true, then it means that the node has a more active route to the destination and in response, a RREP packet is generated and unicasted towards the source. When a node receives multiple RREQ originated from same source as well as for same

destination, then it acknowledges by forwarding only the first RREQ and discarding rest of all, received by it. This way lot of overhead is overcome at each level of intermediate nodes. When the destination node receives a RREQ, it processes the information in it and generates a RREP packet which is unicasted towards the source, and will traverse only the nodes that are contained in the RREQ packet received by the destination. Each node that gets a RREQ packet makes an entry in RREQ packet before forwarding it to next nodes, and makes an entry in routing table [9] about the path from its last node. In the course of RREP packet back to source, the nodes make an entry of the backward path in their routing table. When the source gets the RREP packets it analyze the information in it and start sending data through the sequence of nodes given in it. If during transmission, any node steps out of the scope of the nearby node, and is indulge in transmission, then a RERR packet is transmitted by the last node in path, towards the source. Getting a RERR packet the source again initializes a RREQ packet for a new path. The limitation of AODV is that in case of path break, overhead is incurred to a very large extent. A whole new process of RREQ is initiated in case of losing an intermediate node. Another limitation is that the nodes can detect each other broadcasts. Along with this, if a valid route is expired, how much time is used to detect the expiry of that link.

PROPOSED SOLUTION

The path development phase in AODV is considered optimized and not much is changed in its working as any advancement made to it completely changes the algorithm to some different, already developed algorithms. Whatever changes that can be suggested and implemented in path development phase are very rare to find as very lass scope is find in this scenario. The solution not only works in the development phase of the path but also takes care of all the work done by individual nodes in developing route to destination. Apart from this if a node displaces its position then very less overhead in incurred in maintaining the path or creating a new one. In the very first phase of development of the path, optimizations can be done with the RREQ packets. Normally a RREQ packet is discarded by the nodes when it is already received and processed previously, forwarded by some other node. This is feasible because it prevents a lot of overhead on the network. But, what if, the destination node receives more than one RREQ packet. Default AODV routing algorithm discards any duplicate RREQs at destination also. This algorithm, make changes to default scenario little bit to optimize the whole process. Why discard a packet at destination when it can prove to be a helping agent in making a backup path for the same route. We can buffer a limited numbers of RREQ packets at destination node, depending upon a given attribute of our choice. If we are looking for time constraint then we can gather RREQ packets whose latency is very near to first arrived RREQ packet. If not this, we can have number of hops as the decision making attribute in caching the RREQ packets. Upon defining the attribute and caching the packets, a RREP packet is generated for each of the RREQ packets. During this whole procedure, there

may be RREQ packets arrived which may contain lots of nodes common in most of the routes. Creating double paths with same nodes will just increase the burden on the resources of the nodes, by adding same entries in the routing table. We can delete such entries in most of the intermediate nodes on the basis of destination node and next node similarity but will defer us in removing entries from the node in which the next node is different. This concept is shown in Fig 1 where the entries from routing table are deleted by nodes B and C but not by D, which has two branches going towards the destination. This check will be at intermediate nodes routing table when they find same entries multiple times. We will then define a threshold value for such routes. Only those routes will be considered that will contain at least Ψ % of different nodes starting from the source. This value of Ψ will vary for dense networks to loosely coupled networks, and will be decision making factor for the optimization of the algorithm. Fig. 1 and Fig 2 show a scenario where a destination node gets multiple RREQ packets but discard only some and process others. It must be noted that in Fig. 2 any one node from E or F will be chosen as they have lots of common intermediate nodes.

The algorithm for such a process is stepped down:

1. Start at source, broadcast RREQ.
2. At intermediate nodes, verify destination sequence no. as usually done in AODV
If dest. Seq. No. (Node) < dest. Seq. No. (packet)
Update routing table entry with this path and broadcast this packet
Else send RREP to source
3. If node gets more than one RREQ from same source then: If node!=destination
Discard RREQ
If node=destination
Process RREQ
4. Compare all RREQ at destination on some attribute value like latency or number of hops and selects RREQs to process and discard rest.
5. Create RREP for all collected RREQ and process them towards source.
6. At intermediate nodes, for multiple entries by RREP from same destination, preserve the entries coming from different nodes, delete rest duplicate entries.
7. At source node after getting multiple RREP
Forward data using single path.
Forward data using multiple paths.
8. If RERR is received by source for some path:
Delete the entry of concerned path from routing table
Consider the other path as primary or as needed.

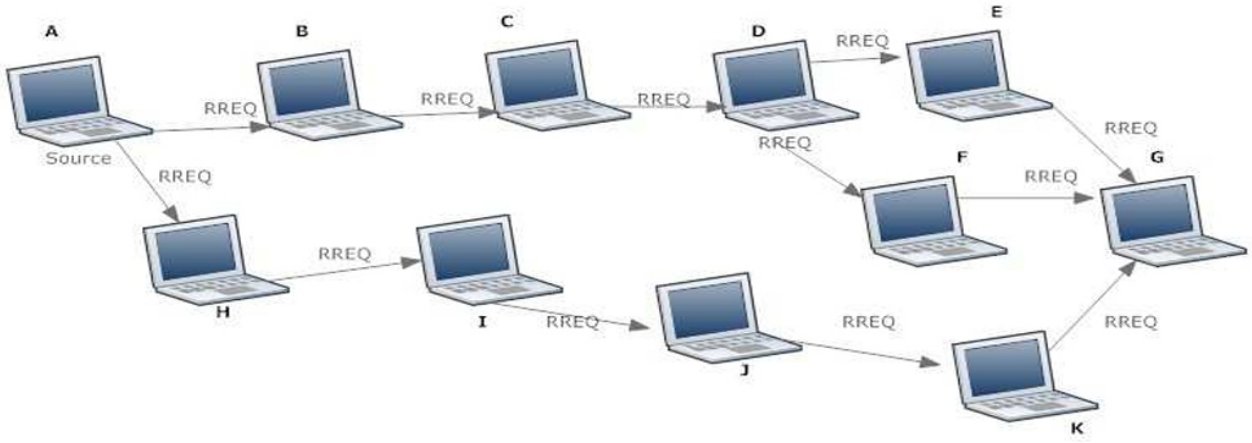

Fig. 1 Multiple RREQ processing at Destination (G)

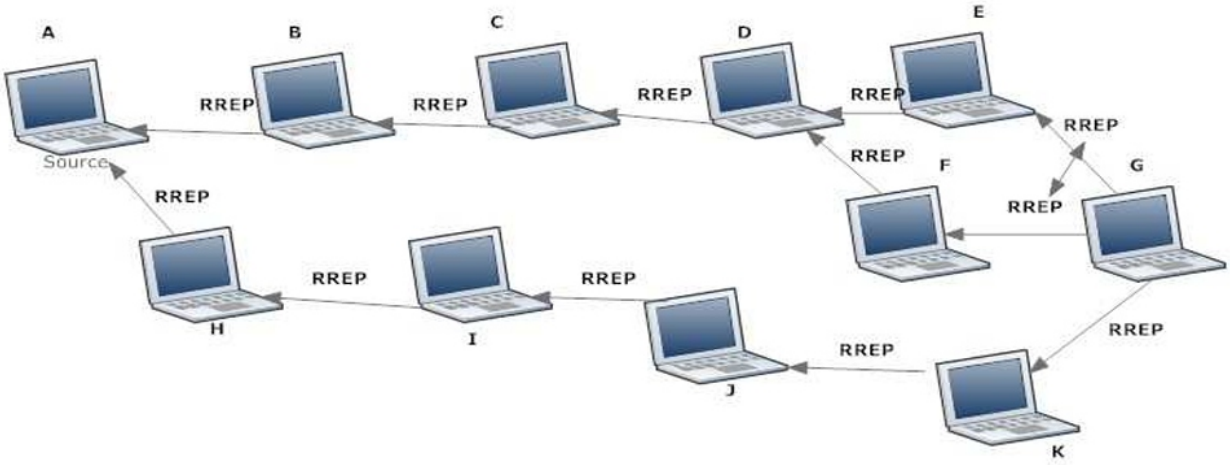

Fig. 2 Sending multiple RREP for source

Advantage of this process lies in the fact that there may be completely different paths from source to destination, which never crosses each other at any node as depicted in the figure. We can consider this path as a backup path and processes it for the time when original path gets disrupted. As soon as source gets RERR message from some node, it deletes the primary route to the destination and starts using next route from the routing table to send the data as shown in Fig. 3. If this is also found to be down, another path, if exists, can be considered for data transmission. Now the probability of path disruption for any route is already low then it can be said easily that the probability of getting all routes down from source to destination is very less. Not only this, the source can send data from more than one path so that the resource utilization is uniform throughout the network nodes. This whole process is initiated by the RREQ packet from the source.

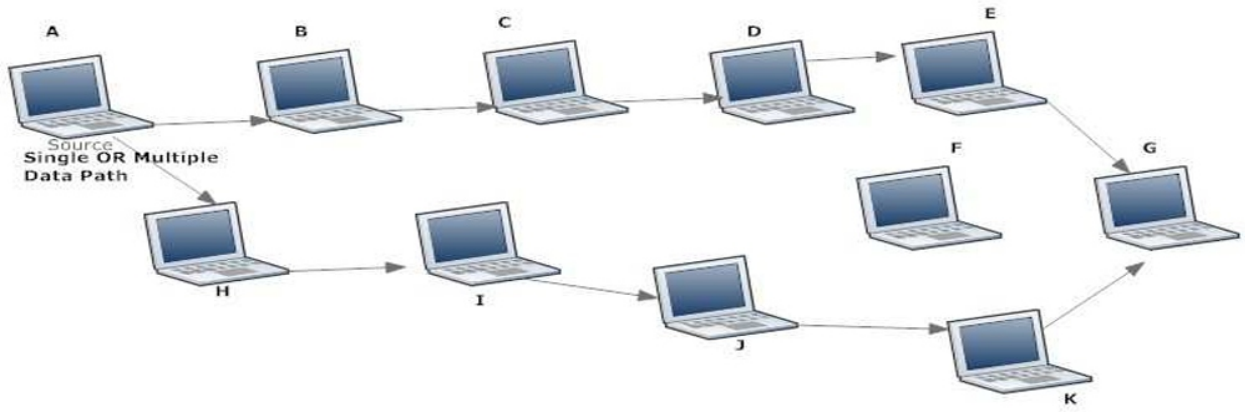

Fig. 3 Using single or multipath for data transmission from source to destination

Another event can also be associated with this process, not from the source but the destination node. If we do not opt for processing of multiple paths from source to destination using RREQ packet then we can try to create a backup route from destination to source for recovery path. The workaround is again done by the destination. When it receives multiple RREQ packets it analyses the very first packets and discards rest of all. Since this RREQ packet contains list of nodes traversed, the destination node constructs a RREQ packet for the source and broadcasts in the network. Again this packet is constructed in such a way that it seldom tries to create path using the original path created by the source node as shown in fig. 4.

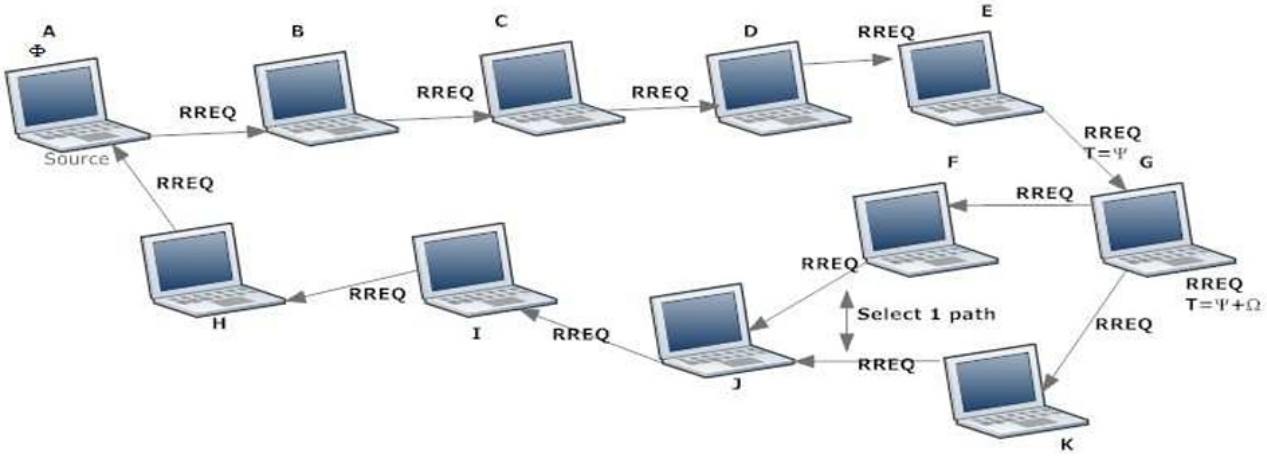

Fig. 4 RREQ process from destination upon receiving RREQ from Source

It is not that it will never construct a path with nodes in parent RREQ but its emphasis will be to gather least number of common nodes in both the paths. If such a packet reaches source node with all different nodes, then we have backup path for our default route. The main difference between this process and the last process is that the latter process is going to work well where we are having different upstream and downstream values of transmission rates.

These all algorithms need path development features to be initiated either by source or destination. Since the source or destination does not initially know how much it is going to use the resources, why should the source or destination waste time and resources in creating paths for bad times. Let the path

break occur and then try something at runtime to cope with the situation. When a node moves out of the scope of the last node in the forward data path, then only the last node is aware of this change. So he will be the only object that can cope with this situation of disruption. The very first thing that it normally does is to send the RERR messages back to source. Now, we will change its work and make it a real decision making node in such a scenario. When noted about a movement in the next node, if the current node is aware of the second node in the path then it can try to find a fresh path to that node. For this there will be a little change to be made in the packet format of RREP message as shown in the fig 5. A next to next field will be added that collects the information of the second node in the path. It is to be noted that such a change is to be made in packet format of RREP as this node information will only flow at this stage of path formation. The routing table update is shown in Table 1. When a path is found to the second node, this change in path is appended to the original path deleting the old redundant entry. This update can either be forwarded to the source node or can be kept to be implemented at local node as shown in Fig. 6.

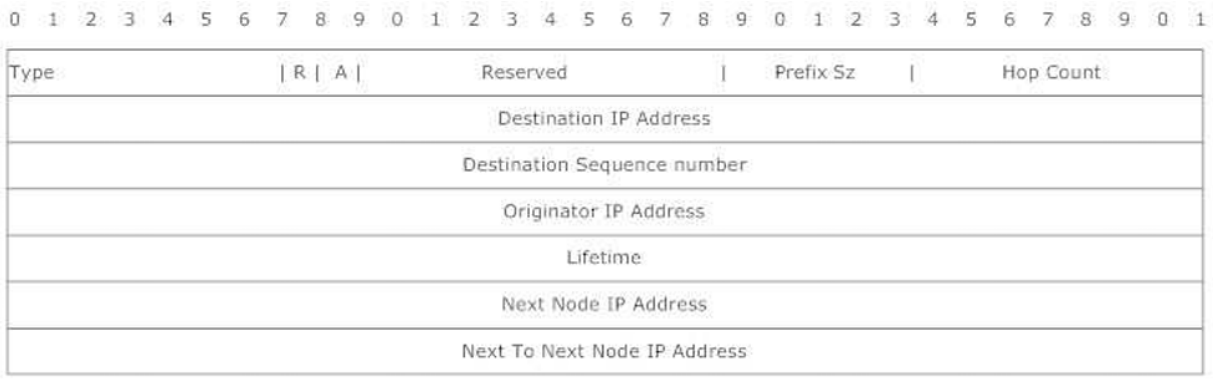

Fig. 5 Next to next field added to RREP packet

Table 1 Advanced Routing Table at a given node for local recovery

Destination Node	Next hop	Next 2 Next Hop	No. Of Hops	Destination Seq. No.	Active Neighbour Nodes	Expiration Timer
-	-	-	-	-	-	-

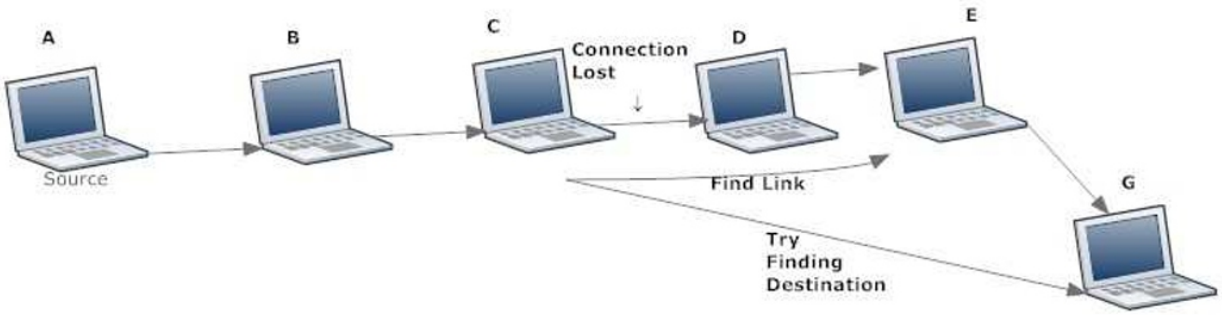

Fig. 6 finding path from last active node to second in line node or destination

If for some reason we are not opting for a path to the next node, to save the default packet format, then we can try searching the destination node from the last node after which the next has moved out of scope. This way we will not mess up with the packet format and there can be less overhead on path forming nodes. When the node gets a fresh new path to the destination, it appends that path to the original path, removing the older non usable path. In this process this has to be remembered that the last node will forward the RREQ packets only towards the destination node and not towards the source side. The default RREQ process will be applied in finding route from node to destination.

CONCLUSIONS

A lot of work that has been done in this field are innovative in nature, but none of them were able to completely rectify the problems occurring due to dynamic nature of the MANETs. Also the resource utilization also poses great difficulties in implementing good algorithms. My proposal may be said to be innovative to the very basic level of implementation, and can may be proved to be effective in different working environments and not limited to any one or all environments.

FUTURE WORK

We have just provided the algorithms for the advancements that can be made in the initial processes of the AODV routing protocol. Since each of them are just collection of words and their feasibility in real or simulated world is still not known, it is a matter of time to prove their applicability of acceptance in the wireless world. Also if we try implementing each of them in a single process them we will be able to get remedies to lot many security problems like black hole etc.

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VEHICLE AUTOMATION USING FUZZY BASED PID TYPE CRUISING CONTROLLER

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ABSTRACT

In view of the increasing number of road accidents in recent years, it is conceded that road accidents have assumed the dimensions of a serious social problem. This paper describes the designing of fuzzy based PID-type (Proportional-Integral-Derivative) controller using VERILOG HDL to avoid the collisions between vehicles on the road. The proposed controller provides a reference for controlling the vehicle speed to either increase or decrease based on the distance of the preceding vehicle. A separate Fuzzy algorithm is developed to monitor and control the engine temperature. The model is established on a SIMULINK platform. The model is coded and simulated using VERILOG HDL. The verified VERILOG model is synthesized using the synthesis tool from Xilinx to get Register Transfer Level (RTL) hardware architecture of the PID modulus. This controller is cheaper in cost compare with the conventional PID controller system. This can be used to reduce the road accidents and ensure the safety of the road users in the future.

KEYWORDS: PID, Fuzzy

INTRODUCTION:

The increasing number of traffic accidents in recent years has assumed the dimensions of a serious social problem, making it imperative to find effective ways of reducing traffic accidents and fatalities. This paper presents the designing of a PID controller based on Fuzzy logic that can be used by vehicles on road to make a smooth and safe drive by enabling it to accelerate or decelerate based on the status of the leading car while maintaining a safe distance away from it.

The best known controllers used in the industries are the proportional - integral - derivative (PID) controller because of their simple structure, robustness and variable structure. The PID controller is used for a range of problems like motor drives, automotive, flight control, instrumentation etc. PID controllers provide robust and reliable performance for most systems if the PID parameters are tuned properly. Among the tuning methods, the Ziegler-Nichols (ZN) technique has been very popular.

However, the conventional PID controller is not suitable for nonlinear system. Fuzzy system is well known with its non-linearity characteristic behavior. Therefore, the nonlinear characteristic of the conventional PID controller can be improved greatly using fuzzy logic algorithm.

In this paper, the control system is modelled and designed using VERILOG, then it is synthesized using XILINX Field Programmable Gate Array (FPGA) for rapid prototyping. The FPGA implementation allows for immediate manufacturing realization and negligible prototype costs. In testing, FPGA allows designers the freedom to redesign portions of their circuit for optimization, without performing full redesign iterations to improve a design..

FUZZY BASED PID-TYPE CRUISE CONTROLLER

This section covers the specifications of the model of the fuzzy based PID type cruise controller. The models of the controller based on fuzzy rules are known as, the Fuzzification module, Inference module, Implication module, and Defuzzification module. All the relevant and crucial parameters are explained and illustrated, including the set of fuzzy rules applicable. The objective of this fuzzy controller is to control the vehicle speed. Figure 1 shows the block diagram of the fuzzy PID controller.

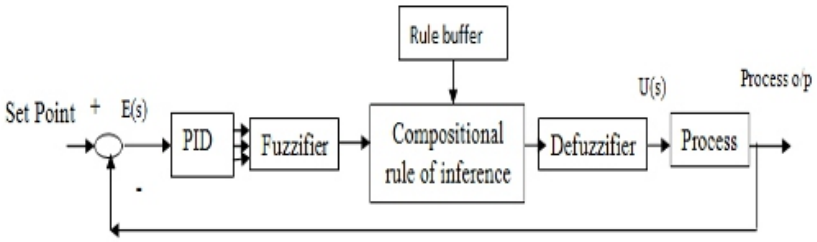
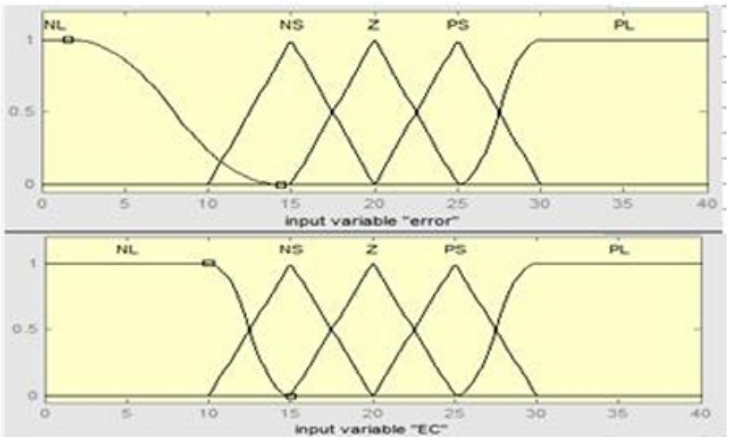


Figure 1: Block Diagram of Fuzzy PID Controller

The three inputs to the controller are calculated for the following variable stages:

1. Error = crisp input.
2. Change in error, ΔE = current error - previous error.
3. Rate of change of error= current delta error - previous delta error.

The inputs and output can be defined using the linguistic terms as NLARGE, NSMALL, ZERO, PSMALL and PLARGE. The graphical representation of the membership functions is shown in Figure 2.



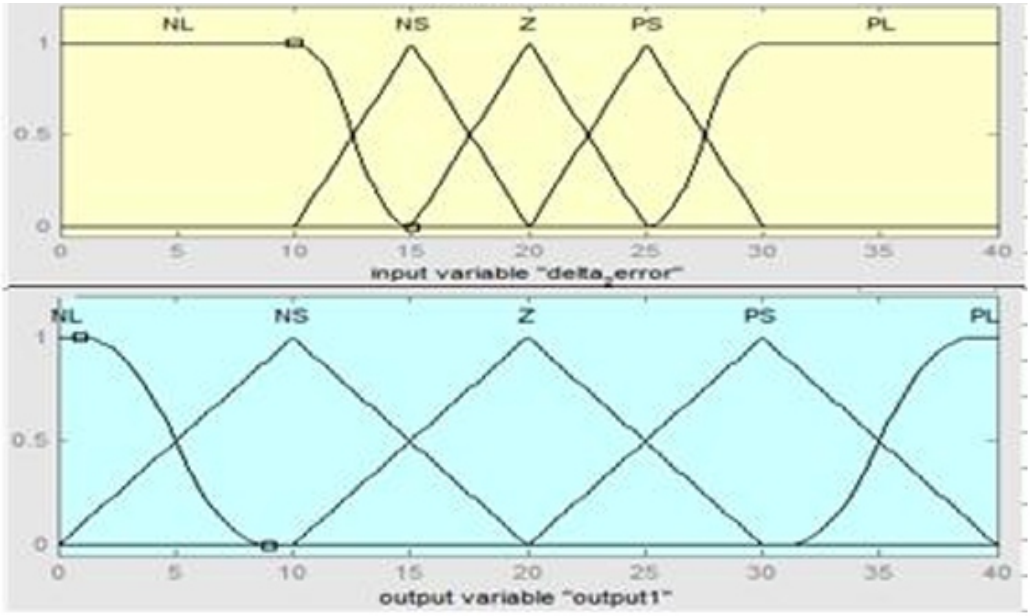


Figure 1: Membership Functions of Fuzzy Based PID Type Controller

A system with three inputs and having five linguistic terms has a total of 5×5×5 =125 different rules can be used to describe the complete fuzzy control strategy. In Table 1, sample fuzzy rules are listed. Since the input grades are connected by a logical "AND" operator, one input is dependent upon the other, selecting the minimum value will satisfy both conditions. Therefore, taking the minimum of the three variables will be used as the output grade of membership function in each rule.

Table 1: Sample Fuzzy Rules of PID Type Fuzzy Controller

Error	Delta Error	Delta^2 Error	Output
NLARGE	NLARGE	NLARGE	NLARGE
NLARGE	NLARGE	ZERO	NLARGE
ZERO	ZERO	ZERO	ZERO
ZERO	ZERO	PLARGE	PLARE

ENGINE TEMPERATURE CONTROLLER

This section covers the specifications of the model of the fuzzy based enginecontroller.The controller adjusts the temperature of the engine according to the current temperature and the target value. A simple block diagram of temperature control system is shown in figure 2.

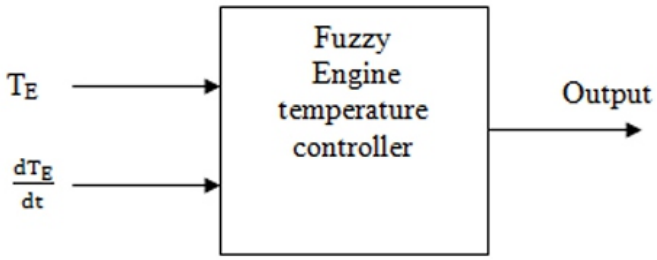


Figure 2: A Simple Block Diagram of Temperature Control System

There are two control variables to adjust the engine temperature: error, which is the difference between the current temperature and the target set temperature and the rate of temperature error change (error dot) with time. Figure 4 illustrates the 3 fuzzy variables, for both input and output are termed Z (Zero), P (Positive) and N (Negative). The triangular membership function will be used throughout this application because of their simplicity and efficiency of implementation in VERILOG. The values of the x-axis of the membership function representing the actual reading from the temperature sensor. Similarly, the y-axis for the grade of the membership functions. Based on these 2 inputs, the fuzzy logic model determines the amplitude of the voltage signal that is necessary to be sent to the heater in order to maintain a constant temperature.

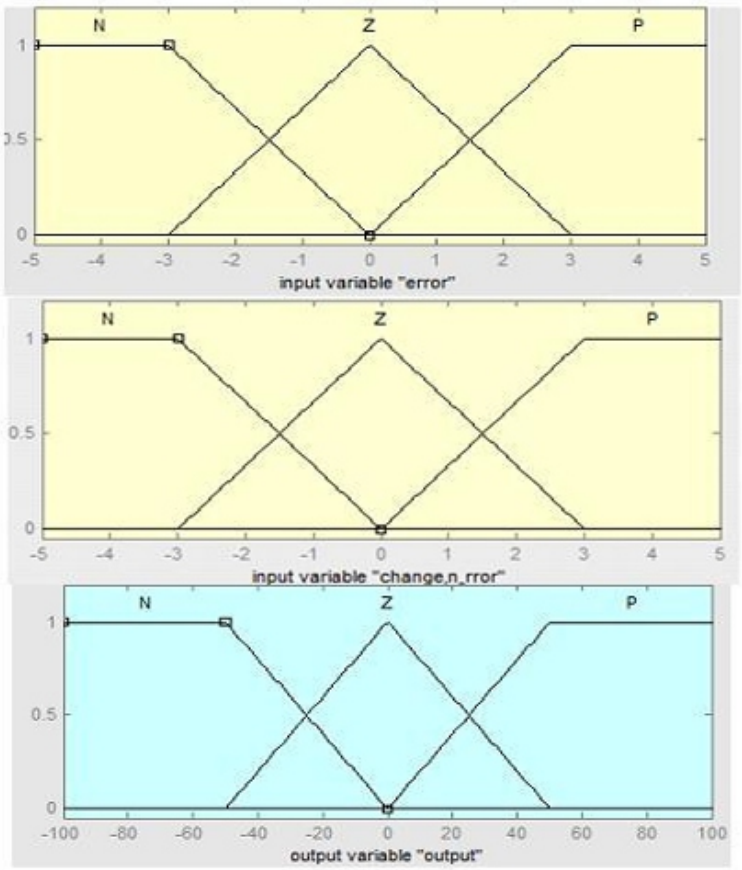


Figure 3: Membership Functions of the Fuzzy Temperature Controller

A system with two inputs and having three linguistic terms has a total of 3 × 3 =9 different rules can be used to describe the complete control strategy. In Table 2, sample fuzzy rules for the temperature control system are listed.

Table 2: Fuzzy Rule Matrix of Temperature Controller

Change in Error/Error	N	Z	P
N	C	H	H
Z	C	NC	H
P	C	C	H

IMPLEMENTATION

The whole system is coded in VERILOG HDL, and simulated using Modelsim SE 6.2d. The simulated VERILOG HDL code is synthesized using Xilinx ISE environment and downloaded in Spartan-3E FPGA kit. Xilinx ISE is a software tool produced by Xilinx for synthesis and analysis of HDL designs, which enables the developer to synthesis their designs, perform timing analysis, examine RTL diagrams, simulate a design's reaction to different stimuli, and configure the target device with the program. The Xilinx ISE system is an integrated design environment that consists of a set of programs to create (capture), simulate and implement digital designs in FPGA or CPLD target device. All the tools use a graphical user interface (GUI) that allows all programs to be executed from toolbars, menus or icons.

There are two modules in this vehicle automation and each module represents various parameters such as temperature of the engine and speed of the vehicle. Each module is separately synthesized using Xilinx tool and downloaded to the FPGA board. The functionality of the modules is tested on the board using toggle switches and output is monitored with output LEDs. Vehicle automation is done using FPGA to reduce the complexity and cost of the existing CAN mechanism. In future more parameters can be added to improve the performance of the car automation system. Also the system can be optimized for speed, area and power using optimization techniques.

SIMULINK MODEL OF FUZZY BASED PID CONTROLLER

Fuzzy logic toolbox from MATLAB is used to develop a controller for fuzzy logic. Using the Fuzzy Inference System Editor (FIS), the editor involve is FIS editor, membership function editor and rule editor. Meanwhile, rule viewer and surface viewer are used to display the output of the controller designed. Afterwards, once the controller is complete, it is integrated with MATLAB simulink.Figure 5 shows the simulink model of fuzzy based PID type controller.

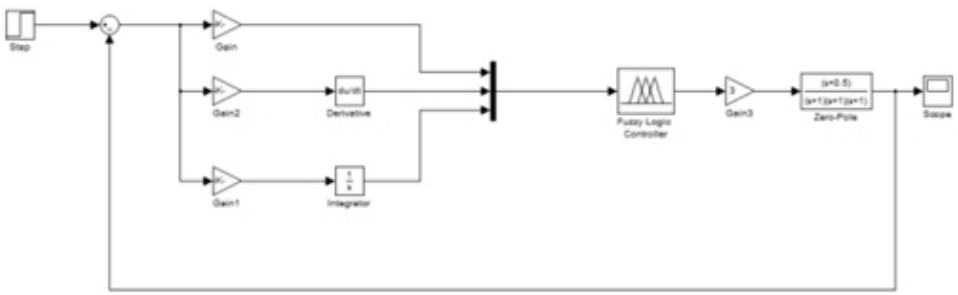


Figure 4: Simulink Model of Fuzzy Based PID Controller

RESULTS AND DISCUSSIONS

A vehicle speed and temperature control system to avoid vehicle collision and to control the engine temperature has been modelled and its functionality verified by simulation. The system provides a reference for controlling vehicles speed and temperature and the distance between vehicles is adjusted based on the above the set point. The modules are synthesized using Xilinx ISE 13.2 to confirm the implementation feasibility. The simulation results as well as synthesis results is presented below.

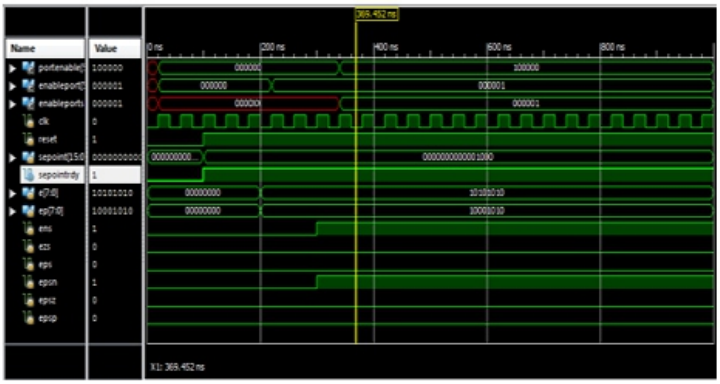


Figure 5: Simulation Result of Vehicle Automation

Figure 7 shows the output response of fuzzy based PID controller obtained in Simulink. It shows that the response of the Fuzzy PID Controller is comparatively better than the conventional PID Controller.

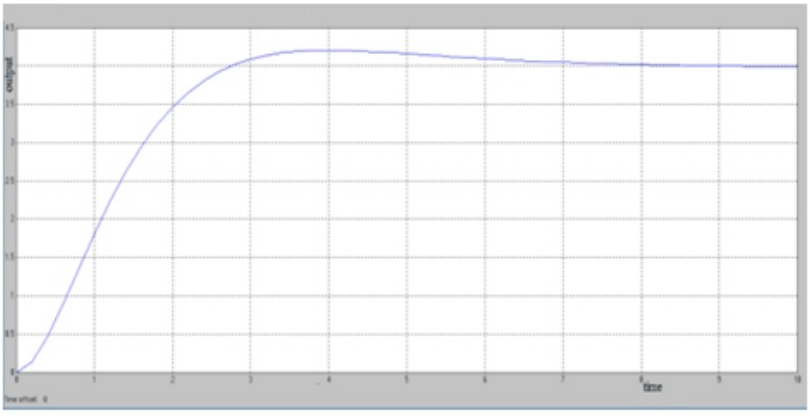


Figure 7: Simulink Output

Figure 8 shows the schematic of the system. From the figure we can see that the whole design is divided into six blocks such as pid_controller part, error_cal part, fuzzy_top part, port_connect part, rulematrix part and flc_new part. The pid_controller part, error_cal part, fuzzy_top part and port_connect part are used to perform the speed control. The pid_controller part is the forepart of the system which contains adders and multiplies. The error_cal part is used to calculate the three crisps inputs of the PID type Fuzzy Controller System. The fuzzy_top part is used to perform fuzzification, inference and defuzzification. The design of engine temperature control is performed with flc_new part and rulematrix part. The rulematrix part uses the state diagram approach and flc_new uses the normal implementation of fuzzy controllers.

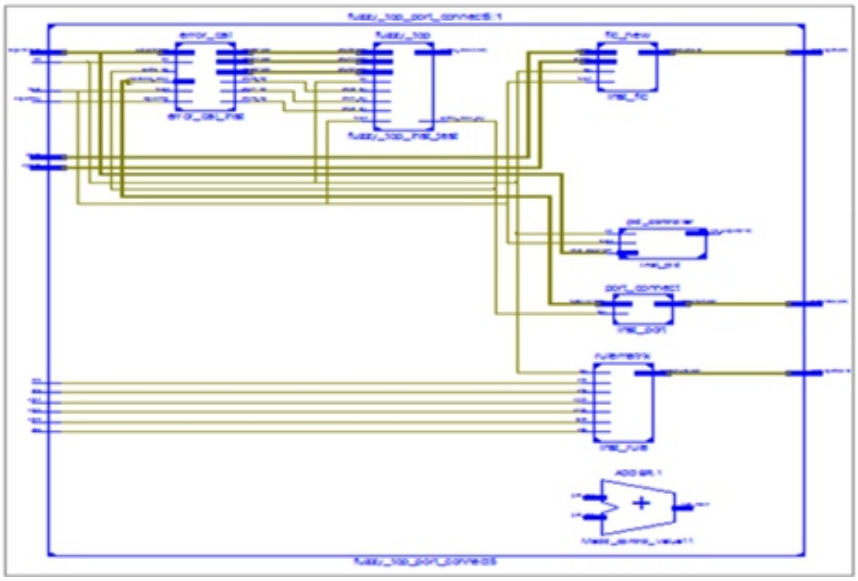


Figure 6: Final Schematic

CONCLUSIONS

A fuzzy based PID controller for transportation applications is being proposed in this project. The described PID controller also has developed with all fuzzy rules for designing the hardware PID chip using VERILOG HDL. Then, the synthesis tool has used to get the logic gates of hardware PID modules. The designed PID chip can be used for the targeted application. The cruising system based on PID controller can be used to avoid the collision between vehicles on the road. The controller algorithm will be further optimized by improving the membership function, the rule base, and the tuning method. It should be done to obtain better control over its application because there are many constraints those needs to be considered in the real world and to ensure the safety of the road user in the future.

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AN INNOVATIVE TECHNIQUE FOR SEGMENTATION OF FOREGROUND OBJECT IN VIDEO

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ABSTRACT

Locating moving objects in a video sequence is the first step of many computer vision applications. Many different methods have been proposed over recent years. Among the various motion detection techniques, background subtraction methods are common, especially for application relying on fixed camera. In this paper we present an innovative technique for motion detection which compares current pixel value with the set of pixel values taken in the past to find whether that pixel belongs to the background or not and thereby foreground object can be extracted and our work shows good results when compared to other techniques.

KEYWORDS: Background Subtraction (BS), Computer Vision, Image Segmentation, Pixel Classification, Video Signal Processing

INTRODUCTION

Background Subtraction (BS) is widely used approach for detecting moving objects of interest in videos in diverse applications including remote sensing, surveillance, medical diagnosis and underwater sensing. As a basic, the background must be a representation of the scene with no moving objects and must be kept regularly updated so as to adapt the varying luminance conditions and geometry settings.

Several approaches are available to detect, segment and track objects automatically in videos. Simple motion detection algorithms compare a static background with the current frame of a video scene pixel by pixel. The idea behind BS is to build a background model and compares this model with current frame to detect area where significant difference occurs. Therefore the aim of the Background Subtraction is to distinguish moving object(s) (foreground object) from background. In real life scenarios background may contain static objects, slow moving objects such as waves on the water, trees shaken by the wind etc. Also when static object starts moving, background subtraction algorithm detects the object in motion. For short video sequences and indoor sequences, static background model might be appropriate, but the model is ineffective for most of the practical situations. In this paper we present an idea for motion detection which compares current pixel value with the stored set of pixel values taken in the past to find whether that pixel belongs to the background or not in a video scene and thereby extracting the foreground region.

PREVIOUS RESARCH

Most BS techniques share a common framework: they make the hypothesis that the observed video sequence Is, is made up of a fixed background B in front of which moving objects are observed. With the assumption that a moving object at a time has a colour different from the one observed in B, the principle of BS method can be explained by

$$X_t(s) = 1 \quad \text{if } d(I_{s,t}, B_s) > \tau$$

$$0 \quad \text{otherwise}$$

Where Xt(s) is the motion label field at time t, d is distance between Is,t the video frame at time t at pixels and Bs the background t pixel s, τ is threshold.

The main difference between most BS methods is how B is modeled, how does it behave, how is the model initialized and how is updated over time. The approaches reviewed in this paper range from simple technique to more sophisticated and complex technique aiming to achieve the highest possible results under any possible circumstances. The authors [1] described the background with a gray scale / color image B. Foreground detection is described in [2] is a comparison process involves the comparison of observed image with an estimated image that does not contain any object of interest and this process divides the observed image into two complementary sets of pixels that cover the entire image:

the foreground that contains the objects of interest, and

the background, its complementary set

Many background subtraction techniques have been proposed with as many models and segmentation strategies. According to [3], a background subtraction technique must adapt to gradual or fast illumination changes (changing time of day, clouds, etc), motion changes (camera oscillations), high frequency background objects (e.g., tree leave or branches), and changes in the background geometry (e.g., parked cars).The method described by Seiki et al. in [4] is based upon the assumption that neighboring blocks of background pixels should follow similar variations over time. While this assumption holds most of the time, especially for pixels belonging to the same background object, it becomes problematic for neighboring pixels located at the border of multiple background objects. A solution to this problem is PCA and in [5] authors discussed on PCA reconstruction error. Independent Component Analysis (ICA) of serialized images from a training sequence is described in [6] in the training of an ICA model which is robust to indoor illumination changes.

In [7] authors proposed a spatio-temporal saliency algorithm especially for highly dynamic backgrounds. By constantly updating the model parameters, Pixel-based background subtraction

techniques [8,9] compensate the lack of spatial consistency. A method for properly initializing a Gaussian background model from a video sequence in which moving objects are present is proposed in [10]. In [11]Stauffer and Grimson discussed the most popular pixel level algorithm named as Gaussian Mixture Model (GMM) in which the distribution of each pixel value over time as a Mixture of Gaussians (MoG), which is adaptively updated in an online manner, and then classify incoming pixels into either background or not.

PROPOSED METHOD

Let p(x) be the value in Euclidean color space taken by the pixel at location x in a frame and B(x) be the background model for each background pixel x which is defined by a sphere having radius R with p(x) as center. Neglecting time parameter, B(x) is modeled with n background samples taken in the previous frames.

$$B(x) = [B1, B2, B3,\ldots Bn]$$

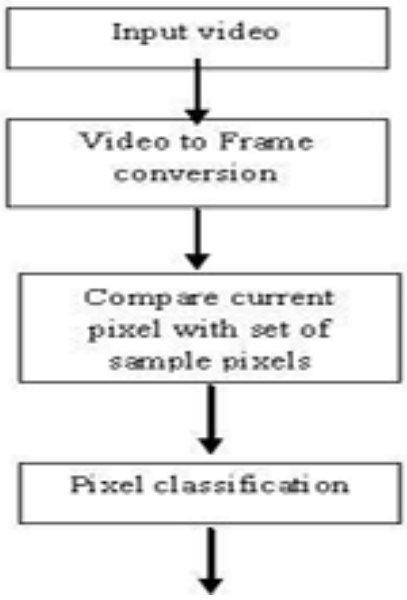
In our Background Subtraction problem, to classify a new or current pixel value, it has to be compared with set of background sample values taken in the past instead of doing comparison with a single pixel value. The flowchart of the proposed method is shown in figure 1.

To classify a pixel value p(x),

Step 1: p(x) has to be compared with B(x) which is defined by a sphere having radius R with p(x) as center.

Step 2: Find the intersection value of p(x) with B(x) which involves distance calculation between p(x) and model samples B1 to Bn individually.

Step 3: If the result of intersection is greater than or equal to predefined threshold value, then p(x) is classified as background pixel. Otherwise it is classified as foreground sample value.



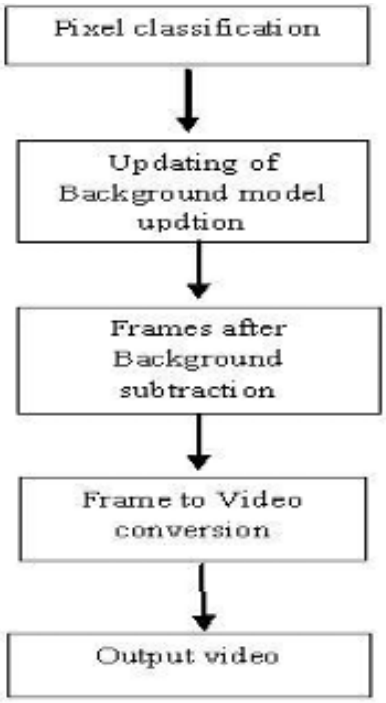


Figure 1: Flowchart of Our Proposed Method

Background model has to be updated continuously to cope up with the changes in the lighting conditions and to handle new objects coming into the scene. We discard the sample randomly according to a uniform probability density function to overcome the drawbacks in blind update policy. So our model contains samples from the recent past but older samples should not necessarily be discarded.

EXPERIMENTAL RESULTS

In this section we are comparing the results of our proposed method with other two methods namely Approximate Median method and Mixture of Guassian.

For our comparison we used two video sequences namely man and san_fran_traffic_30sec_QVGA_Cinepak. Comparative background subtraction for one frame (frame number 53) from man sequence and from san_fran_traffic_30sec_QVGA_Cinepak sequence is shown in figure 2 and figure 3 respectively. From our observation, when we compare the results of Our method with Approximate Median method and Mixture of Guassian method Our method produces clear and noiseless output.

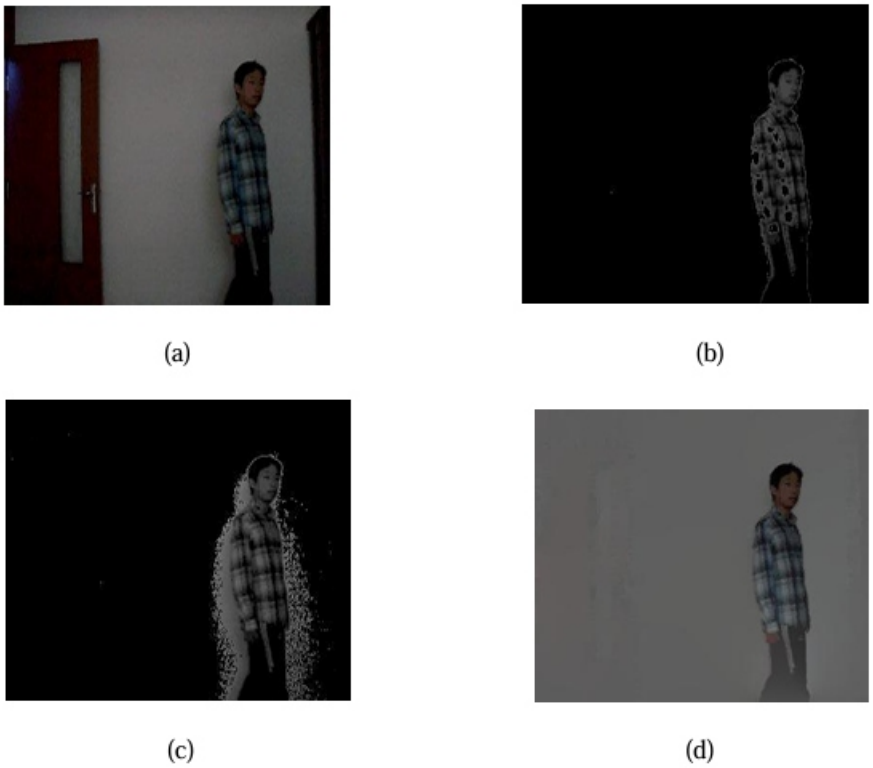


Figure 2: Comparation of Background Subtracted Image Obtained from Three Different Techniques Taken from Man Sequence (a) Input Image (b) Approximate Median (c) Mixture of Guassian (d) Our Method

(c) (d)

Figure 3: Comparation of Background Subtracted Image Obtained from Three Different Techniques Taken from san_fran_traffic_30sec_QVGA_Cinepak Sequence (a) Input Image (b) Approximate Median (c) Mixture of Guassian (d) Our Method

CONCLUSIONS

The key element which makes this system robust is the classification model which is based upon the correlation between current or new pixel and the corresponding background pixel model. Another important key element is updating model in which instead of removing older values first, pixel values are replaced randomly according to uniform probability density function. We then compared our method to other methods with two video sequences. For real time applications we may need a fast high performance system on the other hand offline applications we may use a relatively cheap (and slower in performance). It can also be seen from the diverse nature of the techniques used that the field has a lot of room for improvement.

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APPLICATION OF ELECTRONICS INSTRUMENTATION IN RAILWAYS FOR EARLY REPORT OF PROBLEMS

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ABSTRACT

This paper consist of the implementation of the major techniques of electronics in the order to create a multitasking device which can used in order to check the defects in the tracks of the railways. The idea is to implement a certain kind of tracking device which could check all the disparities present in the bogies of the train. The tracking device is present over the rails which track the distance between the rails, presence of a bomb, any breakage of track etc. The idea behind the device is by the use of proper sensor, multiplexer, data loggers, telemetry etc. the data is received and transmitted through a channel to the receiver. The use of this system can be done over certain tracks to record the information and provide it to the user when required.

KEYWORDS: Data Loggers, Telemetry, Encoders, Mux

INTRODUCTION

There are many principles in the field of electronics which can be applied in order to heal up the present status of railway etc. there were various type of accidents due to various problems, problems relating the status of the track or any mechanical problem. This paper deals with the implementation of a proper system which will track the problem regarding the following:

Increase or decrease of the distance between the rails of the railway tracks.

The presence of the bomb in which bogie at what distance.

Whether the wheels of bogie are running in better condition, friction is perfect or not etc.

Any interruption between the tracks.

The related above can be easily detected by the means of sensors and other electronic circuitry but the major problem is to correct it. This paper deals with a particular method which can be used in order to transfer this information to a hub and then proper steps must be taken to correct them.

Various sought of sensors are involved in the device such the infrared sensor used for the sensing distance between the rails and can also be used for finding out interruption in the tracks. The bomb sensor is used for sensing bomb.

Actually the idea is to set up this device ten km. on the railway track. All the trains which pass through these rails will be sensed first and then proper report will be sent to nearest station by the system discussed below.

First dealing with the circuitry involve

CIRCUITRY

The major circuitry is the sensing the distance between the rails this done by the mean of the infrared rays as the time required to go from one rail to another is counted and that standard time is compared with the time of taken by the rays to actually cross the rails. Other type of rays in order to find whether track is clear or not. Any change in the time required can be detected and that can be concluded as a defect is present between the distance of the rails or the there is obstacle between the two rails.

The other circuitry will test the presence of any bomb or any unnecessary items present in the bogie, as a particular sensor is implemented between the two rails this sensor will continuously check all the bogies right from engine to the last and report if there is any unnecessary object present. Also the distance between the engine and the bogie in which the bogie is counted. This is by the circuitry shown below as when the bomb or any other particle is detected then a trigger circuitry will be automated which will initialize a counter which will be provided the clock period same as that of the time required to pass one bogie from a particular point as we can say that time period can be automated as the average speed of the train is known also the length of bogie is fixed so the time required by the train to cover that distance will be Time period for clock =

$$\frac{length\ of\ bogie}{average\ speed\ of\ the\ train}$$

With this clock period the counter will count the number of bogies passed and the counted value is subtracted by the total number of bogies of that train. To stop the counter we use the concept of state machines of switching, generally state machines consist of output depicted by the mean of 0 or 1. This changing of zero to one or vice versa can act as a switch. Let a state be x in which the counting starts and state y in which the counting stops. The occurrence of both the states depends upon the variation of the switching. Consider a situation if a bomb has been detected in a particular bogie then the state will be changed from x to y and again when the train will complete its passing through the sensor then the state will again be changed from y to x. In the mean time the counter will count the number of bogies present. Subtracting it from total number of bogies will provide the bogie number in which the bomb is expected.

In order to check the presence the proper friction between the rails and the wheels of the rails the sound of the rails is detected as when an improper friction is present between the wheel and the rails then the sound varies, the varying sound can be concluded by the presence some varied amplitude passed. This varying amplitude is being detected and the problem is solved. With the variation in the amplitude the kind of the problem is detected and solved.

In this case the ideal sound which comes through an ideal wheel of a train is catch and these sound waves are recorded in terms of their amplitude v/s time. These recorded data has to be compared with the

data which one gets from the case of non ideal rail.

In order to keep the synchronization between the circuitry an additional circuitry will be required as an encoder is provided as it will encode the particular problem regarding the bomb problem, distance between the rails has increased or decreased, problem of friction etc. to the user. Once the user will know the problem, proper steps can be taken to prevent it.

PROCESS

The process includes the various steps which need to be followed to transfer the information from one point to other. Here point refers to the place where the information is converted from analog signals to binary bits and these binary bits are travelled through a proper channel and after that data is received at a proper station and properly coded.

According to block diagram we have we have firstly the sensing element followed by an encoder or multiplexer.

There are a lot of sensing devices as a lot of items need to be checked so there would be need of a binary code to each of the sensing device and when a particular problem arrives that particular binary code provided to that particular sensing device will become active thus acts a select line for the multiplexer.

The next thing is transmission channel takes place through the telemetry. The telemetry consist of the telemetry transmitter, telemetry channel, telemetry receiver and then a switch is provided through which one can switch to

Display.

Storing device

For further transmission.etc

The information can be directly displayed depends on the user and if the user wants to store another circuitry is present refers to DATA LOGGERS. The data loggers refers to a proper circuitry which consist of firstly input scanner, signal conditioning, analog to digital signal convertor, recorder, clock signal and a proper programmer is required.

The device will store the information in a proper format and will be delivered to the user when required.

The next circuitry involves the conversion of these binary encoded data to the analog signal through any digital to analog signal converter the digital signal is analyzed and the further action is taken.

ANALYZATION OF CIRCUITRIES

Sensing Element

The sensing element is just a type of circuitry consisting sensors which will sense the individual objects

and transfers the information on any change in the value of sensing.

The circuitry involves a lot of sensors so to keep a proper flow of these sensors are terminated to a proper binary bit value so the signal coming from them can be differentiated. These binary bits are used as the select lines for multiplexers.

Use of State Machines

As provided in the introduction about this circuitry here there are two states first one the sensing state itself and the other is the state when the binary data is provided to state in which there is select line input. This circuitry will be provided to all the sensing system.

Consider the condition of the sensing system for bomb detection in this case if the bomb is not present the state will be changed but changed to itself that is zero state is changed to zero itself hence after every clock pulse it will change its state. If the bomb is found then it will be shifted to state one in which it has changed its state from itself to the select lines inputs.

Taking the case of distance measuring sensor in this case we have the state (0) is as usual the state itself that is the sensor continue to do its sensing till it don't get any fault. When any fault is detected then the state (1) becomes active in that case the state (1) resembles the state of being the select line of the multiplexer.

Taking the case of checking the proper friction between the wheels of the trains and the rails. In this case a proper ideal signal (waveform) is provided in order to compare the signal secured so in this case the state (0) is the state in which the signal matches with the original signal (signal matching here doesn't means as the exact overlapping of the waves but just comparing the magnitude of the waveforms by the mean of quantization of magnitude) and when any large change in magnitude of amplitude occurs then the fault is occurred and this will change state from (0) to (1). Here state 1 refers to the state in which the binary resembled to this problem is provided to the select lines of the multiplexer.

Use of Mux

In this case the 4:1 mux can be used or any other can be used depends on the amount of sensors involved. The multiplexer will encode the value of the proper fault by the mean of proper select lines. Generally the encoded data will be provided to further circuitry. The use of this circuit is only to differentiate between the problems as when the problem of variable distance occurs then the state machine provided there will switch to state one from zero which means to make the switch one as then these binary bit will be provided to next state that is to the select line inputs.

Counters

It is the type of circuitry required in the case of bomb detection as the position of the bogie where the bomb is present should be reported in this case when the bomb is denoted a counter should initiate so in

order to initiate that counter a proper trigger is present. The problem generally arises when the counter need to stop counting, in that condition a back up circuitry is present as shown in the block diagram. It will be from the state machine providing the information regarding the end of event. So as the event is over then automatically the clock provided to the counter will be disbanded.

In the case the counters stops counting.

Trigger Circuit

The trigger circuit consist of state machine which consists of two states one is self and other is to trigger the counter to initiate. Particularly if a train is passing over the device and bomb is detected at a particular bogie then the state of trigger circuit changes from self (0) to the state in which the counter will initiate (1). When the train will be passed completely there is requirement of a circuitry to stop the counter.
Similar procedure of state machines can be implemented over there as there should be switch which should be terminated accordingly by the mean of the initial sensing circuitry. As the sensing stops the clock of counter should be automatically stopped. The counter can't be able to count if there is no clock.

Logic Circuitry

In the case of the distance measurement we have to display the distance which is the difference between the actual distance and the measured distance. So a logic circuitry is required which will convert these data to binary data and take a difference of it. Then again converting to proper BCD format and display on the binary decoder display.

L.E.D. Circuitry

In order to make the user known about the increasing friction or sparking from the rails an L.E.D. need to be lightened up as proper voltage is provided to it so that it can light up the L.E.D. when required.

Telemetry

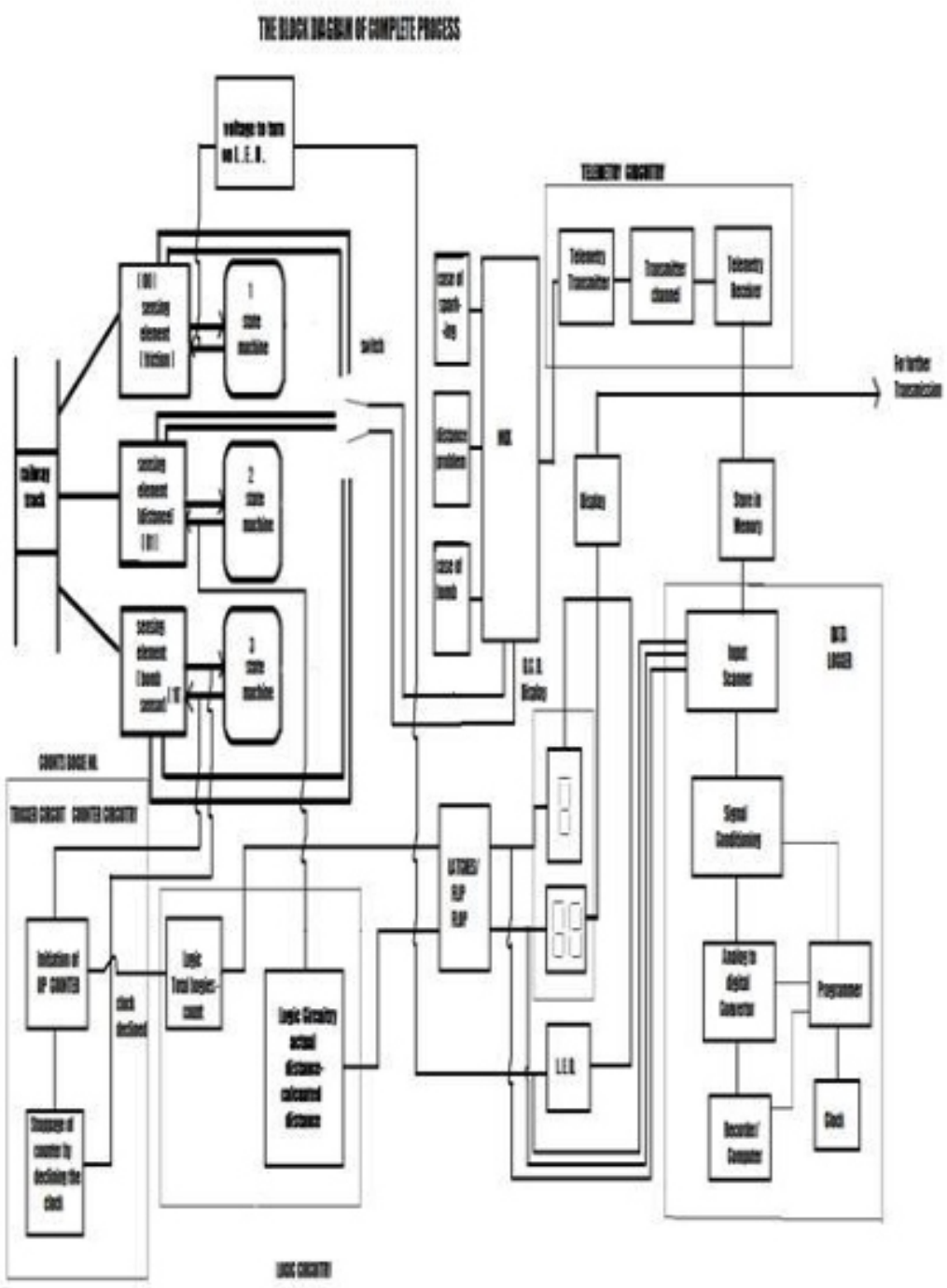
It is actually the circuitry which is required to transfer the information to the desired place. It consists of TELEMETRY TRANSMITTER which is used to transmit the information to the particular position by the mean of TELEMETRY CHANNEL. At the end TELEMETRY RECEIVER which is used to receive the information and retrieve it according to the application, as to display or memory or the information can be passed for further procession.

Data Loggers

This concept is used for memory as the data need to be used for procession and future use. The circuitry involves the SIGNAL CONDITIONING. Firstly the data is taken as an input in the data logger through the input scanner; it refers to a proper sink where the any type of information can be provided. Later,

signal conditioning is used as the signal which we are passing through the system must be well equipped with the system so we must take care that the signal is properly signal conditioned or not. It is a process through the codes of the data is changed according to the system which is storing the data.
In order to save a particular data in memory the data need to be converted in the digital form so the analog to digital signal converter is required in this process. It follows the principle of quantization and then compares the quantized data to the fixed values providing the digital signal and then these digital values are sent to memory according to the programmer. In order to initiate the programmer that is the user a particular clock is required which will be acting as a triggering agent. through the codes of the data is changed according to the system which is storing the data.

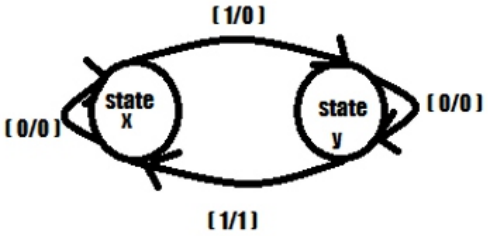
In order to save a particular data in memory the data need to be converted in the digital form so the analog to digital signal converter is required in this process. It follows the principle of quantization and then compares the quantized data to the fixed values providing the digital signal and then these digital values are sent to memory according to the programmer. In order to initiate the programmer that is the user a particular clock is required which will be acting as a triggering agent.



The case described here of the state machine. Consider the case of state machine 1, here the state “x” refers to the state in which either there is no train present on the rails or there is no friction or no case of sparking. State “y” includes the states in which the value of the quantised signal is unequal to the signal found.

Consider the case of state machine 2, the state machine consists of of two states x and y. “x”refers to the state in which the either the train is not present over the rails or the there is no problem over the rails. The state “y” is the state in which the value of the distance found is less or more then the value of the of the

actual distance.



Consider the case of state machine in this case, the state “x” refers to the state in which either the train is not present over the rails or there is no bomb this is (0/0). The case of state “y” in which there is presence of bomb over the train. When the bomb is present over the train then the state changes as the state is changed from x from y.

PROBLEMS

The major problem regarding this system is the presence of more then one problem at one time. The system can hang as there if more then one problem exists. This problem can be solved by providing a priority encoder. The priority encoder will provide the priority to the first problem. So if the other problem is present, then it can be detected by the next (same) circuitry. The next circuitry here defines as the circuit present over the next rails.

CONCLUSIONS

This paper discuss the proper way through which the major accidents regarding the train can be avoided or earlier by the mean of electronics instrumentation circuitry. The major block diagram and the individual circuitries are explained. The major circuitry may consists of some problem which are also discussed. An alternative is also provided in the paper which can solve the problem.

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DESIGN AND DEVELOPMENT OF A MICROCONTROLLER BASED SYSTEM FOR MEASURMENT OF RPM

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A B S T R A C T

RPM measurement meters used in different applications need to meet the high performance, accuracy and reliability to achieve the desired output. But RPM meters have always been expensive tools for the average hobbyists. This paper deals with the design of a microcontroller based system for RPM measurement using proximity sensor and measured RPM is displayed on LCD display which is interfaced with 89C2051 microcontroller in 4-bit mode.

KEYWORDS: LCD, Microcontroller, Proximity Sensor, RPM

INTRODUCTION

This paper deals with the design of a microcontroller based system for acquiring the rpm and to display it on LCD. An Inductive proximity sensor is used to measure the RPM and the measured values are displayed on LCD which is interfaced to microcontroller in 4 bit mode [1]. In such a scenario this paper describes an inexpensive, small scale microcontroller based system for measuring the frequency and rpm of any rotating device. Proximity sensor is used to sense the metal strip stickled on the rotating disc in the present study. It can send a pulse while a metal object reached the detection field of view of the sensor.

This paper describes a new way for the processing of the pulses. The processing takes advantage of new single chip low cost programmable microcontroller, LCD and proximity sensor. The design of the measuring system differs fromtechniques described in the literature [2]. The special feature of this instrument is very simple and portable to carry. When any rotating metal device is placed within the detection field of view of the proximity sensor, it can directly send the measured RPM values to LCD. Software is developed in Embedded C and RIDE is the software used in the present work.

PRINCIPLE OF THE EXPERIMENT

There are many known principles are available for measuring rotation speed [3]. The output frequency generated by rotation speed sensors is proportional to the measured parameter. The rotating disc (wheel) connected with the angle of rotation and can be determined by the instantaneous frequency in any moment of time is proportional to the instantaneous angular speed.

The general formula for rotation speed is given by the following equation:

$$\text{Rotation speed (RPM)} = \text{frequency X } 60/n$$

Where 'n' is the number of encoder's gradations.

There are several methods which can provide a frequency measurement in order to derive the rate of rotation from pulse signals. But all the methods have their disadvantage in all specified measuring range of frequencies [4, 5]. The present system gives a simple counting method for measuring frequency and rotation speed. The present system measures the frequency of pulses range from 0 to 65,535 Hz.

The general formula for calculating frequency is given by the following equation:

$$\text{Frequency, } f = \text{number of pulses/ sec}$$

$$\text{RPM} = [\text{No. of rotations/sec}] \times 60/n = \text{Frequency} \times 60/n$$

If number of encoders on the rotating disc (wheel) is one (n= 1), the rotation speed is:

$$\text{RPM} = \text{Frequency} \times 60$$

EXPERIMENTAL SETUP

Fig. 1 shows the proposed block diagram of the hardware developed in the present work. It requires the following:

Proximity sensor

89C2051 microcontroller

LCD Module

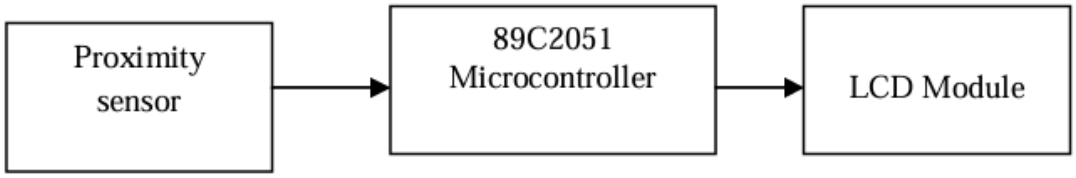

Fig. 1: Block Diagram of LCD Based RPM Measurement System

Proximity Sensor

Inductive proximity sensors operate under the electrical principle of inductance. Inductance is the phenomenon where a fluctuating current, which by definition has a magnetic component, induces an electromotive force (emf) in a target object.

An Inductive proximity sensor has four components, the coil, Oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of the doughnut around the winding of the coil that locates in the device's sensing face [6]. The Photograph of inductive Proximity sensor used in this present work is shown in Fig. 2.

Fig.2. Inductive Proximity Sensor

The detection distance of an inductive proximity sensor depends on the target materials capacity for conducting electricity. Also, the target's thickness will have an influence of its detection. Generally thin materials are easier for an inductive proximity sensor to detect than thick materials. The material conduction and thickness factor to detection distance depends on technology of the inductive proximity sensor.

When a metal object moves into the inductive proximity sensor's field of detection, eddy circuits build up in the metallic object, magnetically push back, and finally dampen the inductive sensor's own oscillation field. The sensor's detection circuit monitors the oscillator's strength and triggers an output from the output circuitry when the oscillator becomes dampened to a sufficient level. For every detection of metal object by the sensor produces a pulse from the output circuitry of sensor.

An output circuitry is connected to a 16 bit counter, which counts the number of pulses produced by sensor. 16bit counter is used to count the number of clock pulses within an input signal period [7]. The counter content is cleared after this information is fed to the microcontroller. So that the system is ready for a new measurement. 89C2051 Microcontroller

The microcontroller used in the present work is a low-cost and popular Atmel's 89C2051 [8]. This microcontroller is selected for the following reasons: 1.

1. It is a 20-pin IC having the architecture and instruction set compatibility with 8051 microcontroller series.
2. It has a on-chip precision analog comparator
3. Interrupt control, timer and serial transmission facilities

Only disadvantage with this IC is that there are only two ports available (one 8-bit port and the other 5-bit port).

Cost-effectiveness and low-pin count have attracted us to use this microcontroller. Selection of 11.0592 MHz crystal across pins 4 and 5 of 89C2051 used to provide stable frequency without any phase difference.

LCD Module

The LCD module used in the present work is of type 16X2, which displays 16 alphanumeric characters and two lines. Pin details of this module are given in Table 1. The LCD module contains 3 control lines and 8 data lines. Control lines are used to control the internal operations of the LCD module. Data lines are used to transmit the data to microcontroller or receive the data from microcontroller. The LCD module used here is, in the 4-bit data interface mode, wherein only data pins for DB4-DB7 are used for data transfer [9]. In this paper the LCD module is connected to higher nibble MSB of port1 of the microcontroller. Three control lines of LCD are connected to LSB of port1 of microcontroller.

A functional diagram is shown in Fig. 3. The 10k potentiometer is used to control the contrast of the LCD module.

Table 1: Pin Description for LCD

Pin No.	Symbol	Description
1	Vss	Ground
2	Vcc	+5V Power supply
3	Vee	Power supply to control contrast
4	RS	RS=0 to select command register, RS=1 to select data register
5	R/W	R/W=0 for write
6	E	Enable
7-14	DB0-DB7	8-bit data bus

Pins of LCD	14	13	12	11	X	6	5(GND)	4
	DB7	DB6	DB5	DB4	NC	E	NC	RS
Pins of 89C2051	P1.7	P1.6	P1.5	P1.4	P1.3	P1.2	P1.1	P1.0
	19	18	17	16	15	14	13	12

Fig. 3: Functional diagram of LCD used in the present work

HARDWARE DESCRIPTION

Fig. 4 shows the circuit diagram of the measuring system designed in the present study. The photograph of the present system is shown in Fig.5. Regulated Power Supply is used as an External Power supply to provide sufficient voltage to the circuit. Another 9V battery source is internally mounted in the case to provide sufficient voltage to the circuit when power is OFF. For this a toggle switch S2 is provided here to choose internal (9V)/External (12V) power supply voltages. Further the External power supply voltage is regulated to provide sufficient voltage (+5V) required for the circuit. In this paper Timer0 is accessed as counter by initializing TMOD register of microcontroller.

The circuit is powered up by pressing the RESET (S1) button provided on the top view of the photograph shown. Then the microcontroller start to activate Counter (Timer0) and is ready to take count of pulses received from the proximity sensor. Software is developed for calculating the RPM value and is displayed on LCD module which is interfaced to 89C2051 Microcontroller in four bit mode. Counter is cleared after sending first value of RPM and it is ready to take another count and send it to LCD through software. The entire circuit is battery backed up [10]

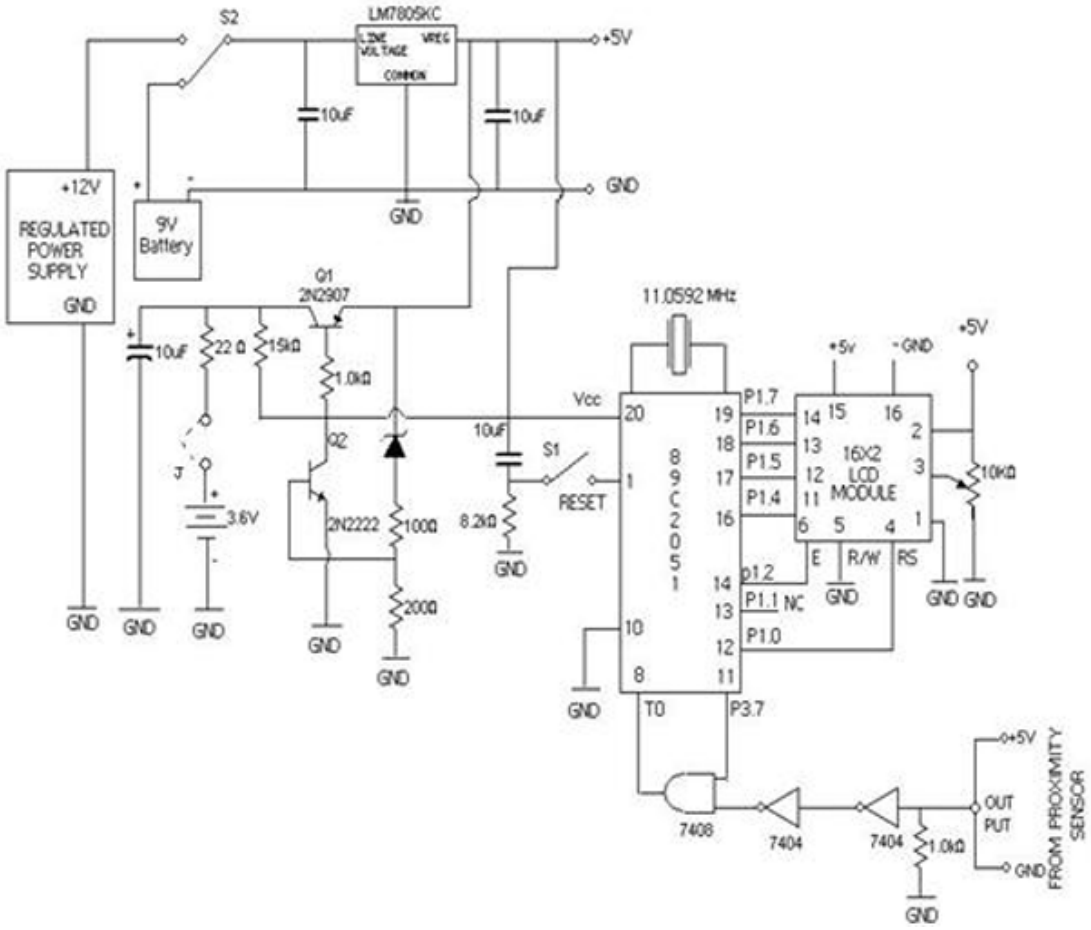

Fig. 4: Circuit Diagram of RPM Measuring System

The circuit is powered up by pressing the RESET (S1) button provided on the top view of the photograph shown. Then the microcontroller start to activate Counter (Timer0) and is ready to take count of pulses received from the proximity sensor. Software is developed for calculating the RPM value and is displayed on LCD module which is interfaced to 89C2051 Microcontroller in four bit mode. Counter is cleared after sending first value of RPM and it is ready to take another count and send it to LCD through software. The entire circuit is battery backed up [10]

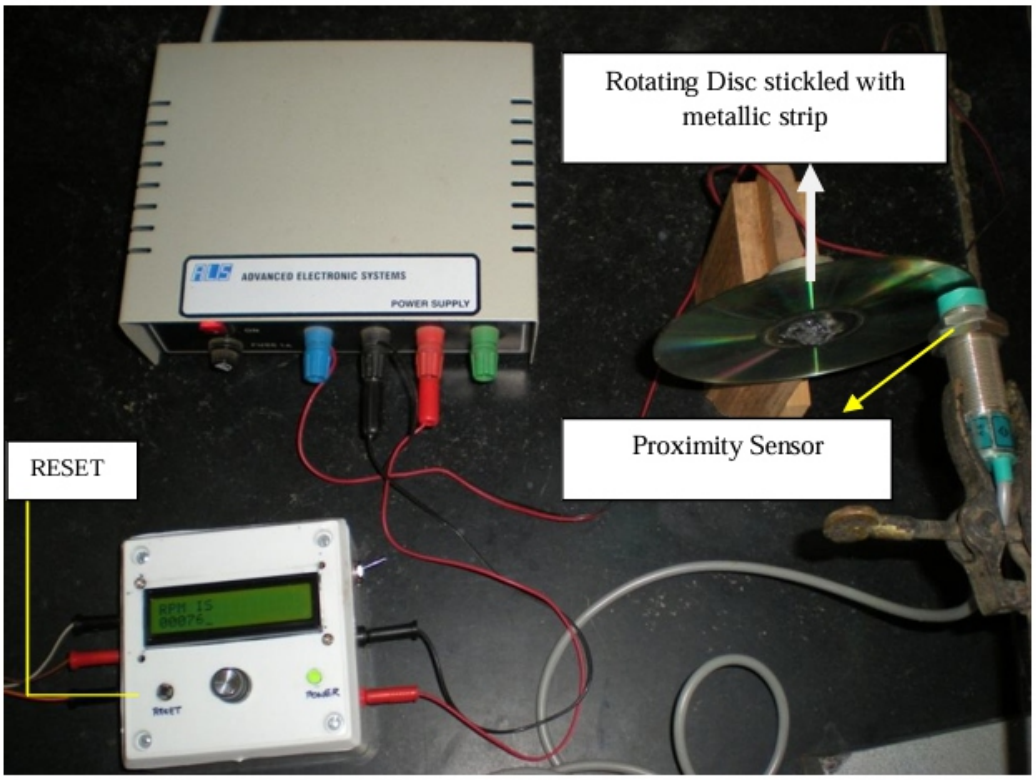

Fig. 5: Photograph of RPM Measurement System

SOFTWARE DESCRIPTION

Code is developed using Raisonance Integrated Development Environment software for the microcontroller in C language [11]. The developed Code can be compiled and run for creating a hex file. The created Hex file can be dumped on to the flash memory of a microcontroller using a special Atmel programmer. The flow chart of the code developed in the present work is shown in Figure 5.

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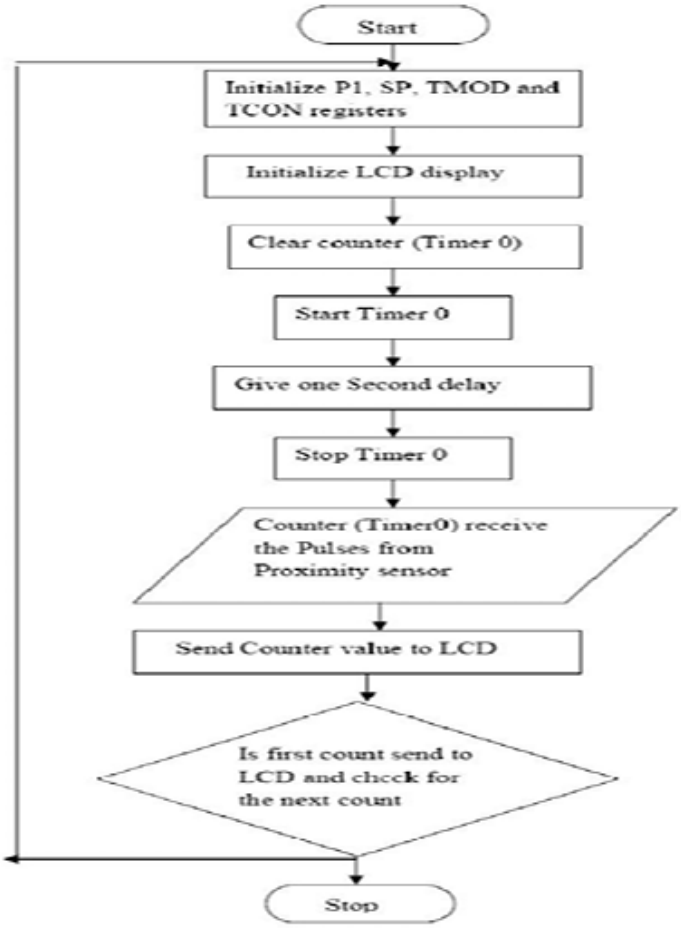

Fig. 5: Flowchart of the Embedded C Program Developed in the Present Work

EXPERIMENTAL RESULTS

The RPM value of a rotating disc in the laboratory has been checked using the instrument developed in the present work. This instrument can also be used in the automobile industry for checking the balance of the rotating wheel by calculating its rotating speed. This is useful in the field also by placing a sensor at a point near to the rotating shaft of the wheel. The present system shows good results in both the cases. And the measured RPM value is displayed on LCD module by using this small system developed in the present study.

CONCLUSIONS

A Simple hard ware and software are developed for measuring the RPM of a rotating disc (wheel). The circuit can easily be constructed on a PCB using cost-effective ICs and readily available components. The constructed PCB enclosed in a small case, which looks very simple and easy to carry it anywhere.

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