Human Hazards Reduce in Pneumatic Operated Buses Using Integrated Safety Systems

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Abstract:
The Main objective of the project is to applying all the technologies available in the modern Industrial revolution to obtain the solution for hazards in the bus to avoid loss of human lives and injury. The pneumatic Buses with current methodology on the accident response system is not fulfilling the current needs since of increase in traffic density and sophistication on the transportation drive us to implement fool proof mechanism on busses. The integrated safety system enables all possible solution for the hazards present in the bus transportation. The integrated safety system for pneumatic operated bus door will give accident response under Fire, accident collision, failure of control switch and helps to rescue team for reaching the bus by use of Global positioning system (GPS), automated accident response system in case of accidents the impact vibration is measured and it trigger signal to open the main and emergency doors. The smoke detector is helps to identify the fire hazard and spontaneously trigger the signal to emergency and main door opening, subsequent fire alarm will accelerate the people to reach the safe path to either emergency door or main door. The archiving of incidents can be possible message output from the bus on every emergency door opening to defined rescue team by use of GSM. In case of failure of one pneumatic switch can be managed by positioning another switch in the bonnet. Integrated safety system gives the safe trip by reducing the hazard and risk rate in Bus journey.

Key words: Global positioning system, Vibration sensor, Smoke detector, Integrator controller, Alarm

1. INTRODUCTION

In a current scenario the hazard rate on bus transportation is quite high, the public transportation is the highest priority of the Nation this is actively involved with state and local transporters, and industry organizations, in establishing standards, guidelines, and programs that will continue to safeguard the future generations Equipping the latest devices in order to obtain integrated safety system in bus to bring down the hazard rate. In Existing Busses equipped with single control of Pneumatic doors which handled by Driver, in case of failure in switch or critical situation there is no provision to open the doors and emergency doors are to be open by physically. In Advanced Technology and Logical views on Safety concern leads, to Design a system which eliminates the hurdles to reach safe mode on Busses by implementing the two way Switch control of pneumatic door as well as the emergency door. For Accidents the emergency door will open automatically by sensing the impact/vibration created on the bus body which is by use of vibration sensor. The Smoke detector helps to sense in case of fire which triggers the emergency and main bus door. In case of emergency when emergency doors were opened the alert message will automatically sent to Rescue team and in build GPS system will communicate the exact location of bus for rescue operation and the archiving of incident report taken spontaneously. In recent Bus door opening and closing operation carrying out by pneumatic driven and motor driven. T 0 make the journey safe in the aspect of control over the passengers and materials the opening and closing on automation is required. For Air conditioned busses the automatic bus doors are preferred in order to maintain the temperature and power savings on air conditioner unit. Most commonly the following types of bus doors are available with respective to the mode of operation.

- Folding door systems
- Inside swing door systems
- Outside swing door systems
- Sliding door systems
- Door operator ‘with pneumatic and electrical drive
- Swivel motor doors

1.1 SAFETY MEASURES IN ALL THE DECADES TO PROTECT THE LIVES OF PUBLIC

The bus transportation provided by the distinct code of safety measures in all the decades to protect the lives of public. Inappropriate conduct at bus stops, on District vehicles, or in the process of boarding or exiting from a vehicle may result in increase of risk rate of bus transportation. The some common practices were educated for travelling in buses is

- Smoking is not allowed on the bus.
- Carrying of flammable liquids and crackers are prohibited.
- Animals or insects are not allowed onto the bus.
- Glass containers are not permitted on the bus.
- Alcoholic beverages shall not be carried in a school bus.
- No weapon, explosive device, harmful drug, or chemical shall be transported in a bus.
The transportation has some measures which is mandatory for all buses to handle the hazard and emergency situation arise.

- Bus must have a First-Aid-Box.
- There must be a Fire Extinguisher in the Bus.
- Bus emergency exit paths marked visibly and the communication of equip of bus to all passenger.
- There must be a competent Attendant from the station in the Bus.

The bus doors are nowadays operated automatically by pneumatic system to ensure the bus under control over the/material and people. Now the time to review the safety system in the buses to ensure the all risk rates under control. The increasing traffic and increase circumstance for hazard since of high comfort on bus are required by human to protect their interest on travelling.

1.2 MOTIVATION

Motivation of this project is quite self driven because the problem is related to the human injury and loss of their lives. There are many such accidents in 365 days round a clock. Accidents happening majorly on speed driving, psychological behavior of driver and violation of traffic regulations. India witnessed one road accident every minute in 2011 which claimed one life every 3.7 minutes, one of the highest in the world.

![Figure 1. motivation](image1)

In a tragic incident on 30th October 2013, 44 passengers travelling from Hyderabad to I Bangalore by an overnight bus were burnt to death when the fuel tank exploded. The Volvo bus was on its way from Hyderabad to Bangalore when it hit a divider and caught flames around 5:15 am on Wednesday. The bus was reportedly trying to overtake a car when it lost control. Its fuel tank reportedly exploded. Officials say it took less than a minute for the entire vehicle to be engulfed in flames. The Major reason for the high fatal is "The automatic locking system is there for these vehicles. The driver apparently-did not understand the mechanism and opened the door. Had he opened the door, perhaps some people have escaped," District Collector Mahbubnagar Girija, Shankar said. Analysis of accidents and the intensity of accident with knowledge on application for the cause of accident drive me to identifying the problem in buses and quantification of risk present in it and to make the suitable solution to do safety on pubic in their day to day transport.

![Figure 2. firearms](image2)

1.3 EXISTING SYSTEM

In Existing Busses equipped with single control of Pneumatic doors which handled by Driver, in case of failure in switch or critical situation there is no provision to open the doors and emergency doors are to be open by physically. In consideration of the buses available across the country and global, the automatic doors are widely used for opening and closing operation and for the accident response by manually. The Pneumatic system of operating Main doors are commonly used there is no automated system for emergency door. The Main door operated by either detent type push button or toggle lever type pneumatic control switch employed, The Air cylinder is placed near to the doors which connected to the 5/2 Directional control valve either by air operated or by energizing electrical solenoid coil. The schematic of the existing system for pneumatic bus door is control over a single switch.

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1.5 OBJECTIVE OF THE PROJECT

- The objective of the project is to developing integrated safety system for pneumatically operated bus door application. The objective of the project is
- Efficient Accident response system
- Effective response over collision accidents and Fire hazards
- Effective utilization of latest devices to eliminate the hazard rate in bus transport
- Accident reporting and incident archiving
- Design model helps to track the bus and efficient accident response system and alert.

1.6 PROBLEM DEFINITION

The existing system has no control over the Accident response mechanism. The bus with no control over on risk and the existing system can only a operator oriented no control on events which leads to human fatal and injuries. If the bus single control switch fails can’t be open the door. In case of accident the driver have to react for opening and closing. The rescue team can also open by use of physical force to the emergency and main door. The fire prevention and accident control is not available. In case of accident or any hazard like fire the passenger might react and help them self. This system is not total system it is only for basic system for opening and closing operation. The Total hazard should be analyzed, measured and to make the packaged system which will give answer for the all hazards related to bus. The Fundamental system on opening and closing to be studied and the hazards are to be identified to obtain the integrated system for totality of hazards. In brief the problems identified areas are

- Road accident response systems in case of collision
- Fire hazard response system
- Rescue systems in emergency
- Alert over emergencies
- Alternate control of main door
- Identification of accident taken place

1.7 PROPOSED SYSTEM

The proposed system having two control switches over the Main door 'and the emergency door. The one switch is placed inside the driver cabin and other one is in outside of bus to operate . in case of failure of cabin switch. For Accidents the emergency door will open automatically by sensing the impact/vibration created on the bus body which is by use of vibration and impact sensors. The ~ Smoke detector helps to sense in case of fire, If any detection which triggers a signal for opening of the emergency and main bus door. When the smoke is detected it gives the alarm for passenger to cautioning. In the case of emergency when emergency doors were opened the alert message by the help of Global System for Mobile communication (GPS) will automatically sent to Rescue team I (as defined by the transporter) and in build GPS system will communicate the exact location of bus for rescue operation and the archiving of incident report taken spontaneously.
II. SELECTION OF ACTUATOR

Selection of the air cylinder is critical measure to handle the load of the door and emergency door. The force acting on the double acting cylinder and cylinder bore size empirical Formulae

\[ F_1 = n \times A_1 \times P \]
\[ F_2 = n \times A_2 \times P \]

Where
\( F_1 \) - Force acting on the A1 side in Newton
\( F_2 \) - Force acting on the A2 side in Newton
\( A_1 \) - Area of A1 side of cylinder in mm²
\( A_2 \) - Area of A2 side of cylinder in mm²
\( P \) - Air Pressure in kg/cm²
\( \eta \) - Load ratio
\( \eta \) is equal or less than 1 for horizontal loads.
Resultant Force \( F_r \)
\[ F_r = P \left( \pi r_1^2 - \pi r_2^2 \right) = P\pi (r_1^2 - r_2^2) \]

2.1 GRAPHICAL METHOD FOR CALCULATING CYLINDER BORE SIZE

![Graph for cylinder bore selection](image)

To Obtain the cylinder bore and the Force acting on the both side of the double acting pneumatic cylinder is based on the load of the main door and emergency door to achieve the required speed, cycle time and desired opening and closing of the door.

2.2 SELECTION OF DIRECTIONAL CONTROL VALVE

Selection of Directional control valve is based on the application where it is working in the pneumatic system.

- 5/2 directional control valve for double acting cylinder
- 3/2 directional control valve for single acting cylinder or control switch application
- Directional control valve with single or double actuation (either by air or electrical)
- 3/2 Directional control valve with push button/ toggle lever / twist selector or etc.

The Direction control Selection based on the air flow rate characteristics requirement of the pneumatic system requirement, the formula for the air flow rate (Q)

\[ Q = 600 \times C (P_1 + 0.1) \sqrt{1 - \frac{P_2 + 0.1}{P_1 + 0.1} \frac{1 - b}{1 - b}} \]

Q- Air flow rate in Litres
\( b \) - Critical pressure ratio
\( P_1 \) - Upstream pressure in kg/cm²
\( P_2 \) - Downstream pressure in kg/cm²
\( t \) - Temperature in Deg C.

2.3 MEASUREMENT OF VIBRATION AND IMPACT

Dominating vibration patterns on the movement of the bus, the following patterns are commonly as follows

- Vertical bouncing (z-axis).
- Pitch-related fore-aft (pitch => x)
- Roll-related lateral (roll => y)
Frequency content: Mainly 10 Hz.
Amplitude peaks over 2 m/s²; extremely uncomfortable
Intensities typically 0.5 1.4 m/s², depending on road condition, speed etc.

![Measurement of vibration and impact](image)

Figure .6. Measurement of vibration and impact

Road accident causes

There are three main modes of operation can be distinguished on measuring the vibration transverse, longitudinal, and shear.

Transverse effect

A force is applied along a neutral axis (y) and the charges are generated along the (x) direction, perpendicular to the line of force. The amount of charge depends on the geometrical dimensions of the respective piezoelectric element. When dimensions a, b, c apply,

\[ C_x = \frac{dx yF y b}{a} \]

where a is the dimension in line with the neutral axis, b is in line with the charge generating axis and dis the corresponding piezoelectric coefficient.

Longitudinal effect

The amount of charge produced is strictly proportional to the applied force and is independent of size and shape of the
piezoelectric element. Using several elements that are mechanically in series and electrically in parallel is the only way to increase the charge output. The resulting charge is

\[ C_x = d_{xx} F n \]

Where \( d_{xx} \) is the piezoelectric Coefficient for a charge in \( x \)-direction released by forces applied along \( x \)-direction (in pC/N). Paris the applied Force in \( x \)-direction [N] and \( n \) corresponds to the number of stacked elements.

2.4 OPERATIONAL METHODOLOGY

The Block diagram for the working methodology is given below, the centralized microprocessor unit placed to take the desired out output of the incident occurrence. The block diagram is below

![Block diagram for method of operation](image)

**Figure 7. Block diagram for method of operation**

III. DOUBLE ACTING CYLINDER AND DIRECTIONAL CONTROL VALVES

For Bus door opening and closing application Double acting cylinder with 5/2 valve and the control push button switch 18 3/2 DCV 15 used. For the Double acting cylinder the stoke length and Bore IS based on the Load and Door opening.

![Double Acting Cylinders](image)

**Figure 8. Double Acting Cylinders**

Directional control valves for the air actuator is 5/2 single solenoid, spring return valve, for the Push button valve is 3/2 push button/toggle lever, spring return valves are used. For connecting the circuit poly ethylene or poly urethane hoses being used.

![Directional control valves](image)

**Figure 9. Directional control valves**

3.1 GLOBAL POSITIONING SYSTEM (GPS) BASED VEHICLE TRACKING

Of all the applications of GPS, vehicle tracking and navigational systems have brought this technology to the day-to-day life of the common man. Today GPS fitted cars; ambulances, fleets and police vehicles are common sights on the roads of developed countries. Known by many names such as Automatic Vehicle Locating System (AVLS), Vehicle Tracking and Information System (VTIS), Mobile Asset Management System (MAMS), these systems offer an effective tool for improving the operational efficiency and utilization of vehicles. The switching off of SA has improved the accuracy of GPS to better than 30 meter, which makes it an ideal position sensor for vehicle tracking systems without the overhead of DGPS. gives the block diagram of a DGPS based VTIS.

![GPS vehicle tracking system](image)

**Figure 9. GPS vehicle tracking system**

The alternative is polling technique. Here each vehicle is addressed by the control station and in response the IVU sends the information. This arrangement enables variable polling rate for different vehicles, non-polling of specific vehicles and expansion of polling list as new vehicles are added. The relatively large investment needed for the communication link, makes VTIS an opportunity area for service providers. Fig. 4 shows the global market for GPS based VTIS in the next three years. In US and Europe many vehicle tracking service providers are already in operation. In a large country like India with a very long network of roads and long coastline, this opportunity area is yet to be exploited.
3.2 GLOBAL SYSTEM OF MOBILE COMMUNICATION (GSM)

This is a plug and play GSM Modem with a simple to interface serial interface. Use it to send SMS, make and receive calls, and do other GSM operations by controlling it through simple AT commands from micro controllers and computers. It uses the highly popular SIM300 module for all its operations. It comes with a standard RS232 interface which can be used to easily interface the modem to micro controllers and computers. The modem consists of all the required external circuitry required to start experimenting with the SIM300 module like the power regulation, external antenna, SIM Holder, etc.

3.3 SMOKE DETECTOR AND FIRE ALARM

Characteristics
- Special chamber design has greatly decreased dust levels and improved detection accuracy.
- Dual LEDs for 360-degree visibility.
- Advanced technology enables this detector to increase its precision in smoke detection, improve signals to avoid noise interference and thus reduce unwanted false alarm.
- Low current consumption that allows more detectors to be used with each control panel.
- Dual contacts on the base which enhance the connecting stability between sensor and base.
- All bases are fitted with a shorting spring to permit maintenance without disconnecting when removing the detector.

3.4 VIBRATION SENSOR

Vibration sensors today are synthetic piezoelectric ceramics and quartz. In a piezoelectric sensor or accelerometer, the sensing element is a crystal that emits a charge when subjected to compression. The crystal is bonded to a mass so that when it is subjected to a “g” force, the mass compresses the crystal and a signal is emitted. The signal value is relative to the force imposed.

VI. PROJECT MODEL DESIGN

Developing a Portable model for the Pneumatic bus door application to fulfill and to do analysis on the theoretical concepts on the safety model into mechanical realization. The Model generation includes building up of the Bus assembly as a
base model and to constructing the bus doors and components involved in it.

Figure 14. micro controller

The Components in the integrated safety system analysed and the prototype requirement of components addressed and the logical view on the prototype function and feasibility of the safety elements taken into consideration to arrive the final elements of the prototype finalized. The block diagram for the prototype bus door application and function wise details made and the same is plotted for executing the model mechanical fabrication. The following components find necessary to show the performance of the system and these are enough to show adequacy in difference of present and existing system.

- Bus mechanical assembly along with doors front and emergency door setup
- DC motors for driving both doors
- Microcontroller for centralized control
- LDR sensor for fire
- Vibration sensor for collision
- Buzzer for alarm

V. RESULTS AND ANALYSIS OF RESULTS

The prototype of the bus with door arrangement made to the following conditions and to meet the below conditions to avoid the hazard rate in the bus. The Conducting the test of each of the below parameters to get the result

- Bus door opening/closing in normal condition
- Provision of the emergency door with control
- Vibration monitoring device
- Fire monitoring device
- Control unit for the drives for both front and back doors

The Results on the various functioning of the bus doors are with table column to understand the safety system is integrated into the bus.

5.1 VIBRATION UNDER COLLISION

The vibration calculated under the dynamic moments across the bus body on each side of the bus. There are possible moments and acceleration for the bus in an normal operating condition. This type of normal momentary across the bus running condition with the safe load condition for avoiding the unwanted report on emergency system. The normal acceleration velocity will be depends on the bus condition and the type of Road and the load. The collision/accident hazard in the bus sensed by the Piezo-vibration sensor unitixied on the Proto type bus door assembly which in turn triggers 5v output to the controller for action. The 5v input is taken by the microcontroller and it programmed and gives the results of following. The vibration starts on the

<table>
<thead>
<tr>
<th>Bus body by means of collision</th>
<th>→sensor Piezo-vibration sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piezo vibration sensor</td>
<td>→triggers 5v output put controller</td>
</tr>
<tr>
<td>From controller signal on collision</td>
<td>→results to open up of both doors</td>
</tr>
<tr>
<td>Opening of Emergency door</td>
<td>→results message alert to concern authority</td>
</tr>
<tr>
<td>Opening of emergency door</td>
<td>→results giving alarm signal for caution</td>
</tr>
</tbody>
</table>

5.2 Fire Hazard

The fire hazard on the bus will get minimized by the existence of safety system for emergency exit and alert system. By the Model system based on the Light detecting resistor type since the heat sensor have to be increased to certain temperature for making the emergency system to work. The fire hazard in the bus sensed by the LDR sensor fixed on the Proto type bus door assembly which in turn triggers 5v output to the controller for action. The emergency on fire will brings the Following results from the proto type of the integrated safety system enabled bus door. The emergency evacuation is done by the rescue team by getting the message alert form the bus when it met fire hazard. The tire module on the microcontroller which will react as programmed with in, the fire detection and the action proposed are the results from the prototype is as follows

<table>
<thead>
<tr>
<th>Fire hazard presence</th>
<th>→Sensor LDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor LDR</td>
<td>→signals to Microcontroller by triggering 5v output</td>
</tr>
<tr>
<td>Microcontroller fire emergency</td>
<td>→results opening of both the doors</td>
</tr>
<tr>
<td>Opening of Emergency door</td>
<td>→results message alert to concern authority</td>
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<td>Opening of emergency door</td>
<td>→results giving alarm signal for caution</td>
</tr>
</tbody>
</table>

5.3 TRACKING AND NORMAL MODE OF OPERATION

Normal opening and closing will be on the same way by pressing the manual push buttons and the reset buttons for the both doors and the microcontroller is mandatory to perform in the prototype since to show the fire and collision hazard in continuous it required. The fixing up of the GPS in the BUS will gives the exact location of the bus. The reset and live instantaneous safety system will enabled and this will activate only when the
situation arise and the set points going beyond the set values or tolerance value. The proposed system is working well in normal mode and the hazard mode when the bus met accidents. The automated response over the hazard will give the safe system for the safe journey through bus. The economical considerations are carried out for the large bus I Volvo busses the Pneumatic components are taken into consideration the approximate costing without doors only the emergency response mechanism/ integrated safety system is Rs. 50,000 to Rs. 60000 per bus. This will include the components of all the system with GSM and GPS.

VI CONCLUSION

The Model for integrated safety system inbuilt bus was made. The bus is analyzed with various collision and fire hazards. The Emergency system on the bus working satisfactorily and the results from the system is excellent. The Proto type bus made with inbuilt safety system which will give the satisfactory, results on emergency rescue and alert over the following hazards

- Collision / accident of the system inbuilt in bus reacts quickly and automatically open the emergency and main door and gives alert over message by using GSM
- On Fire hazard present the Bus inbuilt safety system reacts automatically to open the Main and emergency door and gives emergency alert message and caution alarm.

The Proposed integrated safety system for bus on pneumatic / automated door application will save the human life on hazards and ease on the rescue operation under the hazard. This system can develop and modify in advance by online monitoring and execution of action when the hazard is the future scope of the project.

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