**REPORT:  
Computational Methods and Modelling for Engineering Applications**

**1. Introduction:**

A.I.-based adaptive cruise control (ACC) regulates the vehicle's speed and braking by detecting the speed or proximity of another vehicle or object in front of it. Typically, this component is built into the car's front bumper. Real-time radar is employed by the sensory technology in ACC to measure the speed and distance of the car in front of us and to keep our own speed constant [1]. Moreover, the sensory technology warns the car's driver of impending crashes by flashing an emergency red light on the dashboard or sounding an alarm [1]. With more recent and improved ACC systems, cars can even slow down around tight corners, lowering the danger of an accident or overturn [2].

**2. Objective:**

The primary goal of adaptive cruise control is to maintain a safe following distance and speed between the host vehicle and the vehicle in front of it. Over time, this will lessen the traffic volume and auto accidents.

**3. Requirements:**

**3.1 Components needed:**

1) Arduino ELEGOO



Fig 1

2) Breadboard – 01

3) Ultrasonic sensor - 01

4) LCD display – 01

5) Push buttons – 0

6) Resistor

7) Jumper wires

8) Battery

9) Battery Connector Cable

10) Potentiometer



Fig 2

**3.2 Programs needed for the project:**

1) MATLAB

2) ARDUINO Support Package for MATLAB.

**4. Methodology:**

Set Speed

Adaptive Speed

Acceleration

Deacceleration

LCD

cancle

Ultrasonic Sensor

**Arduino UNO**

**Figure 3: Adaptive Cruise Control System’s Block Diagram**

The system's fundamental operation starts when it is initialised and speed zero is shown on the LCD panel. The display screen should indicate an increase in speed from the start stage when the increase button is pressed. Furthermore, pushing the speed-decreasing button ought to accomplish that. The speed will fluctuate as long as the increase button is depressed and will decrease if the set speed button is deactivated. The speed will be fixed at a constant when the cruise button is pressed, enabling the vehicle to enter its default cruise control mode. While using cruise control, the speed can be changed using the increase and decrease buttons.The system exits cruise control and the speed gradually decreases if the cancel button is hit. When the Adaptive button is depressed, the speed is maintained until an item within a certain distance is detected by the ultrasonic sensor. The speed begins to decrease after the object is recognised, and it then begins to increase again as the object moves further away from the host vehicle. Using the cancel button causes the system to slow down and disables the adaptive cruise control function.

**5. Pseudocode:**

Define Arduino as ‘a’ variable.

Define ultrasonic as ‘u’ variable

Define LCD display.

Display welcome message

Display Group number, name, and student id number.

Define buttons.

I\_B=0; % Increase button

D\_B=0; % Decrease button

C\_B=0; % Cancel button

Crui\_B=0; % Cruise control button

ACC\_B=0; % Adaptive cruise control

count=0;

spd=0; % spd represents speed

while

I\_B = read voltage from increase button

D\_B = read voltage from decrease button

C\_B = read voltage from cancel button

Crui\_B = read voltage from cruise button

ACC\_B = read voltage from adaptive cruise button

dis = to read distance.

if I\_B button is pressed

speed increases by 1 km/hr

elseif D\_B is pressed

speed decreases by 3 km/hr

else if

When no button is pressed than speed decreases by 1

elseif Crui\_B is pressed

speed will be constant at set speed

else if ACC\_B is pressed

Adaptive cruise mode is on

else

C\_B is pressed it will come out of any mode

end

elseif Cruise Control Button pressed then speed of vehicle remains constant till next instruction

elseif Adaptive cruise control button pressed. Then it will measure distance using ultrasonic sensor.

if dis<0.5

Speed decreases

else

Speed increases

end

display speed

**6. Timeline:**

|  |  |
| --- | --- |
| **Milestones Completed** | **Milestones to complete** |
| Project group members gathered. (Week 3) | Assembling of hardware components. (Week 9,10) |
| Project’s tasks equally distributed. (Week 4) | Syncing prototype with MATLAB by using Arduino package. (Week 9,10) |
| Purchased required hardware for project. (Week 5) | Final project report’s drafting. (Week 11) |
| Gathered some information about the project from internet (Week 6) | Final project report submit.  (Week 12) |
| Primary project report format created. (Week 7) |  |

**7. Limitation**

Although while learning something new is exciting, mastering it can be difficult. In this project, learning how to use the Arduino with MATLAB may be the biggest obstacle. We encountered a number of difficulties while wiring up the various components of the adaptive cruise control system.

**8. Connection of circuit:**

**8.1 LCD display connections:**

|  |  |  |
| --- | --- | --- |
| Pin | Function | Connects to |
| 1 | K | GND |
| 2 | V | 5V |
| 3 | D7 | Arduino Pin 2 |
| 4 | D6 | Arduino Pin 3 |
| 5 | D5 | Arduino Pin 4 |
| 6 | D4 | Arduino Pin 5 |
| 7 | E | Arduino Pin 6 |
| 8 | RW | GND |
| 9 | RS | Arduino Pin 7 |
| 10 | V0 | Input of potentiometer |
| 11 | VDD | 5V (positive) |
| 12 | VSS | GND(negative) |

**8.2 Ultrasonic connections:**

|  |  |  |
| --- | --- | --- |
| PINS | FUNCTION | CONNECTS TO |
| 1 | VCC | 5V(positive) |
| 2 | TRIG | Arduino 9 |
| 3 | ECHO | Arduino 10 |
| 4 | GND | GND (negative) |

**8.3 Arduino and push button assembly:**

|  |  |  |
| --- | --- | --- |
| **BUTTONS** | **FUNCTION** | **CONNECTS TO** |
| 1 | Increase Button | Arduino 5 |
| 2 | Decrease Button | Arduino 4 |
| 3 | Cancel Button | Arduino 3 |
| 4 | Cruise Button | Arduino 2 |
| 5 | Adaptive Cruise Control Button | Arduino 1 |

**9. Circuit Diagram of Adaptive cruise control system:**



**Figure 4: - Circuit Diagram of Adaptive cruise control system**

**10. Working of circuit:**

The names of group members and their student ID numbers are displayed along with a welcome message when the system is first started up. Holding the first button for one second increases the speed by one kilometre per hour. The second button is used to reduce speed; hitting it causes a 3 km/hr reduction. In order to exit cruise or adaptive cruise control mode, press the third button. The fourth button, designated as cruise, allows you to maintain a consistent speed. The final button activates adaptive cruise control, which uses an ultrasonic sensor to measure the distance between the car and close objects and adjust speed accordingly.

**11. MATLAB code:**

a = arduino('COM3','Uno','Libraries',{'Ultrasonic','ExampleLCD/LCDAddon'},'ForceBuildOn',true); % call the libraries from the MATLAB

u = ultrasonic(a,'D9','D10','OutputFormat','double'); % Set up the Ultrasonic Sensor in the format of “Double” [4]

lcd = addon(a,'ExampleLCD/LCDAddon','RegisterSelectPin','D7','EnablePin','D6','DataPins',{'D5','D4','D3','D2'}); % Adds the MATLAB support package for Arduino

initializeLCD(lcd);

printLCD(lcd,'Welcome'); % Displaying the necessary value on an LCD

pause(2);

clearLCD(lcd);

printLCD(lcd,'GROUP\_12');

pause(2);

clearLCD(lcd);

printLCD(lcd,'NEEL PATEL');

pause(2);

clearLCD(lcd);

printLCD(lcd,'110081832');

pause(2);

clearLCD(lcd);

printLCD(lcd,'MEET PATEL');

pause(2);

clearLCD(lcd);

printLCD(lcd,'110077623');

pause(2);

clearLCD(lcd);

printLCD(lcd,'NITTANT PATEL');

pause(2);

clearLCD(lcd);

printLCD(lcd,'110081202');

pause(2);

clearLCD(lcd);

I\_B=0; % Increase button

D\_B=0; % Decrease button

C\_B=0; % Cancel button

Crui\_B=0; % Cruise control button

ACC\_B=0; % Adaptive cruise control button

count=0;

spd=0; % spd represents speed

while true % Loop which executes for Infinite Time

% To read voltade from analog inputs A1-A5

I\_B = readVoltage(a,'A5');

D\_B = readVoltage(a,'A4');

C\_B = readVoltage(a,'A3');

Crui\_B = readVoltage(a,'A2');

ACC\_B = readVoltage(a,'A1');

dis = readDistance(u); % dis represents Distance

if count==0 %Circuit turn on when power on

% Speed increase

if I\_B>=1.5

spd=spd;

elseif D\_B>=1.5

spd=spd-2; % When decrease button is pressed then speed decrement is 3 km/hr

else

spd=spd-1; % When no button is pressed then speed decreases by 1

end

elseif count==1 % When button for cruse control press the speed of vehicle remains constant

spd;

elseif count==2 % After determining distance, the adaptive cruise control activates when it is pressed

if dis<0.5 % Minimum distance between two objects

spd=spd-1;

else

spd=spd+1;

end

if spd>speedlimit

spd=speedlimit;

end

end

% Different modes

if Crui\_B>=1.5

count=1;

elseif ACC\_B>=1.5

count=2;

speedlimit=spd;

elseif C\_B>=1.5

count=0;

elseif I\_B>=1.5 && count~=2

spd=spd+1;

elseif D\_B>=1.5 && count~=2

spd=spd-1;

end

if spd<0

spd=0;

end

printLCD(lcd,'Speed: '); % Displaying the necessary value on an LCD

printLCD(lcd,[strcat(num2str(spd))]);

pause(1)

end

**12. Lessons Learned:**

Making an adaptive cruise control system with Arduino while learning MATLAB was a fun experience. We learned how to use Arduino and how to connect the circuit using various components for the adaptive cruise control system, among other things. Second, we learnt how to set up Arduino with MATLAB and worked on the project's coding.

**13. Conclusion:**

As a result, the automatic system that increases car safety while driving is the adaptive cruise control system. This system's primary component, the Arduino UNO, uses real-time control to keep the host car and the vehicle in front of it apart by a safe speed distance and speed limit. However, compared to a car without adaptive cruise control, this device raises the vehicle's fuel consumption by 5-7% [3].

**14. References**

[1] H. A. Research, “What is adaptive cruise control?,” *Car and Driver*, Nov., 29 2021. [Online]. Available: https://www.caranddriver.com/research/a32813983/adaptive-cruise-control/. [Accessed: June 24, 2022].

[2] S. Ogbac, “What is adaptive cruise control? is it worth paying for?,” *MotorTrend*, Feb.,15 2022. [Online]. Available: https://www.motortrend.com/features/adaptive-cruise-control/ [Accessed: June 24, 2022].

[3] 2022 Patrick Masterson June 21, Brian Normile News Editor, Aaron Bragman Detroit Bureau Chief, and Joe Bruzek Managing Editor, “Does cruise control save gas?: News,” *Cars.com*. [Online]. Available: https://www.cars.com/articles/does-cruise-control-save-gas-424626/ [Accessed: June 25, 2022].

[4] “Arduinoobj,” *Connection to ultrasonic sensor on Arduino hardware - MATLAB*. [Online]. Available: https://www.mathworks.com/help/supportpkg/arduinoio/ref/arduinoio.ultrasonic.html. [Accessed: 23-Jul-2022].