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A Project on touch screen controlled steering system involving the concept of Steer by Wire

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Abstract: "Touch-Screen technology"-A technology that has given electronics a new dimension of its own, everything these days begins with a simple touch, so if the similar concept is extended onto the steering shaft of a car of the hybrid electric vehicle; things can become more convenient and efficient.

Keywords: Touch Screen, resistive touch screen, capacitive touch screen, Steer by wire, microcontroller.

I. INTRODUCTION

A touch screen controlled steering mechanism interfaced to a hybrid electric vehicle following a "Steer by Wire" mechanism is presented in this work. This work explains how the proposed system can be used to guide a car by drawing lines on a touch pad. The touch pad can be wired on the dash board of the car to interact between user and the car steering mechanism.

In this project a touchpad [1] has been used. It consists of a grid of coordinates. When this grid is touched, a corresponding pulse is sent. This pulse is then analysed by the microcontroller to find the desired direction. The direction is sensed by calculating the difference between two grids touched consecutively. The speed is also found out by calculating the time difference between the touch of consecutive grids. These data are analysed and the wheels are rotated using the concept of steer by wire. In this way the car can be controlled using a touch screen.

II. WORKING FEATURES

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A. Touch screen

A touch screen is a display that can detect the presence and location of a touch within the display area [2]. It uses more than two piezoelectric transducers located at some positions of the screen to turn the mechanical energy of a touch (vibration) into an electronic signal. The screen hardware then uses an algorithm to determine the location of the touch based on the transducer signals.

Touch screen can be broadly categorised into Resistive, Capacitive, Surface Acoustic Wave and Infrared.

1) Resistive touch screen:

Resistive touch screens consist of a glass or acrylic panel that is coated with electrically conductive and resistive layers made with indium tin oxide (ITO) [3]. The thin layers are separated by invisible space.

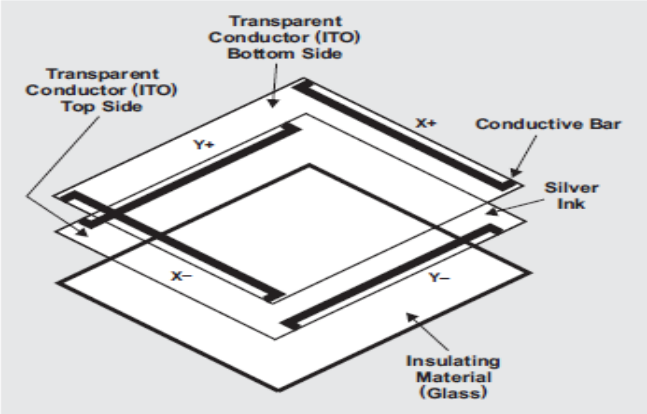

Fig. 1 Resistive touch screen structure

2) Capacitive touch screen:

Capacitive sensing is a technology, based on capacitive coupling that takes human body capacitance as input [4]. Capacitive sensors detect anything that is conductive or has a dielectric different from that of air.

Sensors to detect and measure proximity, position or displacement, humidity, fluid level, and acceleration use capacitive sensing. Many human interface devices like computer mouse can be replaced by track pads based on capacitive sensing.

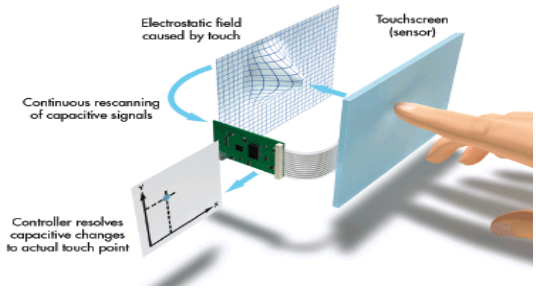

Fig. 2 Capacitive Touch Screen

B. Steer by Wire mechanism

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"Steer by Wire" technology in the automotive industry refers to the use of electrical or electro-mechanical systems for performing vehicle functions achieved by mechanical linkages/actuators [5]. This technology replaces the traditional mechanical control systems with electronic control systems using electromechanical actuators and human-machine interfaces such as pedal and steering feel emulators. Hence, the usual components such as the steering column, intermediate shafts, pumps, hoses, belts, coolers, vacuum servos and master cylinders are eliminated from the vehicle. This is similar to the fly by wire systems used widely in the aviation industry.

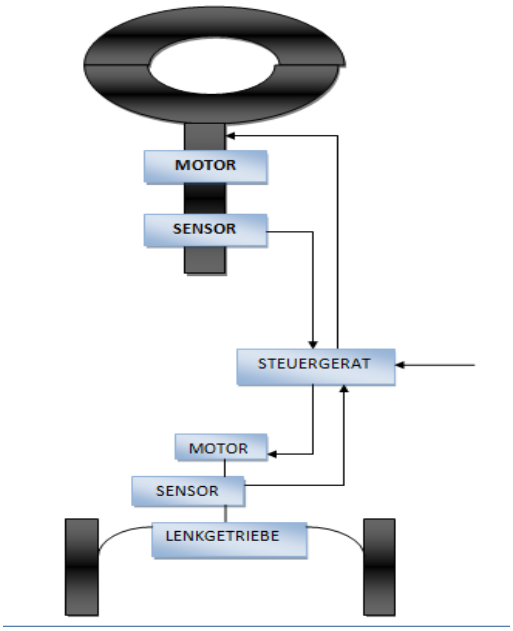

Fig. 3 Steer by Wire mechanism

Taking into account the above concept, a touch pad has been interfaced with the steer by wire system of the car through an ADC. There is a microcontroller which receives data from the touch pad through the ADC and it converts the inputs received into coordinates following a complex algorithm. Corresponding to the coordinates received by the microcontroller, the steering has been controlled. This result in a more sophisticated car design as it will be more compact and efficient thus bringing about a new era in the field of advanced cars.

III. EXTRAPOLATION OF SPEED AND DIRECTION

The distance and direction are the main criteria to find the angle in which the wheels are going to move. The entire touchpad is quantized into a 255 x 255 grid points and for sake of convenience of calculations it is assumed that the touchpad consists of two major halves, the positive half for the clockwise motion and the left half for anti clockwise motion of the steering. It is also assumed that the microcontroller will grab the coordinates of the current location of the user stylus (or nailed finger) 30 times a second. The table shown below gives the values of the X and Y coordinates for a typical user input given in the touch pad.

TABLE I
TYPICAL USER INPUT PATH PROCESSED FOR MICROCONTROLLER INPUT

CLOCKWISE MOTION		ANTI- CLOCKWISE MOTION	
X - AXIS	Y-AXIS	X- AXIS	Y -AXIS
15	30	-45	33
30	32	-60	34
45	36	-75	39
60	42	-90	45
75	54	-105	57
90	72	-120	75
105	120	-132	120
90	165	-120	162
75	184	-105	180
60	195	-90	195
45	204	-75	201
30	207	-60	206
15	210	-45	207

The paths shown in Figure 4 and Figure 5 are processed for the calculation of speed and directions.

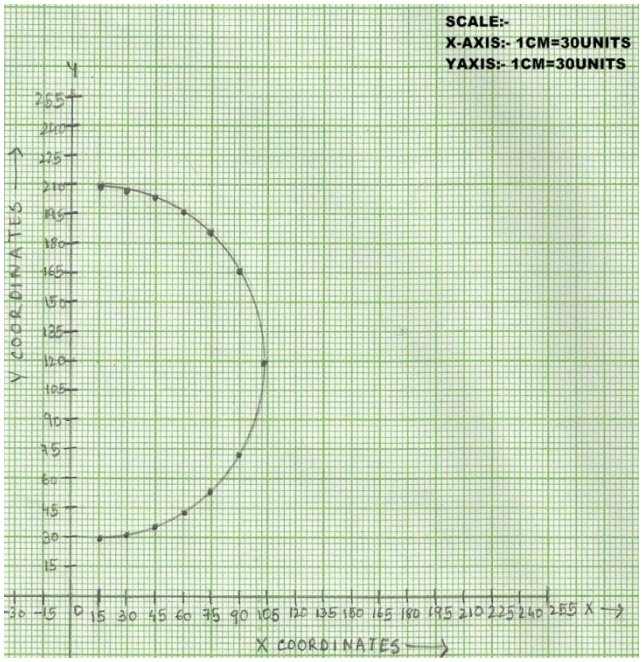

Fig. 4 Inputs to the touch pad for clockwise motion of the steering

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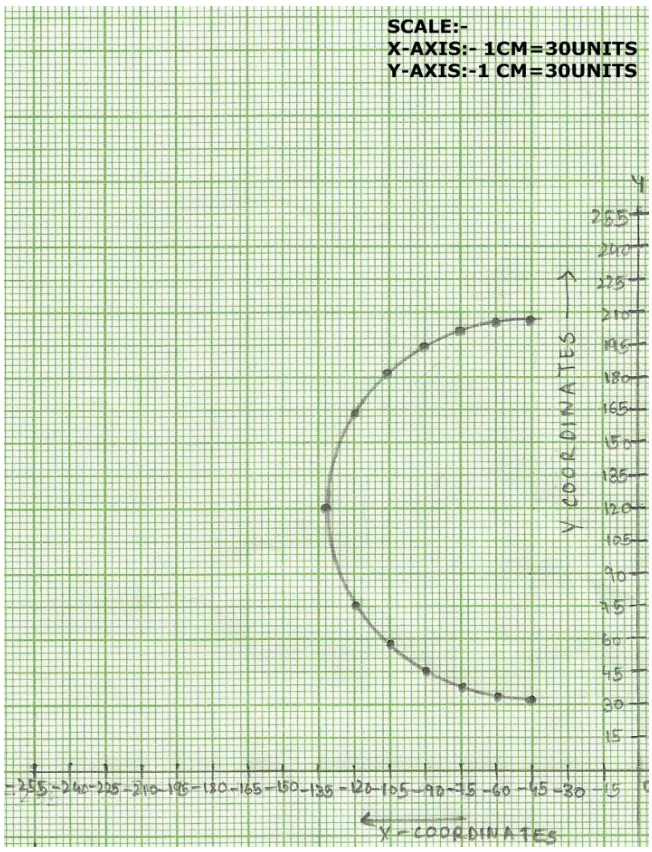

Fig. 5 Inputs to the touch pad for anti clockwise motion of the steering

C. *Speed calculation*

The speed at which the wheels should move is determined by the distance between the two selected coordinates at a fixed time. The distance between the two coordinates is found by the equation given by:

$$D = \sqrt{((X_2 - X_1)^2 + (Y_2 - Y_1)^2)} \qquad (1)$$

The coordinates are sent by the touchpad to the microcontroller in which the calculation of equation (1) is done. Now dividing the distance with a fixed time, the speed at which the wheel should move is obtained.

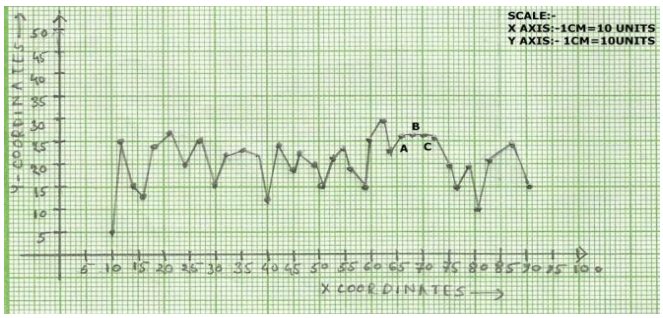

Fig. 6 Graph showing the extrapolation of speed

The graph in figure 6 shows the speed calculations. In the graph, points A, B and C acquire the same value. So instead of taking into account their individual speeds the average of all the speed can be taken for simplicity of calculation.

D. *Direction calculation*

The angle is needed by the car with respect to its current position in order to correctly follow the user path. The desired angle is obtained by finding the slope between the initial position and the next coordinate position that is touched on the touchpad. In this way the angles between all the coordinates are found and every group of 15 points is averaged. The final direction is calculated from these points. Thus assuming a sampling frequency of 30 points/second, the direction will only be updated twice a second.

A car is restricted in the range of angle it can turn, thus all angles greater than a predefined value are declared as invalid inputs.

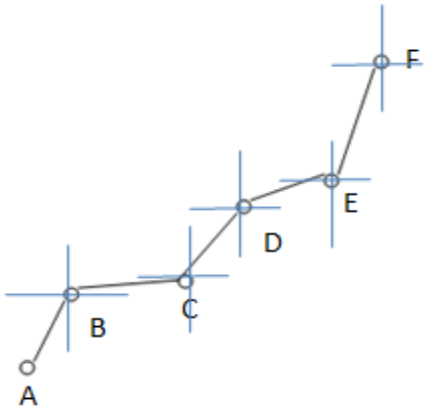

Fig. 7 Diagram showing Direction Calculation

IV. HARDWARE DESIGN

The Block diagram of the system is shown in the Fig. 8. It is evident from the figure that the system mainly consists of three parts: Touch Screen controller where the user gives his path, The Microcontroller which performs the path processing task and finally with the microcontroller the steer by wire system is interfaced for the proper control of the steering.

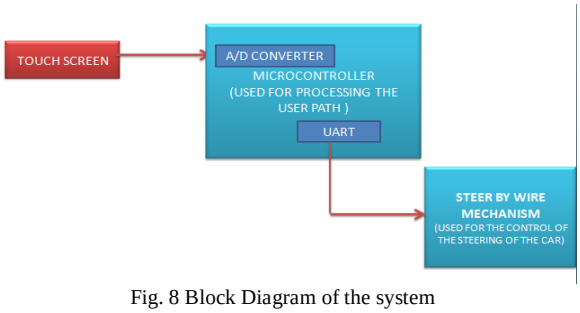

Fig. 8 Block Diagram of the system

A. *Touch Screen controller [6]*

For the sake of simplicity of the design and for reducing the cost of design a resistive touch-screen can be used.

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The resistive touch screen gives voltages as outputs that are based on where the user is touching the screen. Positive voltage (Vcc) is applied to the 3rd wire and ground applied to the 1st wire, the remaining wires will give a voltage that corresponds to the Y coordinate, which is fed into the ADC to be read as a value from 0 to 255. When the 4th and 2nd wire are fed to Vcc and ground respectively, voltage readouts will correspond to the X coordinates.

Now the values of the ADC [7] are inserted into the microcontroller. The microcontroller first receives the value of Y coordinate and then of the X of the initial position. After this input it takes the value of the next coordinate and finds the speed using Equation (1) and the corresponding direction.

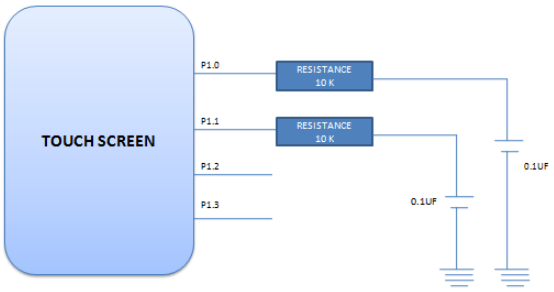

Fig. 9 Touch screen controller

B. Steering Control

As the microcontroller calculates the speed and the direction of the wheel movement, it sends the corresponding signals to the wheel.

The microcontroller gives its output to motor controller which moves the axel of the wheel in the desired direction up to the required angle.

V. CONCLUSION AND FUTURE WORK

"Touch Screen Technology" is becoming one of the most used technologies of this decade. If this concept is installed in a Steer by wire hybrid vehicle then it can lead to several advantages as the car can be controlled very easily with just a touch. In future even RF communication [8] can be used to implement this technology so that the touch screen controller need not be wired on to the dash board of the car. In a nutshell it can be concluded that Cars with touch screen controlled steering might just be the beginning to a whole new era of future cars.

The main drawbacks that were faced in the work are **1)** Processing of the path and calculation of speed and direction did not prove to be efficient at all time. **2)** Additional arrangements were required when safety factors are taken into consideration. Hence in future the work can be extended to improve the efficiency of the touch sensing and also protection from stray touching.

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BIOGRAPHIES

Sharmistha Chattopadhyay, born on 13th June 1992,is pursuing B.Tech in Electronics and Communication and is a Final Year Student of MCKV Institute of Engineering under West Bengal University of Technology (WBUT).Her interests lies in the field of VLSI Design,Robotics and Embedded System Design.

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