2D and 3D Air Mouse

Anand Bora,
Department of Electronics and Telecommunication,
Sinhgad Academy of Engineering,
University of Pune,
Pune, India,
bora.anand@yahoo.com

Abrar Chapalgaonkar, Nikhil Dalshania and Aditya Bhongle
Department of Electronics and Telecommunication,
Sinhgad Academy of Engineering,
University of Pune,
Pune, India,
abrar2010@gmail.com, nikhilsae@gmail.com,
aditya.bhongle11@gmail.com

Abstract—This paper presents an air mouse, which would not need any contact surface for its operation. Single device shall be able to operate in two modes, 2D and 3D modes. In the 2D mode, mouse movements shall be recorded in 2 Dimensions, which can enable full functionality of a mouse pointer on screen. 3D mode will assist 2D mode in further enhancing the mouse pointer functionality for functions such as zoom in and zoom out. 3D mode can be utilized for various applications such as 3D images or games, for 3 Dimensional interfaces with the PC.

Setup of the project consists of a non-echo ultrasonic system with three receivers at different corners of the display screen and one hand held transmitter, which acts as the mouse. Upon measuring the three distances, position of transmitter in three dimensions can be determined. Once the spatial coordinates of the transmitter are known, the x, y, and z values can be applied for various uses. Planar coordinates, when used, will help us to create a mouse pointer on the screen, and the movements of the mouse pointer will be determined by x and y coordinates. Spatial coordinates of the mouse can be used for 3D application such as zoom functionality, 3D imaging and gaming.

Keywords— ***2D, 3D, mouse, ultrasonic, spatial, planar, interrupts***

I. Introduction

The standard PC mouse has been in use for over 40 years, and recent developments in 3D technologies are testing the limits of the mouse's design. To compensate for the two-dimensional nature of the mouse, a scroll wheel has been added to the mouse, which can traverse the third dimension when needed. One of the features of the standard mouse is that it needs a contact surface for operation. Surface is taken as reference to calculate mouse coordinates on the screen. This design doesn't allow free movement of hands for cursor movements. Moreover, this design does not allow for simultaneous movement in three dimensions, nor does it have a high resolution along the depth axis. 2D and 3D Air Mouse is a human interface device, which lets the user interact with PC in 2 and 3 Dimensions, without having the need for any contact surface [4].

The device times the delay of high-frequency ultrasonic waves from the unit held by the user to each of three receivers and then passes this information along a serial cable to the PC. Here, the spatial coordinates may be used as per the application.

Ultrasonic transmitter-receiver pair works at 40 KHz. Controller generates a 40 KHz square wave, using timer, which is transmitted by the mouse. Time of generation of pulse is known to the controller. The three receivers will detect this signal, which will be amplified to TTL level. Controller will note time of reception of each receiver. Time delay is then calculated for each of the three receivers. Speed of wave is assumed to be 345m/s and thus we can calculate three distances, using the formula Speed=Distance/Time. Distances are transmitted to the PC..

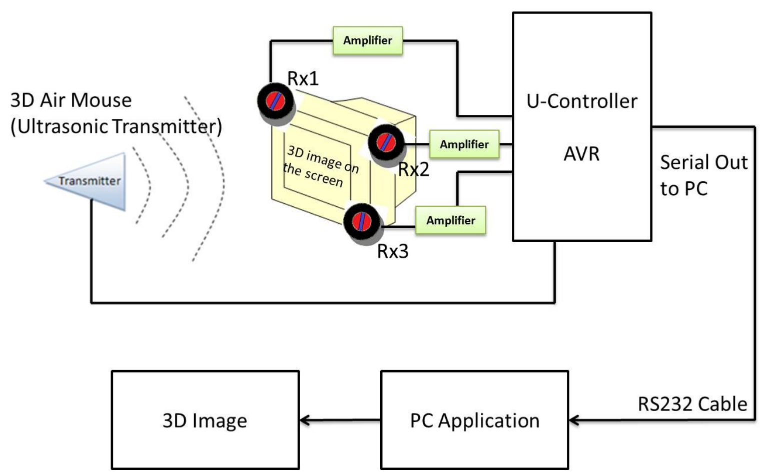

Figure1: Block Diagram

II. 3 Dimensional Positioning Using Ultrasonic

Figure 2 shows the placement of Ultrasonic sensors to find out the spatial coordinates of the transmitter. There are three sensors at the three corners of the screen. Minimum of three sensors are needed to find out the spatial coordinates, but different combinations of three or more sensors are also possible for more accurate coordinates.

Ultrasound travels through air at approximately 345 m/s. From this, the time it takes for sound to travel between a transmitter and receiver can be described as:
Time = Distance/345. From this, a reasonably fast counter could keep track of a time delay between transmission and reception and back calculate a distance [1].

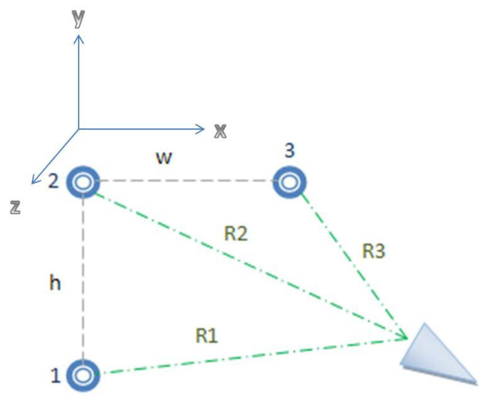

Figure2: Placement of Sensors for 3D positioning [1]

If the time of transmission and the time of reception on each of three receivers are known, distances from transmitter to their respective receivers, R1, R2, and R3 can be calculated [2]. Assuming Receiver 2 at origin, and with known values of w and h, the 3d coordinates of the transmitter can be calculated by solving a system of equations:

Coordinates of Receiver 2 = (0,0,0)
Coordinates of Receiver 1 = (0,-h,0)
Coordinates of Receiver 3 = (w,0,0)

$R1^2 = x^2 + (y+h)^2 + z^2$

$R2^2 = x^2+y^2 + z^2$

$R3^2 = (x - w)^2 + y^2 + z^2$

Thus, we get coordinates of the Transmitter (x,y,z) as:

$x = (R2^2 - R3^2 + w^2)/2w$

$y = (R1^2 - R2^2 + h^2)/2h$

$z = sqrt (R2^2 - x^2 - y^2)$

For, cursor movements of the mouse, only the x and y coordinates are sufficient. For zoom feature, z coordinate may be used. For 3 D applications, spatial coordinates may be used.

III. Transmitter

To drive the ultrasonic transmitter an alternating voltage at 40 kHz must supplied across the transmitters two leads. To accomplish this, we used a digital output pin the MCU to drive the gate of a power transistor [1]. By placing the transmitter, in parallel with a resistor, between the transistors drain and the supply voltage, a 40 kHz signal supplied by the MCU can drive a 40 kHz signal across the transmitter ranging from supply to ground. To transmit as strong a signal as possible, we use the voltage coming directly out of the AC/DC transformer which tends to range from 9- 13 volts.

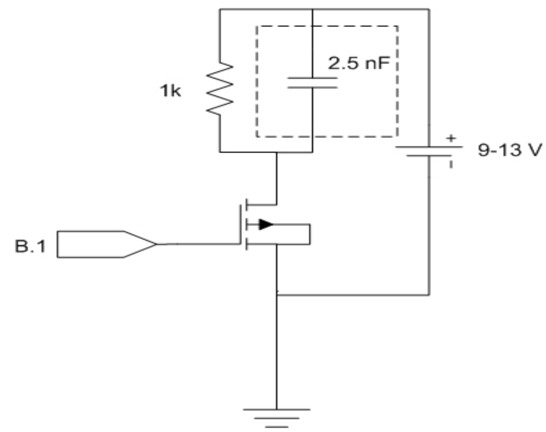

Figure3: Transmitter Circuitry [1]

Ultrasonic transmitter oscillates at frequency of 40 Khz. Controller generates a 40 Khz square pulse, and boosting the pulse will help to have sufficiently large levels at the receiver. Moreover, several buttons may be added to the transmitter, for left and right mouse clicks, 2D and 3D mode change, and mouse ON and OFF.

IV. Receiver

Ultrasonic signals at receiver are of magnitude 15mV and above. And noise levels are approximately 5mV. We, propose a BJT amplifier with a gain of 100 for amplification of the signal and further use of comparator to convert the received signal to TTL levels [3].

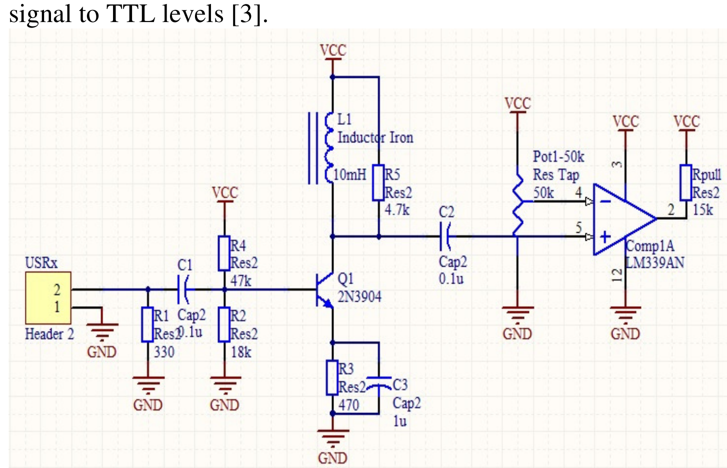

Figure4: Receiver circuit

Whenever an ultrasonic pulses is detected by the receiver, comparator will be triggered and a TTL high will be observed at the output of the comparator. This signal will again go the microcontroller and in turn, time of reception is is calculated by the controller. Absence of ultrasonic inpul will result in a Ground at output of the comparator. Three such receiver circuits will be needed for each of the receiver.