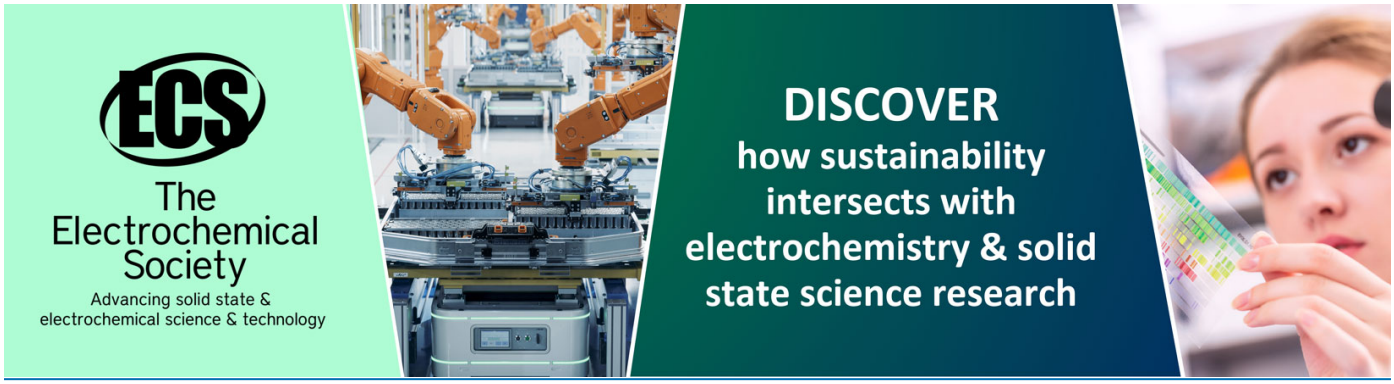
Wireless Control of Miniaturized Mobile Vehicle for Indoor Surveillance



Wireless Control of Miniaturized Mobile Vehicle for Indoor Surveillance

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Abstract
This work is based upon electronic automation and Smart Control techniques, which constitute the basis of Control Area Network (CAN) and Personal Area Network (PAN). Bluetooth technology has been interfaced with a programmable controller to provide multi-dimensional vehicle control. A network is proposed which contains a remote, mobile host controller and an android operating system based mobile set (Client). The client communicates with a host controller through a Bluetooth device. The system incorporates duplex communication after successful confirmation between the host and the client; the android based mobile unit controls the vehicle through the Bluetooth module.

Index Terms — Miniaturized vehicle, wireless control, Bluetooth, programmable controller, duplex communication, android interface.

1. Introduction

The past decade can be termed as a revolutionary decade in the field of electronics; it provided new horizons for automation and control techniques. Various smart control techniques provided the designers to have more control over various applications. These techniques provided a great deal in control area network (CAN) and Personal Area network (PAN). A secure, accurate and effective remote surveillance monitoring is a crucial requirement these days.

Modern communication interfaces protocols include, WIFI, ZIGBEE, and Bluetooth etc. Each of the connection has their own unique specifications and applications. The comparisons of the protocols are listed in table 1.

	Zigbee	Wi-Fi	Bluetooth
Range	10-100 Meters	50-100 meters	10- 100 Meters
Networking Topology	Ad-hoc, peer to peer, Star, Mesh	Point to hub	Ad-Hoc, very small networks
Operating Frequency	868 MHz (Europe) 900-928 MHz (NA), 2.4 GHz (worldwide)	2.4 and 5 GHz	2.4 GHz
Power Consumption (Battery option and life)	Very low	High	Medium
Security	128 AES plus application layer security	Encryption and MAC address	64 and 128 bit encryption
Typical Applications	Industrial control and monitoring, sensor networks, building automation, home control and automation, toys, games.	Wireless LAN connectivity, broadband Internet access	Wireless connectivity between devices such as phones, PDA, laptops, headsets(smart Phones)
Android Connectivity	Not possible	Possible (not Possible)	Direct Connection is possible

Table1: Comparisons among various techniques.

Among the three popular wireless connections Bluetooth has been chosen with its suitable capability. Bluetooth a short-range communications technology that is simple, secure, with globally available frequencies of 2.4GHz is able to provide connectivity up to 100 meters at speed of up to 3Mbps depending on the Bluetooth device class [1]. In addition, a Bluetooth master device is able to connect up to 7 devices in a "Pico net" [2].

Bluetooth communication has been interfaced with android operating system which is a Linux-based operating system designed primarily for touch-screen mobile devices such as smart-phones and tablet computers. It is open source software, hence cost effective.

In this paper, the proposed navigation method of the mobile surveillance system is evaluated in small premises.

2. System Description

The Bluetooth based mobile surveillance vehicle (MSV) design architecture, proposes a Bluetooth based MSV that is controlled by an android mobile's GUI, but it does not provide remote function for a larger coverage. For the system, all the controls are performed only at the GUI on android operating system (OS) based mobile phone is designed with cellular phone remote control. The system configuration is shown in Fig # 1.

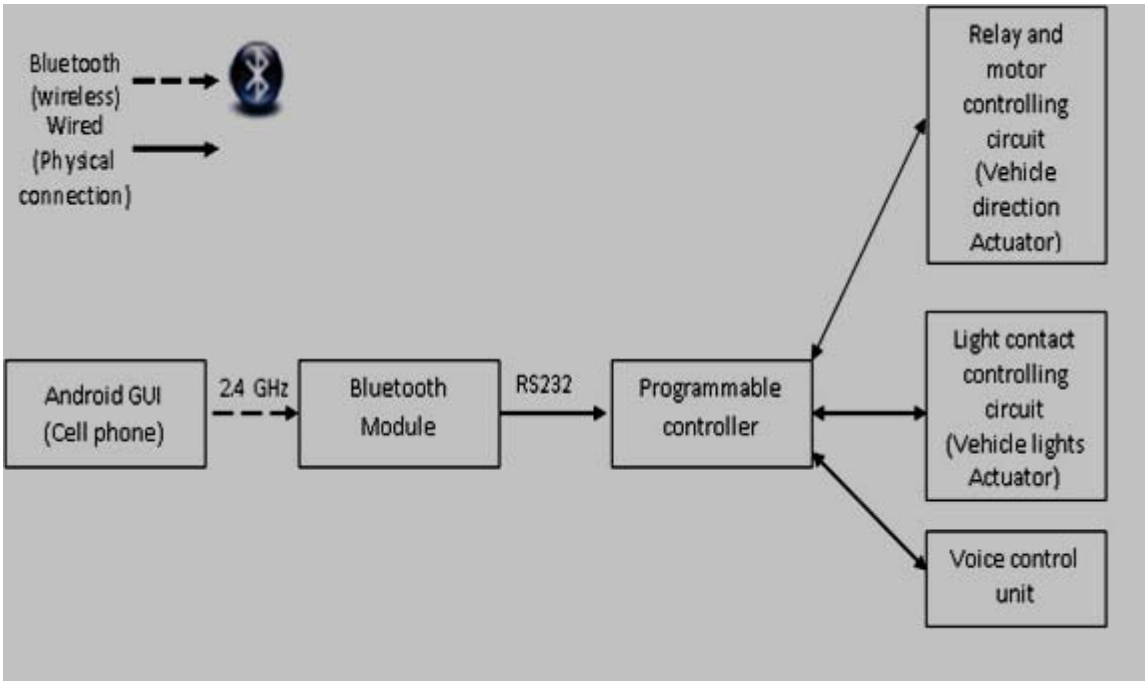

Figure-1: block diagram of the system.

A mobile phone with an android based operating system is proposed to control the mobile surveillance vehicle (MSV)'s devices and actuators wirelessly by means of Bluetooth which gives easy access for communication within an indoor proximity of 100 meters. The Bluetooth module is further connected with programmable controller via serial communication (RS232). The programmable controller performs the actuation on signal received from Bluetooth communication channel by making the vehicle perform its desired task. The controller is programmed to record the surrounding sounds. The controller is capable to establish duplex communication with the actuators thus getting feedback if any error occurs in the operation. The errors in the system are continuously monitored so that the efficiency of the system can be increased with minimum error/ loss rate.

3. Hard ware Design

The Android application on mobile phone sends the character to Bluetooth module which forwards the character to Ardunio microcontroller. The Arduino microcontroller receives that character as a numerical value and then matching the condition sends pulse on the desired port. The Pulse will continue to transmit until the button on android application is in contact.

Arduino microcontroller is being used in the project, which is an open-source single-board microcontroller, descendant of the open-source Wiring platform and designed to make the process of using electronics in multidisciplinary projects more accessible.

The hardware consists of a simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board.

Bluetooth module is the most reasonable and easiest way to go wireless for this module, the 4 pins are +5V, GND, TXD, RXD. Supply voltage should be 3.3 - 6 V. Absolute maximum is 12V.
The connections for duplex communication channel of programmable controller are displayed in fig#2.

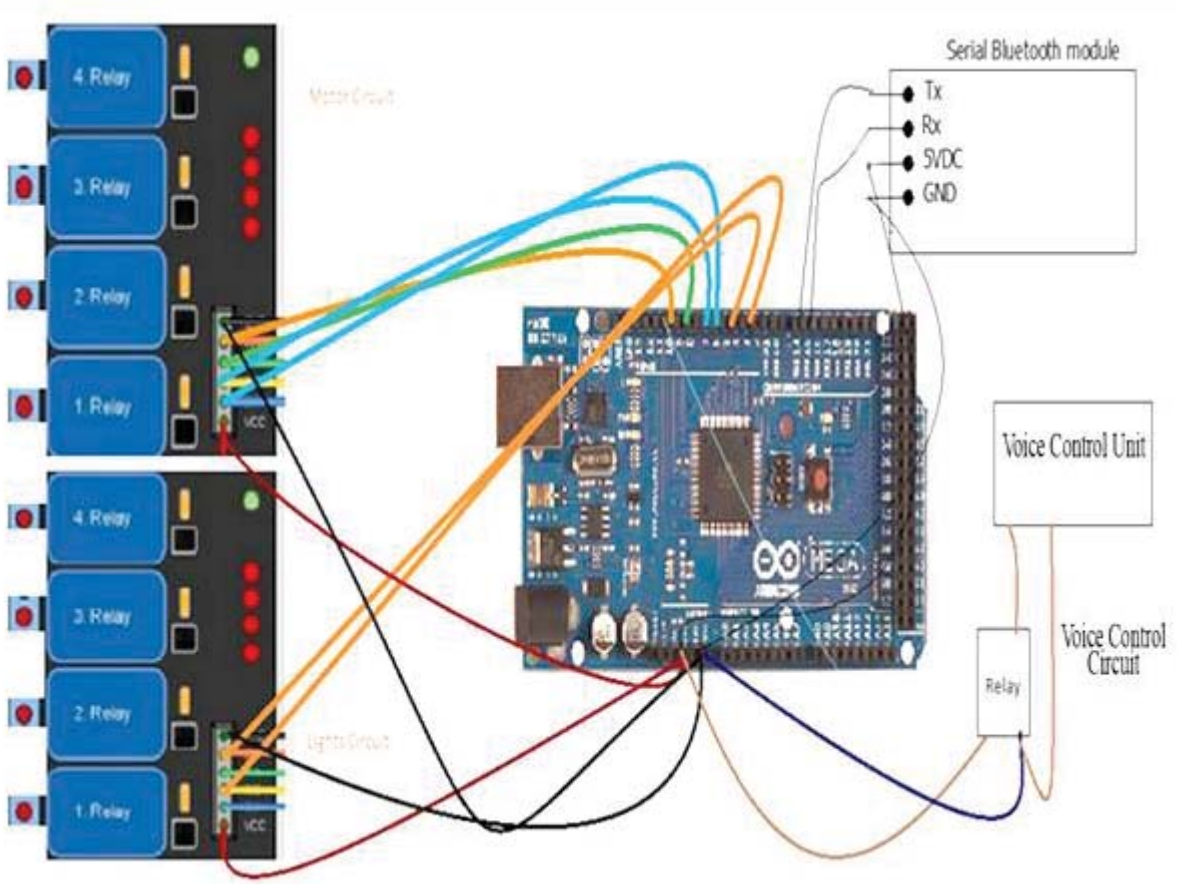

Figure # 2: pictorial for connection with Arduino microcontroller

The relay connection circuit is further listed in figure # 3. There are two modules of these Circuits, one for mobile surveillance vehicle (MSV)'s movement direction and another for front and backward motion control. The vehicle can perform basic movement control via forward, reverse, left and right turns with 360^{o} rotation with two front and back lights.

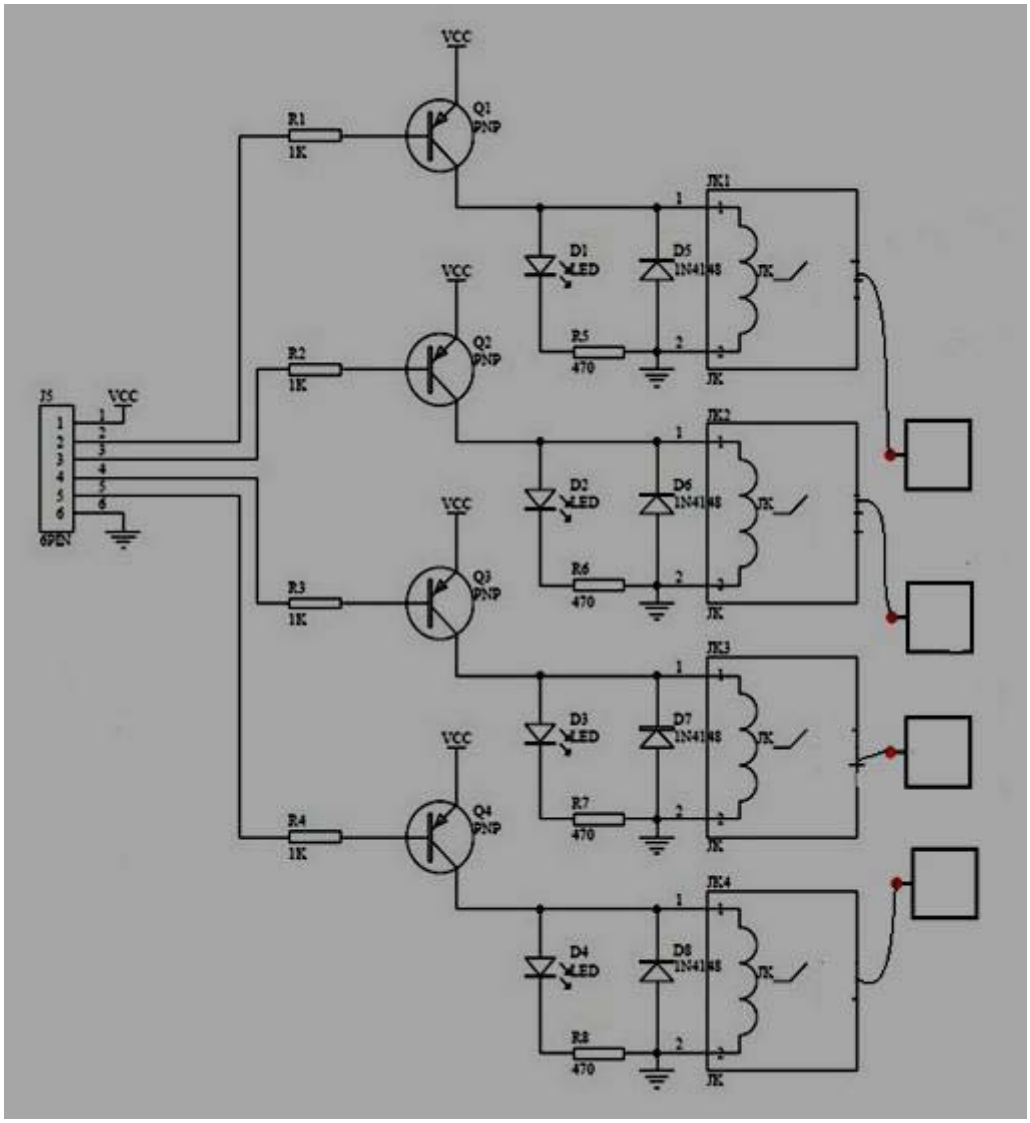

Figure #3: Relay connection with microcontroller.

4. Soft ware Design

The software design mainly revolves around the programming of the microcontroller. The Arduino microcontroller is an open-source single-board microcontroller which is programmed in C or C++. Figure 4 illustrates the process of activating various controls in the system. The command detection function is performed by the microcontroller. The Android application on mobile phone sends the character to Bluetooth module which forwards the character to Ardunio microcontroller. The Arduino microcontroller receives that character as a numerical value and then matching the condition send pulse on the desired port.

The Pulse will continuously be transmitted as long as the button on the android application remains depressed. The activating actuators are designed to react to this pulse signal. If any of the input switches is released; it will interrupt the main function loop of the microcontroller. Then, the microcontroller will deactivate the relay and stop the ongoing task.

The proposed system decision command flow is further listed in figure#4.

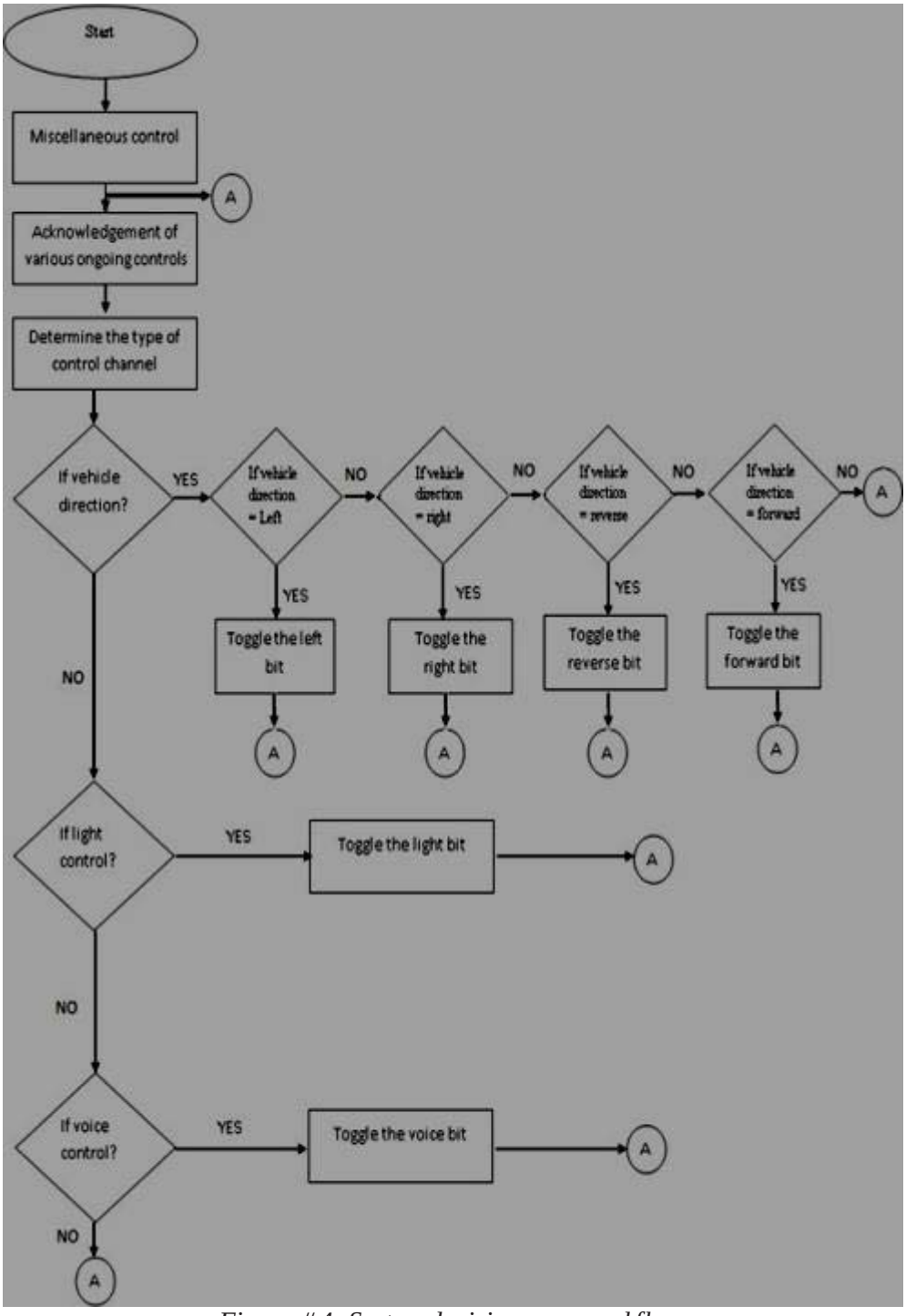

Figure # 4: System decision command flow

Android GUI is designed by a user-friendly interface. The four directions indicate the desired control for the MSV that is connected to the system. User can simply click on the direction button to toggle the various controls. Control board's "Connect to BT"" button is provided to establish connection to main control board by Bluetooth. Phone's "Connect to BT"" button establishes connection between Android GUI and Bluetooth module. When the connection is established, Android GUI acts as the control panel between main board and the phone. All the data received from main board is forwarded to the phone. The data sent from the phone is also directed to the main board.

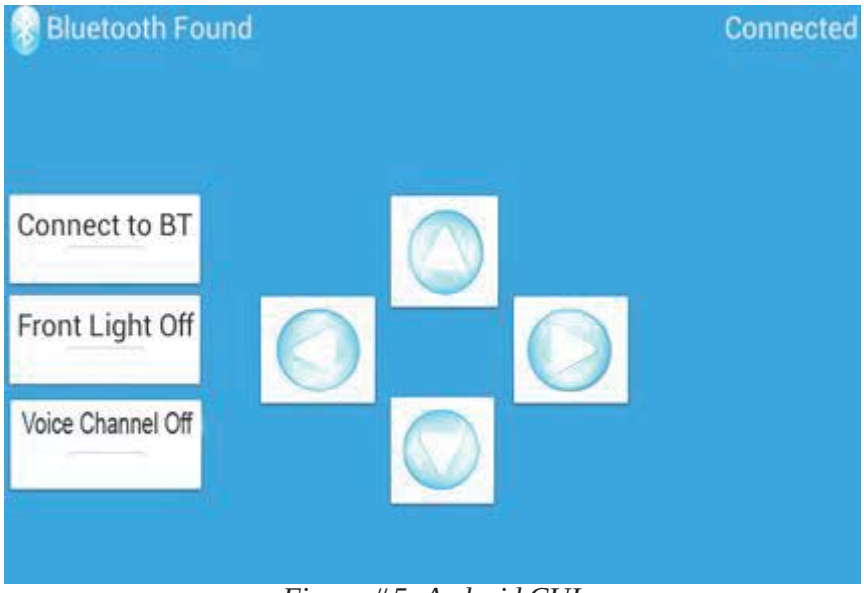

Figure # 5: Android GUI

The application is designed in low API level so that the devices with higher version are compatible with it. Fig 4 illustrates the Android GUI tested on smart phone with android Version 4.0.4 (Ice Cream Sandwich). The interface is simple to use, user can simply touch the icons on the interface to perform MSV's control tasks after been connected to the Android GUI.

5. Conclusion

A simple, low cost, user friendly and effective control system for MSV has been implemented using the android based SMART phone and the Bluetooth technology that is ideal for tactical remote surveillance and monitoring.
The connected GUI is synchronized with the control board to indicate the real-time control action implementation feedback.

For future work, the android GUI could be implemented with voice control. The android based GUI could also be replaced with windows based GUI for making the system compatible with non-android based applications. The system can also be equipped with a wireless camera that transmits the real time images. The vehicle can also be replaced by an intelligent remote sensing robot with decision making capabilities.

Acknowledgment

The authors extend their gratitude to their parent institutions that created a research based environment for continuing with projects like this and providing the necessary motivation for such activities.

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