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Automatic Electronic Toll Collection System for Transportation by using Passive RFID Technology

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ABSTRACT

Automated Toll Collection System used for collecting tax automatically from the moving vehicle. Here we do the identification with the help of radio frequency. A vehicle will hold an RFID tag. This tag contains unique identification number. This unique identification number will be assigned by RTO or traffic governing authority. Reader will be strategically placed at toll collection center. Whenever the vehicle passes the toll collection center, the tax amount will be deducted automatically from his prepaid balance. New balance will be updated in his account. Incase if one has insufficient balance, his updated balance will be negative one and the warning message will be send to the user. As vehicles don't have to stop in a queue, it assures time saving, fuel conservation, avoid traffic congestions and also contributing in saving of money.

Keywords: ATCS, RFID Reader, RFID Tag, Toll Collection, prepaid account, GSM and Sensors.

1. INTRODUCTION

Nowadays almost all highways toll plazas are manually operated, here an operator collects the cash from the driver and provides a receipt. Since this procedure can be slow, we often encounter traffic jams at the busy toll plazas on busy highways. Automatic process of toll collection will save time, effort, and man power. In this system propose a low cost and efficient technique. It is called Electronic Toll Collection system using RFID modules. This proposed system automatically collects the toll from moving vehicles when the vehicle crosses the toll plaza. We also assume that an owner maintains a prepaid account at toll plaza, so that toll tax is deducted automatically from the owner account at toll plaza. If the balance in the owner's account is low the warning message will be send to the user. If the vehicle is not equipped with an RF system, the toll gate remains close and vehicle owner will have to pay the toll tax in cash and collect the receipt. The owner receives an SMS message on his mobile about the details of the payment and there is no need for him to stop the vehicle. Here we can find out how many vehicles passing through the toll gate will be stored in toll database and also find out each vehicle how many times passing through the toll gate in a day.

Need for automatic toll gate: Any structure, building or system needs maintenance, which are of course costly. Highways and roads are also not an exception. From the very past, the construction, extension, maintenance and operating costs of highways, roads, bridges and tunnels taxes are very high. The taxes are collected either directly or indirectly. In the old indirect method the expenses are compensated either by toll tax payment for fuel or by budget allocation of the national income. The shortcoming of this method is that a number of tax payers, who do not use any of the roads and carriageways, have to pay extra money. In direct method, the tolls are collected directly from the drivers passing the toll plaza. The other three main reasons are why tolling, or road pricing, is implemented are listed below.

Finance/Revenue generation: To repay the costs of building, operating and maintaining the facility. Road pricing is becoming a more engaging means of funding transportation. Moreover, toll financing allows projects to be built in or after a short time instead of waiting for tax revenues to accumulate.

Fig.1. Articulation of Toll Gate

Demand management: To moderate the growth in demand on the transportation an arrangement between people to make a regular journey in a single vehicle, typically with each person taking turns to drive the others. For example, vehicles are charged to enter inner London, England, as a way of regulating the demand in the region.

Congestion management: To place a tax on restricted roadway space in proportion to demand. In this application the toll increases with the level of stuffing. In the absence of such tax, drivers do not appreciate the costs they impose on others as a result of the stuffing they cause.

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Fig.2. Traffic Congestion

2. LITERATURE SURVEY

Literature survey earlier to begin a research project is essential in understanding an automatic toll collection system, as this will supply the researcher with much needed additional information on the methodologies and technologies available and used by other research complement around the world. This chapter provides a compressed summary of literature reviews on key topics which related to automatic toll collection systems. The comparison between the present project and the related topics of the existing information will also be discussed.

Automatic toll collection system using RFID [1]

According to Automated Toll Collection System using RFID technology used for collecting the tax automatically. Here we do the identification with the help of RF (radio frequency). A vehicle will hold an RFID tag. This tag is nothing but unique identification number was assigned. This number will be assigned by RTO or traffic governing authority. In accordance with this number we will store, all basic information like address, ID number, date, time as well as the amount details which he has paid in advance for the toll Collection process. Reader will be strategically placed at toll collection center. Whenever the vehicle passes at the toll plaza, the tax amount will be reduced from his prepaid balance and new balance will be updated. Incase if one has insufficient balance, his updated balance will be negative one. To solve this problem, we have a camera on the toll plaza which is capture the image of the respective vehicle. So the vehicles don't have to stop in a queue, it automatically translates to reduce Traffic congestion at the toll plazas. This helps in lower fuel consumption. This is very important advantage of this system.

Electronic toll collection system using passive RFID technology [2]

This paper focuses on an automatic electronic toll collection System using RFID technology. Research On electronic toll collection has been around since 1992, during which RFID tags began to be widely used in vehicles to automatic toll processes [1]. The proposed system uses RFID tags that are mounted on the windscreen of vehicles, through which information are read by RFID readers; the proposed system eliminates the need for motorists and toll authorities to manually perform ticket payments and toll fee collections, respectively. Data information is also easily exchanged between the motorists and toll authorities, thereby enabling a more efficient toll collection by reducing the traffic and eliminating possible human errors.

It reference to the Journal of Theoretical and Applied Information Technology. This studies regarding the existing techniques such as using Optical Camera Recognition (OCR), Microwave Technology, RFID technology (active tag), GPS was proved to be inefficient in some ways and these are discussed below. When taken into consideration the optical camera recognition (OCR), here the whole object will be captured.

It is a time consuming process and also the error rectification in the laser cameras is very difficult. Come to the Micro technology it requires different transponders and also it regularly to produce various problems regarding reflection.

The ETC system in Malaysia has been introduced in the year 1994. It has developed since then, and many changes have been done. The most recent Electronic Toll Collection (ETC) system consists of the Touch NGO and Smart TAG. It referred to as the single ETC system in the country.

This system uses IR technology, making it very unprotected to failure. Other than that, users also have to take the high cost of owning the two-piece tag required for this system. Thus, Malaysian highway authorities have been looking for alternatives, such as the multi-lane free-flow (MLFF) ETC system.

However, this proposed system requires major changes in the basic physical and organizational structures of the existing toll roads. In contrast, the Electronic Toll Collection system proposed in this paper will require only minimum changes. Moreover, the existing toll plaza could be re-used with only small modifications.

Automatic Toll Gate System Using Advanced RFID and GSM Technology [3]

Most of the Electronic Toll Collection (ETC) systems around the world are implemented by Dedicated Short Range Communication (DSRC) technology. The concept of proposed system is of automatic toll tax payment and the amount transaction information sends to the mobile phone of the motorists through the GSM modem technology.

It is an innovative technology for expressway network automatic toll collection system. In this paper, the frame formulates and working flow of the system is described and data information is also easily exchanged between the motorists and toll authorities. It is more efficient and the automatic toll collection system by reducing traffic and eliminating possible human errors.

3. DESIGN OVERVIEW

A block diagram is the total blue print of the proposed project. The total essence and functioning of the project is represented in a single block diagram. It depicts the pictorial

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representation of working function of a project. Block diagram is something which gives the overview of a project. The block diagram consists of the following components:

- Microcontroller-AT89S52
- IR Sensors
- RFID Reader
- GSM Module
- LCD
- Motor Driver

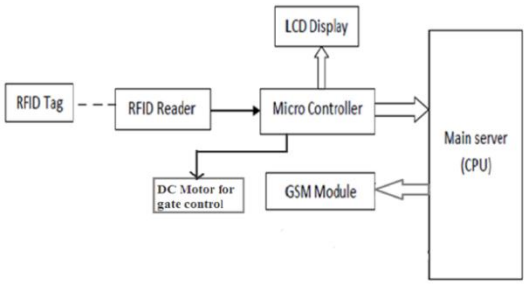

Fig.3. Block Diagram

Microcontroller

The AT89S52 it consume low-power, high-performance. It is a CMOS 8-bit microcontroller with 8K bytes of programmable Flash memory. The device is manufactured by using Atmel's high-density nonvolatile memory technology and is compatible with the 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in the system or conventional nonvolatile memory programmer. It will combine a versatile 8-bit CPU within system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller. It is highly-flexible and cost-effective solution to many embedded control applications.

GSM

GSM is the acronym for Global System for Mobile Communications, originally Group Special Mobile, is a standard which was developed by the European Telecommunications Standards Institute (ETSI).Which describes a protocols for second-generation (2G) digital cellular networks was used by mobile phones. GSM supports voice calls and data transfer. The GSM speeds of up to 9.6 kbps, and also with the transmission of SMS (Short Message Service).GSM uses a time division multiple access (TDMA).It is the most widely used of the three digital wireless telephony technologies which is TDMA, GSM, and CDMA. GSM digitizes and compresses the data, and then it sends down a channel with two other streams of user data, each in its own time slot.

It operates at 900 MHz or 1800 MHz frequency band. Many GSM network operators have operates with roaming agreements with the foreign network operators, often users can also continue to use their mobile phones when they travel to other countries. SIM cards (Subscriber Identity Module) containing home network access configurations, it may be switched to those will meter local access, significantly reducing roaming costs while experiencing no reductions in service.

GSM can also operate together with other technologies; this is the part of the evolution of wireless mobile telecommunications. This also includes HSCSD (High-Speed Circuit-Switched Data), GPRS (General Packet Radio System), EDGE (Enhanced Data GSM Environment), and UMTS (Universal Mobile Telecommunications Service). Using TDMA is a narrow band process; it is 30 kHz wide and 6.7 milliseconds long within the range. This split time-wise into three time slots.

Fig.4. GSM Module

Narrow band means channels (in the sense traditional). Each conversation gets the radio for one-third of the time. This is possible because of the voice data that has been converted into digital information, which is compressed so that it takes up significantly less transmission space. Finally the TDMA has three times the capacity of an analog system which using the same number of channels. TDMA is the main access method used by the GSM module. GSM systems provide a many useful features: Uses encryption to make phone calls more secure within the network, Data networking, SMS (Short Message Service) for text messages and paging, Call forwarding, Caller ID, Call waiting and Multi-party conferencing.

SIM 300

This is a plug and play GSM Modem with a simple to interface with serial interface. It is used to send SMS, make and receive calls, and do other GSM operations by controlling it through simple AT commands from PIC micro controllers and computers. It uses the popular SIM300 module for its operations. It comes with a standard RS232 interface which can be used to easily interface the GSM modem to micro controllers and computers. The modem consists of all the required external circuitry which is required to start Experimenting with the SIM 300 module like the power regulation, external antenna, SIM holder etc.

Features

- It uses the extremely popular SIM300 GSM module
- It provides the industry standard serial RS232 interface for easy connection to computers and other devices.
- It provides serial TTL interface for easy and direct interface with microcontrollers.

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- The Power, RING and Network LEDs for easy debugging
- Onboard 3Volt Lithium Battery holder with appropriate circuitry for providing backup to the module's Internal RTC.
- It can be used for GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP stack.
- It can be controlled through standard AT commands.
- It also comes with an onboard wire antenna for better reception.
- The board provides an option for adding an external antenna through SMA connector.
- The SIM300 allows serial baud rate from 1200 to 115200 bps (9600 default)
- Low power consumption during normal operations.
- The Operating Voltage: 7 – 15V AC or DC (board has onboard rectifier.

RFID

RFID stands for Radio Frequency Identification. The RFID device serves as same as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identification to the object. The bar code or magnetic strip must be scanned to get the information; the RFID device must be scanned to retrieve the identifying information. An RFID reader's function is to check the RFID tags. The means of checking is done through wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary. A reader contains an RF module, which acts as both a transmitter and receiver of RF signals.

The Transmitter consists of an oscillator to generate the carrier frequency; a modulator to collide the data commands upon carrier signal and an amplifier to amplify the signal enough to awaken the tag. The receiver has a demodulator to extract the returning data and also contains an amplifier to boost the signal for further processing.

An RFID reader, also known as an checker, is a device that provides the connection between the tag data and the enterprise system software that needs the information. The reader interact with tags that are within its field of operation, performing any number of tasks including simple continuous checking, filtering (searching for tags that meet certain criteria), writing (or encoding) to select tags, etc.

Fig.5. RFID

The reader uses an attached antenna to get data from tags. It then sends the data to a computer for processing.

Just like RFID tags, there are many different sizes and types of RFID readers. Readers can be affixed in a fixed position in a store or factory, or integrated into a mobile device such as a portable, handheld scanner. Readers can also be embedded in electronic equipment or devices, and in vehicles.

EM18 RFID Reader

This module directly connects to PIC microcontroller UART or through a RS232 converter to Personal Computer. It gives UART/Wiegand26 output. This RFID Reader Module works with 125 KHz RFID tags.

Fig.6. RFID Reader

Specifications

- 5 Volt DC through USB (External 5V supply will boost range Of the module)
- Current: less than 50mA
- The operating Frequency: 125 KHz
- Read Distance: 10cm
- The size of RFID reader module: 32mm (length)* 32mm (width)* 8mm (height)

LCD

A 16x2 LCD means it can display 16 characters and there are 2 lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data registers. The command register stores the instructions given to the LCD. A command is predefined instruction to perform task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed. The data is the ASCII code of the character to be displayed.

DC Motor

A DC motor is an electric machine which converts electrical energy into mechanical energy. DC motor works on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. DC shunt motors can be used where constant speed is required and very high starting torque is not required such as lathe, machine tools, centrifugal pump and etc. Series motors are used when very high starting torque is required as electric traction, trolley car, crane, etc. cumulative compound motors are used for applications where the load fluctuates such as rolling mills, printing press, reciprocating type compressors, crusher units, etc. Differential compound motors are rarely used because of its poor torque characteristics.

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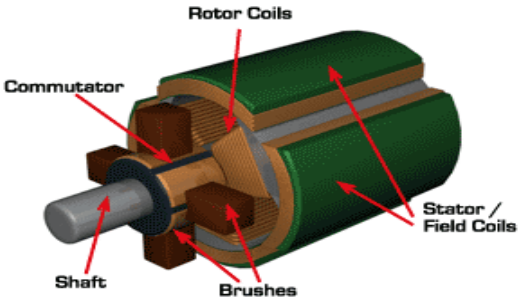

Fig.7. DC Motor

L293D IC

L293D is a dual H-bridge motor driver integrated circuit. Motor drivers act as current amplifiers since they take a low-current as control signal and provide a higher current signal. This higher current signal is used to drive the motors.L293D has two inbuilt H-bridge driver circuits. The common mode of operation is that the two DC motors can be driven simultaneously, both in forward and reverse direction. The two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the respective motor. Logic 01 and 10 will rotate in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 must be high for motors to start operating. When an enable input is high, the driver gets enabled, the outputs become active and in phase with their inputs. Similarly, when the enable input is low, the driver is disabled, and their outputs are off and in the high-impedance state.

Vcc is the voltage that is need for its own internal operation 5V; L293D will not use this voltage for driving the motor. For driving the motors it has a separate section to provide motor supply Vss (V supply). L293D use this to drive the motor. It means if you want to operate a motor at 9V then you have to provide a supply of 9V across Vss Motor supply. Vcc pin 16 is the voltage for its internal Operation. The max voltage ranges from 5v and up to 36V. The max voltage for Vss motor supply is 36V. It can supply a max current of 600mA/ channel. Since it can drive motors up to 36Volts hence you can drive pretty big motors with this L293D.

LOGIC 1. Let's considers a Motor connected on left side output pins (pin 3, 6). For rotating the motor in clockwise direction the input pins must be with Logic 1 and Logic 0.

Pin 2 = **Logic 1** and **Pin 7** = **Logic 0** | Clockwise Direction
Pin 2 = **Logic 0** and **Pin 7** = **Logic 1** | Anticlockwise Direction
Pin 2 = **Logic 0** and **Pin 7** = **Logic 0** | Idle [No rotation] [Hi-Impedance state]
Pin 2 = **Logic 1** and **Pin 7** = **Logic 1** | Idle [No rotation]

In a similar way the motor can also operate across input pin 15, 10 for motor on the right hand side. L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on both directions. L293D is a 16-pin IC which can control a set of two DC motors in any direction. It means that you can control two DC motor with a single L293D IC. Dual H Bridge Motor Driver integrated circuit (IC).

Pin Description

Table 1. Motor Driver IC Pin description

Pin No.	Function	Name
1	Enable pin for Motor 1; active high	Enable 1, 2
2	Input 1 for Motor 1	Input 1
3	Output 1 for Motor 1	Output 1
4	Ground (0V)	Ground
5	Ground (0V)	Ground
6	Output 2 for Motor 1	Output 2
7	Input 2 for Motor 1	Input 2
8	Supply voltage for Motors; 9-12V (up to 36V)	Vcc 2
9	Enable pin for Motor 2; active high	Enable 3, 4
10	Input 1 for Motor 1	Input 3
11	Output 1 for Motor 1	Output 3
12	Ground (0V)	Ground
13	Ground (0V)	Ground
14	Output 2 for Motor 1	Output 4
15	Input2 for Motor 1	Input 4
16	Supply voltage; 5V (up to 36V)	Vcc 1

Sensor

An infrared sensor is a detector that reacts to infrared radiation. An infrared sensor is an electronic instrument. This IR sensor is used to sense certain characteristics within its surroundings by either emitting or detecting infrared radiation. Usually the sensor is used for collision detection or obstacle detection. This sensor module consists of an IR transmitter and IR receiver pair. Here the LED (Light Emitting Diode) is used as a transmitter and photo diode is used as a receiver. The IR pairs are placed parallel to each other. The output of the receiver is given to a 358 comparator which compares and given the input to the reference input and gives information to the microcontroller.

Fig.8. IR sensor

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Infrared sensors are mainly classified into two types:

Thermal infrared sensors – Here use infrared energy as heat. Their photo sensitivity is independent of the wavelength being detected. Thermal detectors do not require to cooling but it has slow response time and low detection capabilities.

Quantum infrared sensors –It provide higher detection performance and faster response to speed. Their photo sensitivity is dependent on particular wavelength. Quantum detectors have to be much cooled in order to obtain the accurate measurements in the output.

4. PROJECT OUTCOME

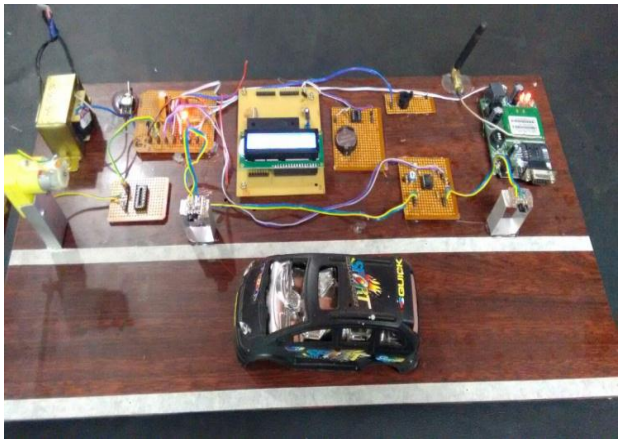

Fig.9. Automatic Toll Collection System Using RFID & GSM Technology

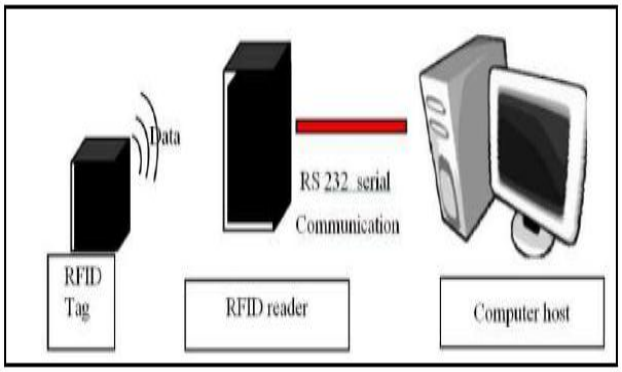

Fig.10. General System

Here, when a vehicle comes into the toll plaza, the IR sensor gives the information to the microcontroller which is in the device and the RFID reader reads the information from the tag in the vehicle. Microcontroller processes it and the transaction takes place at the toll plaza. The details will be displayed on the LCD as well as it is send to the user's mobile through the GSM. When person enters the toll plaza with an invalid card, with a card having no balance or without any card the microcontroller intimates the motor to close the gate at the plaza. By this way we can control the wrong passing in the toll plaza. By introducing this method we can avoid the inconveniences experiencing in the toll plaza and we can also have more convenient and new generation toll plazas.

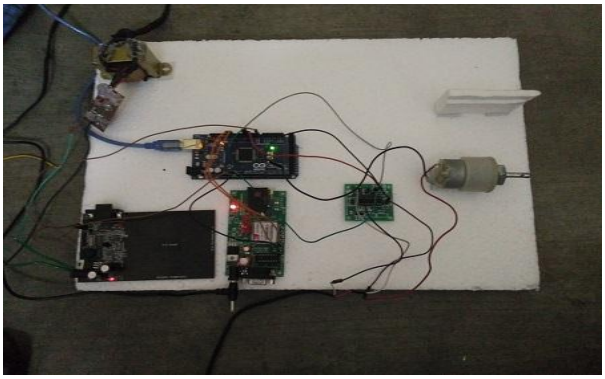

Fig.11. ATC system

5. CONCLUSION

We had introduced the automatic toll gate system controlled by ATMEL microcontroller i.e. AT89S52. It is a 40 pin IC which having the property of burning a program while running another program. It is reliable, flexible and of low cost. By practically implementing 'Automatic Toll Gate System using RFID& GSM Technology' we can provide a convenient transportation for the public i.e. we can avoid traffic congestion. It is the most efficient way of toll collection which can reduce the manual effort at the toll Plaza. We are avoiding the emergency vehicles such as ambulance, fire force etc. from the toll collection. In this busy world we give preference for time and efficiency, so for fulfilling this we can implement this kind of toll collection system.

6. FUTURE SCOPE

Designed a system to give complete result for traffic and transport related problems such as Toll gate control, traffic signal control, traffic rules violation control, parking Management and special zone alert using the RFID technology. It is proposed as a low cost optimized technique using RFID and GSM mobile technology. At the toll plaza, there will be a large LCD screen for displaying details of the transaction.

At the same time, it will show:
1. The duration of toll plaza.
2. Total cost of that road.
3. Embedded System can design for easy to Pay Toll Fees Using RFID and Alcohol sensor to Prevent Accidents on the Highways.
4. And the remaining balances after each transaction.
5. Automatic control system using RFID for toll collection powered by compound power generation from speed breakers and solar cells with GSM technology: a compound electricity generation system using speed breakers and solar cells to power the whole system automatic. This does not consume electricity from the power utility companies. Hence there are no transmission & distribution losses.
6. Implementation of image processing for data recording: In our present concept we are using the RFID system for toll collection. So we can extend the scope for centralize data recording. For that purpose we can use the Infra Re courting at the entry gate. This is followed by the Camera which will be continuing image capturing of the vehicles entering into the toll plaza. Then the RFID is collecting the vehicle number.

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Now when the vehicle passes through the Infrared Courting it tresses the outline of the vehicle, in the next step the camera will take the image of the vehicle & followed by the RFID to record the data. The load cell considers the vehicle & classifies it into two categories as light and heavy vehicle. The whole data collected together & sent to the server which will store it for stipulated time. This application will help in detecting the vehicles in the crime cases such as terrorism & smuggling of goods. It will also reduce the burden on check posts.

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