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Design an Intelligent Monitoring for Anti-Theft System Using GPS/GSM

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ABSTRACT

Abstract-In this paper introduced the principles of satellite navigation, an instrument designed to indicate the communication satellite positioning GPS, time, location and speed on the internal flash memory stores. These coordinates are time stamped, accessed by the microcontroller and sent to predetermine mobile phones via the GSM network. This paper proposes an anti-theft system to ensure car owners for avoiding car theft and finding car location after stealing, and a vehicle tracking system that works using GPS and GSM technology. The GPS readings are accessed at short regular intervals and transmitted on demand by the GSM modem under the control of the microcontroller upon the receipt of a location request SMS. With putting this memory in the computer, the program show storage areas on the map and can also send an SMS to a mobile device, position information sent with the SMS to sender. This system is designed to be permanently on and it is run on batteries that can last for very long periods before requiring a recharge. The remote module has a GPS mounted on the moving vehicle to identify its current position, and to be transferred by GSM with other parameters acquired by the automobile's data port as an SMS to a recipient station.

Keywords: Anti-Theft system, GPS, GSM, intelligent monitoring, microcontroller.

1. INTRODUCTION

Today, with technological advances and the increasing need for proper positioning and routing actually seem inadequate, many countries attempt to launch a satellite positioning systems have. Among such systems, we can mention the following:

- ✓ American (USA) Global Positioning System (GPS)
- ✓ Russian Global Navigation Satellite System (GLONASS)
- ✓ European project Global Navigation Satellite System (GNSS), that most of them are as follows:
- ✓ European Geostationary Navigation Overlay System (EGNOS)
- ✓ GALILEO positioning system
- ✓ Universal Mobile Telecommunications System (UMTS)
- ✓ Global Transportation Management (GTM)

To provide location and time information anywhere on earth, Global Positioning System (GPS) is commonly used as a space-based global navigation satellite system [1]. The tracking system currently deployed in the country utilizes the GSM system to locate the tracked object. The limitation of this system is that the GSM technology can only identify the BTS and the sector antenna under whose coverage the tracked object is located and this operation requires the services of the mobile operator whose network is used to carry the tracking information for the information to be accessed [2-3]. In wireless data transporting, Global System of Mobile (GSM) and Short Message Service (SMS) technology is a common feature with all mobile network service providers [4, 5].

The anti-theft device on the market processes passively alarm signal in many cars. Generally, it determines safety state of automobile depending on a single signal from sensor, therefore it have some defects, such as less reliability, existing phenomenon of misreport and failing to report [6, 7]. The control center can be implemented with a GSM modem and a computer system configuration or a mobile phone. The use of the mobile phone enables the control center manager to communicate with the tracker at will and allows the manager to monitor the tracker from any remote location [8]. The location information provided by GPS systems can be visualized using Google Earth [9]. Utilization of SMS technology has become popular because it is an inexpensive, convenient and accessible way of transferring and receiving data with high reliability [10].

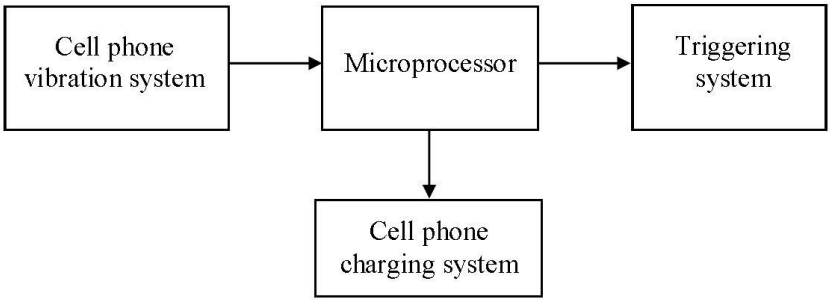

Figure 1
The overall block diagram

One of the important issues in large cities is to strengthen the car safety. Due to the apparent reasons, in this paper designing and construction of an anti-theft system is performed. Fig 1 shows the overall block

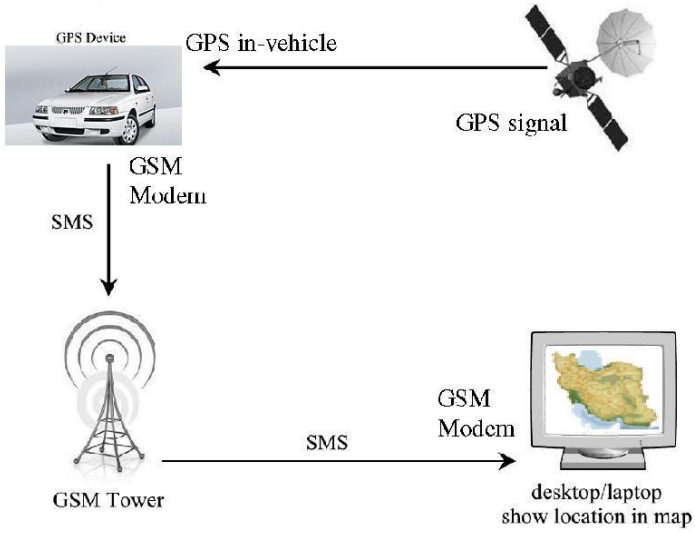

Figure 2
The block diagram of GPS tracking system

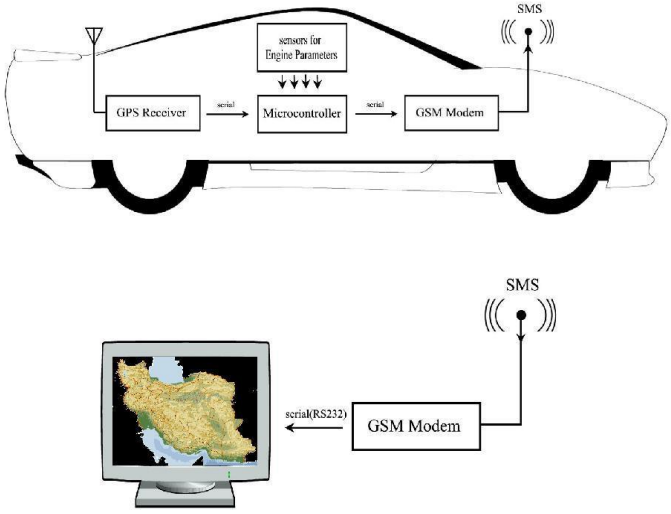

Figure 3
The system architecture: GPS tracking and GSM modules

diagram of this system [11]. Generally this system is meant to be installed for the four wheelers here is the cheapest source of an anti-theft tracking system [12].

The ability to accurately detect a vehicle's location and its status is the main goal of automobile trajectory monitoring systems. These systems are implemented using several hybrid techniques that include: wireless communication, geographical positioning and embedded applications [13]. The vehicle tracking systems are designed to assist corporations with large number of automobiles and several usage purposes. A Fleet management system can minimize the cost and effort of employees to finish road assignments within a minimal time. Besides, assignments can be scheduled in advanced based on current automobiles location. Therefore, central fleet management is essential to large enterprises to meet the varying requirements of customers and to improve the productivity [14]. As shown in Fig. 2, the proposed system consists of: in-vehicle GPS receiver, GSM modems (stationary and in-vehicle), and embedded controller [15].

The users of this application can monitor the location graphically on Google Earth; they also can view other relevant information of each automobile in the fleet [16, 17].

In this paper, the performance of the Global Positioning System (GPS) deals. It also describes how this technology is used. In section 2 is describe the GPS system, then in section 3 describe about GPS receiver and NMEA 0183 protocol. In section 4 and 5 is hardware and software specification, and in this sections describe about microcontroller. Finally, in section 6 is Anti-Theft system and in section 7 is conclusion.

2. GPS SYSTEM

The GPS system is based on 24 satellites located in six orbital planes at a height of 20,200 km and they circle the earth every 12 hours. Each plane is inclined at 55° to the earth's equator and contains 4 satellites each. The GPS system was developed and is operated by the United States government. With an unobstructed and clear view of the sky, GPS works anywhere in the world, 24 hours a day, and seven days a week. [18-20]. Each satellite transmits two signals: L1 (1575.42 MHz) and L2 (1227.60 MHz). The L1 signal is modulated with two pseudo-random noise signals - the protected (P) code, and the course/acquisition (C/A) code. The L2 signal only carries the P code while civilian navigation receivers only use the C/A code on the L1 frequency. Each signal from each satellite contains a repeating message, indicating the position and orbital parameters of itself and the other satellites (almanac), a bill of health for the satellites (health bit), and the precise atomic time [8].

GPS signals work in the microwave radio band. They can pass through glass, but are absorbed by water molecules (wood, heavy foliage) and reflect off concrete, steel, and rock. This means that GPS units have trouble operating in rain forests, urban jungles, deep canyons, inside automobiles and boats, and in heavy snowfall among other things. These environmental obstacles degrade positional accuracy or make it impossible to get a fix on the GPS location [21].

The system has two main modules, as shown in Fig. 3. The first module is the tracking device which is attached to the moving automobile. This module composes of: a GPS receiver, Microcontroller and a GSM Modem. The GPS Receiver retrieves the location information from satellites in the form of latitude and longitude real-time readings. The Microcontroller has three main tasks: to read certain engine parameters from automobile data port, to processes the GPS information to extract desired values and to transmit this data to the server using GSM modem by SMS. The chosen engine parameters are: RPM, engine coolant temperature, vehicle speed, percent throttle [13].

The second module consists of a recipient GSM modem and workstation PC. The modem receives the SMS that includes GPS coordinates and engine parameters. This text is processed using a Visual Basic program to obtain the numeric parameters, which are saved as a Microsoft Office Excel file. The system's efficiency is dependable on the sufficiency of the used communication network [13].

Table 1. GPS data format and field descriptions [21]

Field	Description
1	Latitude in ddmm.mmm format. Leading Zeros transmitted
2	Latitude Hemisphere indicator, 'N' = North. 'S'= South
3	Longitude in ddmm.mmm format. Leading Zeros transmitted
4	Longitude hemisphere indicator, 'E' = East, 'W'=West
5	UTC time in hhmmss.ss format. 000000.00~ 235959.99
6	Status, 'A' = valid position, 'V'= navigation receiver warning
7	Mode indicator: 'N'= Data Invalid 'A'= Autonomous 'D'= Differential 'E'= Estimated
8	Checksum

Latitude and longitude of current position, time, and status are in format shown in Eq. (1).

$GPGLL, <1>, <2>, <3>, <4>, <5>, <6>, <7>*<8><CR><LF> (1)

The description of the data content of each field is shown in Table 1.

The GPS Visualizer is a free online utility that can be used to graphically display a track or series of waypoints, and create maps and profiles from GPS data. GPS Visualizer can read data files from many different sources, including raw NMEA strings or tab-delimited or comma-separated text of relevant GPS data [22].

3. The GPS receiver and NMEA 0183 protocol

3.1. GPS receiver GM-R500

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Figure 4

GM-R500 GPS receiver

In this paper, the GM-R500 GPS receiver is used. The GM-R500 GPS receiver (Fig.4) provides EverMore's latest 12-channel GPS technology, contained inside a mouse-like box with a host connection cable. The GM-R500 pushes forward EverMore's high standard for rapid startup time and high performance in foliage and urban canyon environments.
Applications will benefit from improved reliability provided by the new 500 GPS receiver. The Receiver applies the latest semiconductor technology to reduce power consumption and provide robust performance. The GM-R500 feature set includes NMEA-0183 output, one serial I/O, and position & velocity filtering. With Flash-based program memory, the firmware is upgradable, thus protecting your GPS investment [23].

The GM-R500 is an all-in-one GPS receiver that is designed for the end-users with less understanding on GPS knowledge. It is ready for use with PDA, Notebook, and PC in various situations: Marine, Land Survey, travel assistance and Vehicle tracking [23]. Some of GM-R500 GPS receiver specifications are in Table 2 (in Appendix).

3.2. The NMEA 0183 protocol

Table 3. NMEA 0183 parameters	
Baud rate	4800
Number of data bits	8 (bit 7 is 0)
Stop bits	1 (or more)
Parity	none
Handshake	none

The National Marine Electronics Association (NMEA) is a non-profit association of manufacturers, distributors, dealers, educational institutions, and others interested in peripheral marine electronics occupations. The NMEA 0183 standard defines an electrical interface and data protocol for communications between marine instrumentation [24]. NMEA has also established a working group to develop a new standard for data communications among shipboard electronic devices. The new standard, NMEA 2000, is a bi-directional, multi-transmitter, multi-receiver serial data network. It is multi-master and self-configuring, and there is no central controller [24]. NMEA 0183 devices are designated as either talkers or listeners (with some devices being both), employing an asynchronous serial interface parameters, shown in Table 3.

NMEA 0183 allows a single talker and several listeners on one circuit. The recommended interconnect wiring is a shielded twisted pair, with the shield grounded only at the talker. The standard dos not specify the use of a particular connector. Note: The new 0183-HS standard (HS = high speed) introduced in version 3.0 uses a 3-wire interface and a baud rate of 38400. This type of interface is not discussed here. It is recommended that the talker output comply with EIA RS-422, a differential system with two signal lines, "A" and "B". Differential drive signals have no reference to ground and are more immune to noise [24]. However, a single-ended line at TTL level is accepted as well. The voltages on the A line correspond to those on the TTL single wire, while the B voltages are inverted (when output A is at +5 V, output B is at 0 V, and vice versa. This is the unipolar RS-422 operation. In bipolar mode ±5 V are used). In either case, the recommended receive circuit uses an opto-isolator with suitable protection circuitry. The input should be isolated from the receiver's ground. In practice, the single wire, or the RS-422 "A" wire may be directly connected to a computer's RS-232 input. In fact even many of the latest products, like hand-held GPS receivers, do not have a RS-422 differential output, but just a single line with TTL or 5 V CMOS compatible signal level [24]. All data is transmitted in the form of sentences. Only printable ASCII characters are allowed, plus CR (carriage return) and LF (line feed). Each sentence starts with a "$" sign and ends with <CR><LF>. There are three basic kinds of sentences: talker sentences, proprietary sentences and query sentences [24].

4. HARDWARE SPECIFICATION

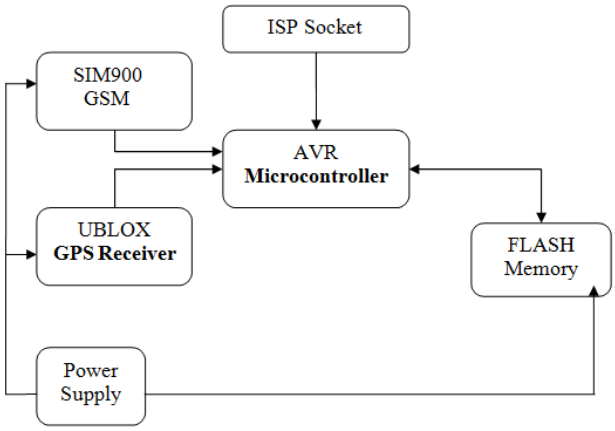

Figure 5

Block diagram of hardware

In this section hardware overview description, block diagram of hardware as shown in Fig. 5, consists of two main inputs: The first received input is the GPS output, which has a sentence based on NMEA 0183 standard. For this study, we chose certain parameters to show the status of the engine: RPM, engine coolant temperature, vehicle speed and percent throttle.

The GPS receiver is EverMore GM-R500. The GPS module supports up to a 10Hz update rate. The microcontroller is the main operational unit of the tracking device. The GPS receiver collects the latitude, longitude and speed information and forwards them to the microcontroller [25]. The GSM module communicates with the microcontroller to send the information package to another GSM Module at the recipient station. The tracking unit is designed to be powered by the automobile battery. However, a power source is built-in the device as an emergency backup.

4.1. Microcontroller

The Microcontroller is a single chip containing a microprocessor, memory (RAM and ROM), input /output ports, timers and serial ports and it is designed for embedded control applications. The prime use of a microcontroller is the control of a machine or system using a fixed program stored in the ROM and this program does not change over the life time of the system. The microcontroller is the brain of the system. It accesses the memory location data from the GPS module and compares them with data stored in the memory. It then sends the names of the five consecutive locations to a predefined phone number and to the control center. In the event that the tracked object is out of the range of the GPS locations stored in the memory, the microcontroller will send the GPS coordinates alone [8]. Microcontroller used in this paper is ATMEGA32 shown in Fig. 6, AVR series of microcontrollers. AVR microcontrollers are divided in three classes TINY, AT90S and ATMEGA; ATMEGA is of more capable than the other AVR's. All AVR microcontrollers architecture with RISC, can execute most instructions in one clock cycle and point them towards some microcontrollers, such as MCS8051 series of microcontrollers which are ordered in the 12-hour cycle, distinguishes [23]. The high-speed this microcontroller and powerful compilers like Code Vision BASCOM and justification for their use in this paper. ATMEGA32 microcontroller using BASIC software and despite its complexity, is easy to understand. In this case, the design of the modular structure of the microcontroller we used seems. The main body of the program is very short. After some practice initializations, Show Main Menu is executed and continues to be assigned to this function.

5. SOFTWARE SPECIFICATION

The engaged GPS Module has NMEA 0183 Protocol for transmitting GPS information to a PC. It provides current time, date, latitude, longitude, altitude, speed, and travel direction/heading, among other data, and can be used in a wide variety of commercial applications, including navigation, tracking systems, mapping, fleet management, auto-pilot, and robotics [21]. This protocol consists of several sentences, starting with the character $, with a maximum of 79 characters in length. The NMEA Message to read data with both position and time is: $GPRMC [26, 27]. Therefore, only the $GPRMC information is used to determine the location of the automobile to reduce SMS text. The status of the automobile along with $GPRMC information is sent

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by the GSM modem of type EverMore GM-R500. Consequently, the recipient GSM, also has NMEA 0183 protocol, receives the transmitted SMS to obtain GPS coordinates and status information of the automobile.

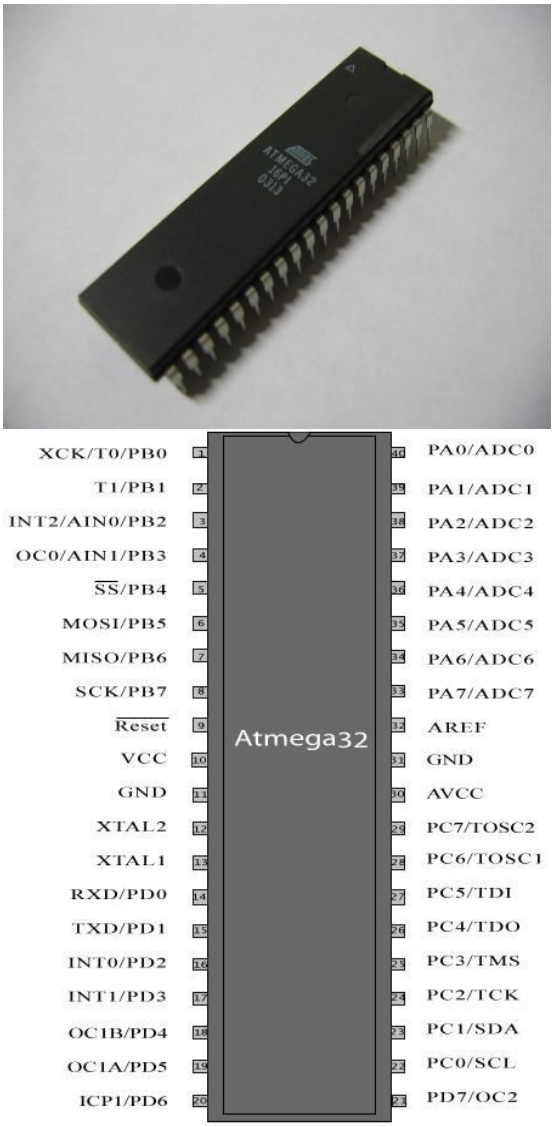

Figure 6
ATMEGA32 microcontroller

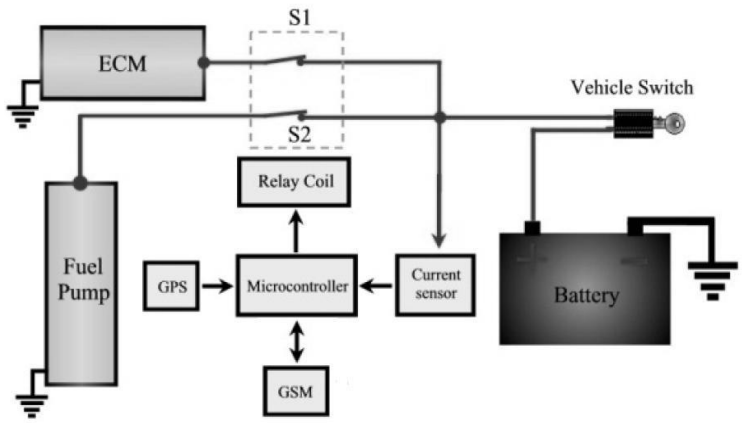

Figure 7
Structure of Anti Theft system

Figure 8
Mobile Anti Theft Application

6. ANTI-THEFT SYSTEM

Structure of Anti Theft system has two main units; the first is security unit which is embedded in the vehicle. This unit consists of: a GSM modem, GPS receiver, control relay, current sensor and Microcontroller as shown in Fig.7 [28]. The current sensor will send an analog signal to the microcontroller when the car is running. The microcontroller will send SMS directly to the owner to confirm that. NC control relay contacts are connected with the hot line that powers the fuel pump and ECM. The microcontroller can send a signal to the relay to cut off the power, when received SMS contains code from owner mobile to stop it. The GPS Receiver retrieves the location information from satellites in the form of latitude and longitude readings in real-time [29].

Mobile Anti Theft System (MATS) is a project which is based on GPS satellite tracking system which is been used by cars and road transport industry from years. GSM phone tracking is likely to show the radius in which the phone is location but not the exact place and even accuracy depends on factors like network coverage, landscape and weather conditions also. When we couple GPS with Google maps the postal address of the lost mobile can be found accurately [30]. Mobile anti theft system is a project which helps us to track the location of the smart phones. It consists of Android client application which will automatically send SMS when SIM card is changed (Fig. 8). Position tracker works on Global Positioning System (GPS) and GPRS. When requested MATS will fetch latitude and longitude satellites and send it as a SMS, moreover if mobile is connected to the internet it retrieves the postal address from Google maps [31].

7. CONCLUSION

This system utilizes the signal strength monitoring feature of the GSM modem. The microcontroller is the brain of the system and the GSM modem controlled by AT commands facilitates data transmission over GSM network while the GPS module provides the location data. The system will provide accurate data in a timely manner such that it will enable the security agencies to know the location of the tracked object and facilitate an early recovery of the tracked objects. Anti-theft system designed and built in this research is a dynamic anti-theft system. This means that after stealing the car owner car can calls number assigned to this system and trigger his car in each geographic and then thieves cannot turn on it again. The GPS readings are accessed at short regular intervals and transmitted on demand by the GSM modem under the control of the microcontroller upon the receipt of a location request SMS. With putting this memory in the computer, the program show storage areas on the map and can also send an SMS to a mobile device, position information sent with the SMS to sender. The system is designed to be permanently on and it is run on batteries that can last for very long periods before requiring a recharge. The remote module has a GPS mounted on the moving vehicle to identify its current position, and to be transferred by GSM with other parameters acquired by the automobile's data port as an SMS to a recipient station.

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APPENDIX

Table 2 GM-R500 GPS receiver specifications

Features	Description
General	L1 1575.42MHz, C/A code, 12-channel, Carrier-Aided with HWTrack©
Sensitivity	-143 dB minimum
Update Rate	1Hz
Accuracy	Position: 15m CEP without S/A Velocity: 0.1 m/sec without S/A Time: ± 1µs
WAAS Accuracy	Position: 5m CEP Velocity: 0.05m/sec
Acquisition	Cold start: < 120sec (typical) Warm start: < 45sec (typical) Hot start: < 15sec
Reacquisition	< 100msec
Dynamics	Altitude: -1000m to 18000m Velocity: 500 m/sec Acceleration: ±4g
Protocol	EverMore Private @ 4800/9600 baud, 8-None-1 NMEA-0183 v2.20 @ 4800/9600 baud, 8-None-1
NMEA Message	GGA, GLL, GSA, GSV, RMC, and VTG
Interface	PS/2 or RS-232 or USB
Dimension/Weight	56mm x 53 mm x 22.5 mm/ 81g

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