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Platform Attitude Data Acquisition System

Sanjeev Afzulpurkar

National Institute of Oceanography, Goa - 403 004.

Abstract

A system for automatic acquisition of underwater platform attitude data has been designed, developed and tested in the laboratory. This is a micro controller based system interfacing dual axis inclinometer, high resolution digital compass and an echo ranging altimeter. Additional analog channels are available for further expansion of the system. Large number digital input / output TTL compatible lines provide flexibility for future developments. Real time clock based acquisition enables user to select required time interval. The design provides sufficient battery backed memory to log data and can provide a serial output of the same to any other instrument. The data obtained can be transferred, on retrieval, to an IBM compatible Personal Computer. Turbo C has been used to write a program to convert raw data to appropriate sensor values. These are displayed on the screen with simultaneous archival. This system can be advantageously used to monitor two dimensional attitude of an underwater platform and close to seabed (<99 Meter height) can monitor even vertical movement. It can also be made applicable to any system requiring this kind of information.

Introduction

Any underwater package, whether it is a sampling device or a highly sophisticated system, when deployed in the ocean is subjected to different forces due to the prevailing surface and subsurface conditions.

The surface conditions are a result of sea state, which affects dynamic behaviour of any floating platform. It is subjected to rolling, pitching, heaving and drift. As this is the launching platform for all data and sample collection, these dynamic motions are coupled to the underwater device. Additionally underwater currents subject these devices to abnormal movements in two and three dimensions. These manifest in the form of roll, pitch, heave, yawing and sometimes drifting. As these instruments are generally designed to perform under stable conditions, the data obtained are not very accurate and must be subjected to compensation for. Even under very normal operating conditions it is necessary to monitor the behaviour of these system to correct these anomalies.

This requirement becomes almost imperative in case of underwater television and still camera systems, towed platforms, autonomous underwater vehicles, remotely operated vehicles and submersibles. Some of the latest sampling systems also need to have this information to monitor the system during lowering and just prior to touchdown.

A system, which realizes some of these requirements, is designed around Intel 8051, 8-bit micro-controller that provides necessary capability to run the system software and large data storage facility. This system is described in the following pages.

System Configuration

The 8-bit micro-controller Intel 8051, Anon. [1], can directly address 64 KB blocks of program and data memory, which can be expanded further if required. In addition the micro-controller has a full duplex serial port supported by two 16 bit timer / counters. It also has two 8-bit ports, one of which is used as a special function port that outputs the read / write signals along with interrupt and timer functions. The remaining port can be used for normal I/O operations. It can also be used to decode signals for selection of peripheral devices.

The system design provides an 8 channel analog multiplexer and a high resolution 12-bit ADC using Analog Devices AD 574A, Anon. [2]. An Intel 8251A Universal Serial Asynchronous Receiver and Transmitter (USART), Anon. [3] and Maxim MAX 232 RS 232 driver chip provide an additional full duplex serial port for downloading data to a PC. A real time clock MM 58167A, Anon. [4], provides the time keeping capability. In addition an Intel 8255 Programmable Peripheral controller, Anon. [5], gives the system much needed digital input / output capability.

The full system is shown in Fig. 1 in a block diagram form. From the figure it is seen that fully buffered address, data and control buses interface all the hardware necessary to connect different sensors. The additional serial port can be utilized to connect a Personal Computer (PC) or any other instrument with serial port capability. The dual axis inclinometer, Anon. [6], is connected to two separate analog channels. These channels are capable of handling inputs from 0 to 10V Dc. The digital compass, Anon. [7], is connected to micro-controller serial port through level translator MAX 232. This compass can be configured to any type of output namely serial, digital or analog. The echo ranging altimeter Anon. [8] is connected to PPI port C. Entire operation of the system is based on real time clock, which provides time ticks for data acquisition. Data obtained is stored in the data RAM bank formed by two 32 KB RAM chips 62256. With battery back up capability provided by a 3.6V rechargeable battery, it can retain the data for days. The system program is stored in an electrically programmable ROM. The capacity of this can be increased from 16 to 64 KB by way of appropriate jumper selection.

The operation is controlled by system software, Fig. 2, which is divided in five parts. These are the

- 1) Front Page Module. (FPM)
- 2) Self Test Module. (STM)
- 3) User Entries Module. (UEM)
- 4) Data Acquisition Module. (DAM)
- 5) Data Processing Module. (DPM)

The system software runs in above order. In FPM, the system first displays appropriate power on messages. This message is held for a minute for the user's information. The STM basically tests all essential hardware for proper operation. In initial stage it checks the system software in EPROM by checksum method. If any error is detected in the checksum, EPROM error is indicated. A RAM test follows in which all RAM locations are

tested by a read after write operation. A failure message is flashed if any location is found faulty. The RTC is checked for proper functioning by first resetting it then checking it against a predetermined interval of time. If during this test any deviation in the value of RTC is found then an RTC error message is flashed indicating a hardware failure. The next test checks Analog to Digital converter by switching the analog multiplexer high channel to which a fixed reference voltage is connected. This is digitised value and compared against the expected standard value. An error more than a few digits indicates an overall error in the ADC / multiplexer chain.

On completion, the system software embarks on acquisition of user parameters. These include data such as Ship name, Station number, Latitude and Longitude, Depth etc. In addition a sensor-enabling sub-module allows user to select the sensors of his choice to log appropriate data for application in hand. Results of STM and the user entries are as shown in Fig. 3. During enabling of sensors, the module checks for only proper entries so that no error is encountered subsequently. These are stored in memory for enabling / disabling of respective sensor software modules. On completion of above module, the data acquisition phase is entered in DAM module. This checks the entries made against each sensors and starts collection of data at the specified interval of time entered during the sensor enabling phase. In this module, once acquisition is begun, all sensor data are collated along with time from the RTC. A full record is stored on the RAM. The software next executes a wait loop till the RTC wakes DAM module upon generation of a time based interrupt to CPU. The CPU acknowledges this interrupt by executing another cycle of data acquisition loop. The data collected can be downloaded to any IBM compatible PC through standard RS 232 port to a file. This file is subjected to some post processing to extract individual sensor data and present it in a tabular format for user analysis. This part of the software is written in Turbo C language. The operational logic of the software written in Turbo C is shown in Fig. 4. The program first reads all the data bytes, which are stored in Hex ASCII format. Figure 5a shows an example of raw data as acquired. Appropriate data bytes are extracted and assigned to a variable representing the sensor and converted to required format. Individual modules are then invoked to calculate sensor data values and are displayed on screen as shown in Fig. 5b.

Conclusions

The system has been primarily designed to collect data on underwater platforms, especially with towed ones in mind. Its applicability can be wide ranging. Further improvements can be carried out by adding accurate tilt and altimeters sensors. The presentation of the data can be greatly enhanced by writing modules to generate graphs of the variables against time. As spare analog channels are present other sensors with 0 - 10 VDC output can be added to enhance the system capability. The micro-controller can also be effectively used for controlling system behaviour but that would mean extensive hardware and software additions.

Acknowledgments

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References

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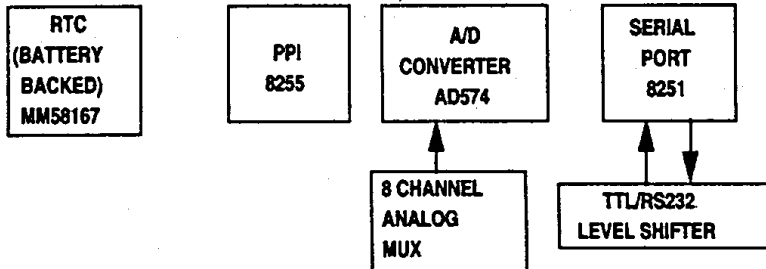
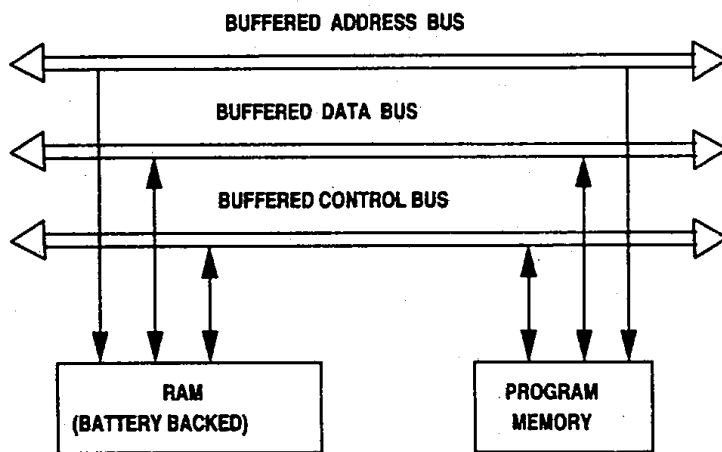
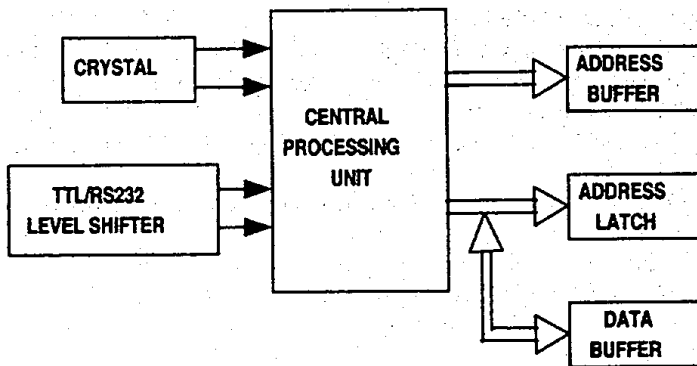


Fig. 1 BLOCK DIAGRAM OF DATA ACQUISITION SYSTEM

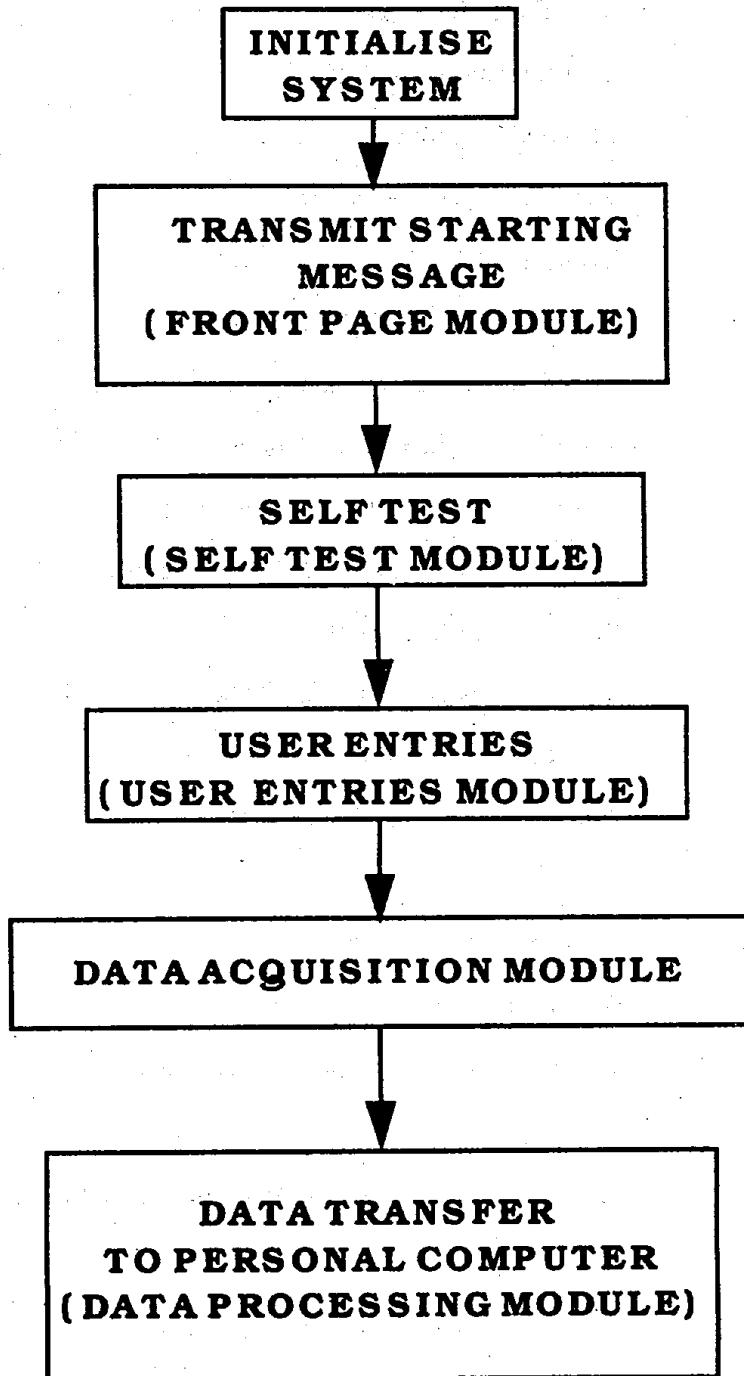


Fig.2. SYSTEM OPERATION

SYSTEM SELF TEST

System Manager test-PASS

Data RAM Test-PASS

Real Time Clock Test-PASS

Analog to Digital Converter Test-FAIL

SYSTEM SELF TEST COMPLETED

Enter Date (dd-mm-yyyy):12-07-1997

Enter Time (hh-mm-ss):14-35-60 6

Enter Latitude (dd mm sss N/S):15 23 123 S

Enter Longitude (ddd mm sss E/W):73 48 456 W

Enter Heading (ddd.m):256.4

Enter Depth in meters (xxxx.x):1234.5

Enter Station no. :SK/100/3

Enter Vessel name :SAGARKANYA

Enable Sensors ? (Y/N)

1) Compass -Y

2) Tilt -Y

3) Altimeter -Y

Interval for acquiring data (1 or 2 minutes)-1

Fig. 3. Self Test, User Entries and Sensor Enabling.

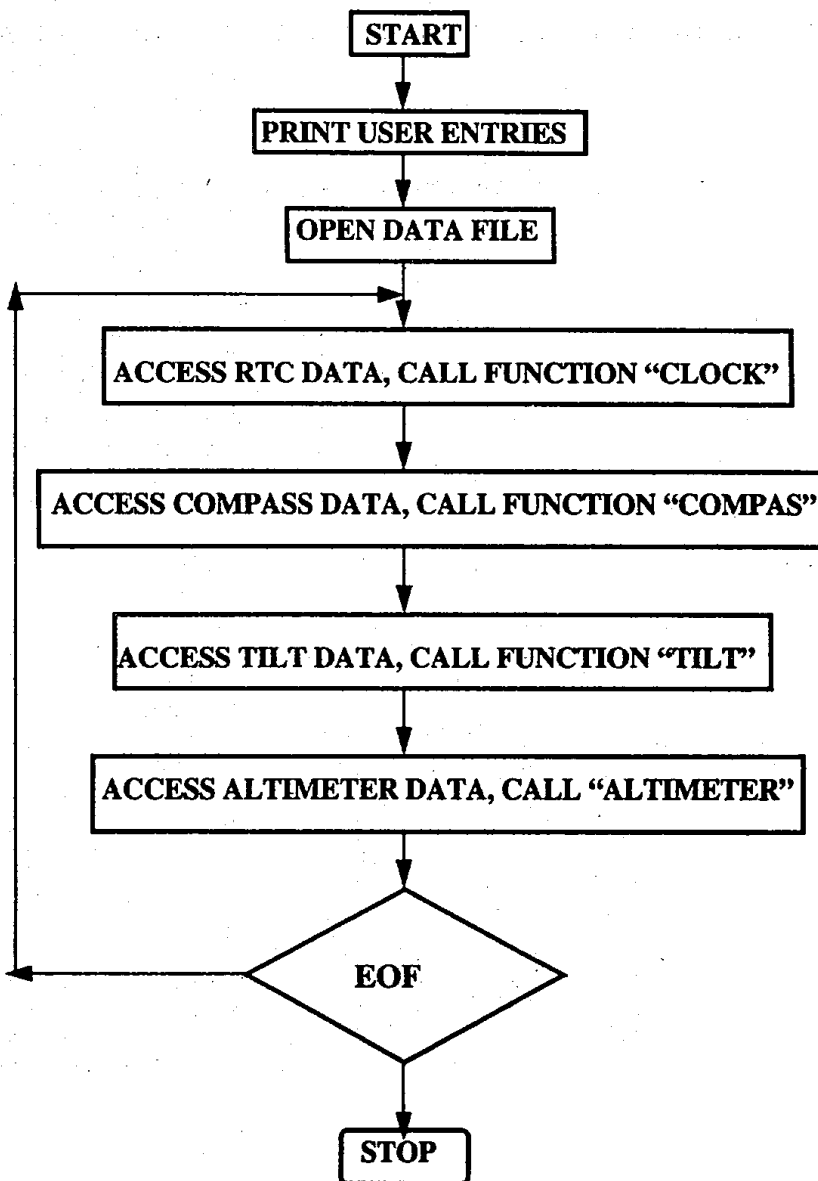


Fig. 4. POST ACQUISITION DATA PROCESSING

31322D30372D3139393731332D32302D3435323320313220313233204E333435203233203
 1323320453130382E34313233332E35534B2F3130302F3053414741524B414E5941595959
 59590101

Fig. 5a. Raw data in RAM. (Hex format)

DATE : 13 07 1997	TIME : 13:20:45
LATITUDE : 23°12'123''N	LONGITUDE : 345°23'123''W
HEADING : 108.4	DEPTH : 1233.5-meters
STATION NO. : 58 100.0	VESSEL : SACARKANYA

TIME	COMPASS	ROLL	PITCH	ALTIMETER	TEMPERATURE
13-21-0	158.1	+0.906	+3.156	99.900	29.026
13-22-0	158.1	+0.766	+2.547	99.900	28.936
13-23-0	181.2	-4.781	+2.891	99.900	31.154
13-24-0	206.5	-0.375	-3.203	99.900	29.141
13-25-0	206.5	-0.625	-3.078	99.900	29.920
13-26-0	206.3	-0.620	-3.172	99.900	29.141
13-27-0	206.4	-0.625	-3.203	99.900	28.987
13-28-0	206.5	-0.734	-3.094	99.900	29.141
13-29-0	206.5	-0.375	-3.141	99.900	29.141
13-30-0	206.5	-1.141	-2.969	99.900	29.090
13-31-0	206.5	-0.766	-3.078	99.900	29.128
13-32-0	224.7	-3.656	-5.734	99.900	28.321
13-33-0	224.7	-4.266	+5.609	99.900	28.679
13-34-0	224.7	-3.953	-5.797	99.900	29.154
13-35-0	224.8	-3.875	+5.750	99.900	29.013
13-36-0	224.8	-3.859	+5.969	99.900	29.103
13-37-0	224.8	-4.094	+5.750	99.900	28.987

Fig. 5b. Processed and printed data.