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MONITORING DEVICE FOR OPERATING CLIMATIC CONDITIONS LIGHT AIRCRAFT

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Abstract—*The article deals with the necessity of information-computation systems development on light aircraft operating conditions monitoring factors. Requirements are imposed for an experimental sample of an on-board nonvolatile instrument for operational monitoring of airframe operation climatic conditions. Described the results of its implementation and testing.*

Index Terms—Light aircraft; operating conditions; temperature and relative humidity of air.

I. INTRODUCTION

Operating conditions of transport impose significant imprint on their technical condition, with a change in the cost of their technical operation. This applies to both transport means and means sea and air transport. In this connection it is necessary to take account of conditions of vehicles, and with it the need to develop information and measurement systems to assess factors conditions.

So for light aircraft need to develop information and measurement systems to assess factors conditions of light aircraft, both during the flight and when he was parked disclosed in [1]. Based on the results of a comprehensive assessment of the impact factors of conditions for the technical condition of the aircraft and an analysis of the technical documentation types of aircraft indicated that a significant impact on their technical condition providing high and low temperature combined with high humidity and rainfall.

The urgency of the decision on the establishment of the said information and measurement systems proved in [2], indicating that the investigation of aviation accidents and incidents manufacturers of aircraft should make efforts to collect data and information on extreme weather events and sharing based on an analysis of events which they inform the operator.

Along with this there is a need to gather information on the impact of climatic factors conditions for aircraft structures made from polymer composites. Numerous studies in the field of climate aging of polymeric composite materials made BIAM employees [3]–[5] show that the main factors that cause aging climatic polymer composite is temperature and humidity. This is not so important temperature as the temperature design based heating by solar radiation, in which even at low ambient temperatures of test samples have positive temperatures. Raising the temperature increases the flow of sample physical and chemical processes of aging. And for example, the impact wind has virtually no effect on the temperature of the samples.

II. PROBLEM SOLUTION

All of the above are prerequisites for the creation of airborne volatile device operative monitoring of relative humidity and temperature, and the temperature airframe structural elements.

The main requirements that apply to the above product should include complete independence of operation of the aircraft, and no need for re-equipment of the aircraft under the proposed device.

The device does not interfere with aeronautical radio equipment and aircraft to change its flight performance.

Also, the device being developed should provide a discrete record data coming from sensors on the built-in memory formats available for reading and processing programs MS Excel, etc. Matlabta.

Device Management (changing the parameters of its diagnosis and reading of information) should be provided using the configure-installed on a personal computer and executed employee of aircraft maintenance.

Feasibility Prototype onboard device operative monitoring volatile climatic conditions aircraft structures has been developed at the Department of NAU aircraft aviation equipment under the working title "MeteoTracker" (Fig. 1.) One of the main requirements – energy independence – implemented by providing the device from the battery voltage of 3V CR 2032 and the use of electronic components with low power consumption. The design of the device is based on the debug board NUCLEO-L152RE based microcontroller

STM32L152RET6. This card is compatible with expansion modules 3 and ArduinoUnoRevisionSTMicroelectronics Morpho.

As used precision sensors, modular sensors HTU21D, thermoresistive heads are equipped with temperature sensors and capacitive relative humidity sensors. Measuring range of relative humidity is 0–100% with an accuracy of ± 2%. Temperature measurement range of -40ºC to 105ºC with an accuracy of ± 0,3ºC.

Recording data from sensors carried on chip memory SST25VF032B-80-4I-S2AF capacity of 32 MB as a file format .txt.

The device operates in two modes: monitoring mode and connecting to a PC. Changing the work carried permutation Jumpers and RESET button on the debug board. To communicate with a personal computer device has a virtual serial port based on FTDI FT232RL. Evaluation and change the parameters of the device, and download recorded data from the memory chip device to a personal computer through a program Configurator “MeteoTrackerConfig”, the window of which is shown in Fig. 2.

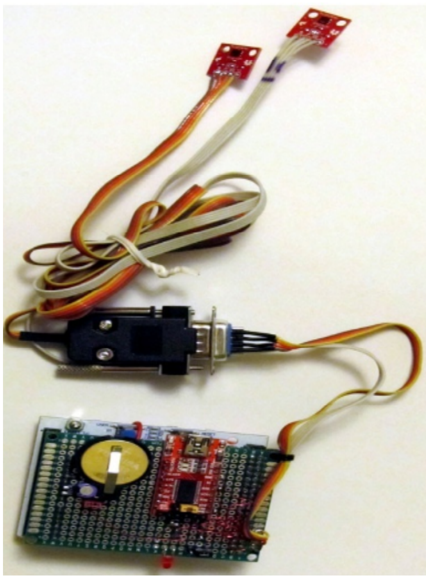

Fig. 1. General view “MeteoTracker”

The window to configure the program includes the following positions:

– ComPort – port selection device connected to a personal computer;

–ReadConfig –read current settings of the device;

– Periodreaddatasensors – read and change the frequency of reading information from sensors in monitoring mode. The period is set within 10 – 600 s, while the installed capacity 32 MB memory chip ensures data recording over 19 to 1.165 days, respectively;

– DateandTime – reading and setting / time synchronization of the internal clock of the device;

– Flash-memorydata – check filling level of the memory, cleaning it and upload the data file on a personal computer;

– Checkingsensors – diagnostics of sensors.

The efficiency of the device was tested in the period from late April to early June all-metal aircraft, which at the time the experiment was in storage. Sensor devices were placed on the console wings, namely the one in the inner cavity console wings, and the second – under the protective cap on the wing.

Analysis of the data was performed by charting changes in temperature and relative humidity, and comparing them with data in Kirovohrad provided by Ukrainian Hydrometeorological Center (UHMTS).

Generally there are three types of curves combination of daily changes in temperature (Fig. 2):

– Type A is characterized by overall dynamics and small deflection temperature inside and outside the wing compared with the temperature UHMTS;

– Type B is characterized by general dynamics, but there is a significant difference in temperature inside and outside temperature UHMTS on the wing;

– Type C is characterized by different dynamics and temperature difference inside and outside temperature UHMTS on the wings.

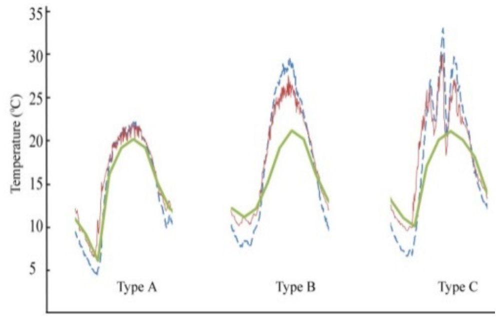

Fig. 2. Type a combination of curves daily temperature changes

A similar situation with a combination of curves of daily changes in relative humidity (Fig. 3).

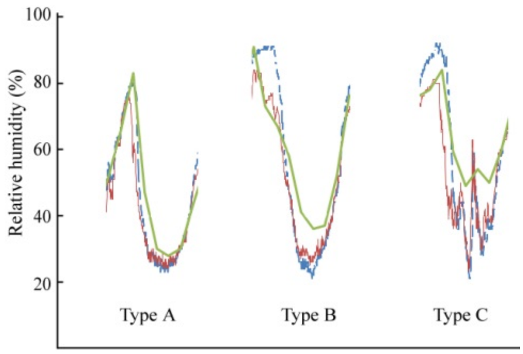

Fig. 3. Type a combination of curves of daily changes in relative humidity

As shown in flight schedules, data provided by Ukrainian Hydrometeorological Center may differ significantly from the actual values indeed possible fluctuations in value not reflected it.

III. Conclusions

Tests of a developed unit showed its full efficiency of the declared functionality. In turn, the weight has been achieved without the device housing about 100 ºC and dimensions of 70 × 55 × 30 mm.

For full integration tool developed in light maintenance, including teaching and training, aircraft need to develop a number of methods, including:

– method of determining the optimal zone placing sensors on-board non-volatile device operative monitoring environmental conditions in the construction type of training a light aircraft;

– method of processing and using information from the onboard device operative monitoring volatile climatic conditions of training light aircraft in the system of maintenance.

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О. Л. Пузирьов, О. М. Алєксєєв, В. В. Лефтор. Прилад для оперативного моніторингу кліматичних умов експлуатації легких літаків

Розкрито питання необхідності розробки інформаційно-вимірювальних систем для моніторингу факторів умов експлуатації легких повітряних суден, встановлені вимоги до дослідного зразка бортового енергонезалежного засобу оперативного моніторингу кліматичних умов експлуатації авіаційних конструкцій. Описані результати його реалізації і випробування.

Ключові слова: легкий літак; умови експлуатації; температура і відносна вологість повітря.

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О. Л. Пузырев, О. Н. Алексеев, В. В. Лефтор. Прибор для оперативного мониторинга климатических условий эксплуатации легких самолетов

Раскрыт вопрос о необходимости разработки информационно-измерительных систем для мониторинга факторов условий эксплуатации легких воздушных судов, установленные требования исследуемого образца бортового энергонезависимого средства оперативного мониторинга климатических условий эксплуатации авиационных конструкций. Описанные результаты его реализации и испытания.
Ключевые слова: легкий самолет; условия эксплуатации; температура и относительная влажность воздуха.

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