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A NOVEL APPROACH FOR INTERNET OF THINGS BASED INTELLIGENT WEATHER DATA ACQUISITION IN AIRCRAFT

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ABSTRACT

Today, every device which is connected to the Internet collects, shares and augments data of each other. This key feature fosters researchers to use the power of sensors while designing intelligent and cognitive systems. One of the widespread usage area of sensors is weather data acquisition because of their place in internet of things. In previous works, it is not found a well-coordinated approach for collecting and sharing weather data in aircraft. In our approach, we propose a novel system which has the capability of self-exploring, self-learning and self-decision under different weather circumstances. An aircraft equipped by powerful sensors is expected to designate its next step according to weather data including deciding whether to fly or flight safety while on air. By applying genetic (evolutionary) algorithm to aircraft sensors, it becomes possible to optimize parameters of remote sensing devices and analyze them in terms of weather data. According to IOT mechanism of our system, it is provided for all electronic devices to be labeled and to be ready for data exchange. Despite the fact that every mechanism works properly in our system, one prominent limitation becomes discontinuous data flow between different sensors. As a result, our system becomes capable of preventing problems while weather data is being shared among different devices.

***Keywords*:** Weather data, sensors, big data, internet of things, machine-to-machine (M2M) interaction

1. INTRODUCTION

Today, it is a big challenge to combine internet of things elements with space environment. With dramatic increase of the amount of sensor data, putting it into service for a special purpose aircraft via smart interfaces gains in importance day by day. Realizing the algorithm is one of the main goals to achieve of this work.

Obtaining and saving data from physical things is called data acquisition. This process includes both event and condition data. Event data is about what is going on and what the condition data constitute [1]. Monitoring an event (e.g. weather) can either be continuous or periodic. Continuous one is generally automatically realized by sensors. As for periodic monitoring is accomplished by humans and includes checks at certain intervals. Monitoring is a tough and costly task for aircraft [2]. Because of the fact that weather can significantly affect aircraft operations, placing smart sensors and optimizing them during a flight operation gain in importance in relation with weather data [3]. If a generic model of sensor system is designed, them it would be possible to find suitable results automatically from numerical weather data [4].

As a result, a well-coordinated approach for collecting and sharing weather data in aircraft is not found in the literature. As following, Section 2 summarizes our technique which sensors collect weather data and communicate with each other by providing reliable flight for aircraft. In Section 3, genetic algorithm that is used to optimize sensor parameters is shown for every weather variable. The results are evaluated and discussed in Chapter 4.

2. SENSOR SETUP AND COMMUNICATION MECHANISM

TAMDAR (Tropospheric Airborne Meteorological Data Reporting) System is a multi-function atmospheric sensor installed on aircraft like UAVs and weather balloons. It is also a dedicated data center for quality monitoring, archiving, and distribution systems. In our system, TAMDAR sensor system is responsible for development and integration of customized forecasts and weather applications.

Especially short-duration flights fly straight though the lower atmosphere, taking on the rain, wind, snow, ice, and other conditions that are very similar to what we feel on the ground. Weather forecasters rely on measurements of conditions made at the ground, plus a small number of weather balloons launched into the atmosphere. Our aircraft is planned to behave in a similar way. As the number of weather measurements increased dramatically, the mechanism takes advantage of the wealth of weather data that the aircraft experiences daily.

In our aircraft, TAMDAR sensor measures humidity, pressure, temperature, winds with the help of location, time and altitude provided by built-in Global Positioning System technology. Observations are sent to a expert analyzer (located in a data center) on the ground, which processes and distributes up-to-date weather information among stakeholders.

Figure 1. TAMDAR sensor attached on aircraft [5].

With global features of TAMDAR sensor system, it becomes possible to automate data collection and communication with other aircraft. Hourly and daily reports are regularly collected and displayed via a smart interface relating with real-time global aircraft position. Also a database of all flight histories are kept. This is thought to be a foundation for future operational benefits.

In our system, broadband data is uploaded/downloaded to/from aircraft. This brings about weather forecasters to have results from the aircraft and represent them graphically. Dynamic flight planning and flight path optimization are other abilities of the aircraft. Today, many researchers study on dynamic path planning problems for aircraft.

Collecting these data can really benefit all weather forecasts and weather forecasting models, because the presence of TAMDAR increases the number of observations in the lower atmosphere by a significant amount. Currently, the number of weather balloons that are used to collect temperature, wind and moisture data are increasing (not enough yet). These balloons collect twice daily atmospheric soundings.

3. SYSTEM ARCHITECTURE AND ALGORITHM

Genetic Algorithm (GA) is a learning method motivated by analogy to biological evolution. In Table 1, weather data variables and related GA initial values are set. In this system, we search the hypothesis space by generating successor hypotheses which repeatedly optimize parameters of the aircraft weather data sensor.

Table 1. Weather data variables and related features.

Variable	Feature	GA initial value
Air temperature	Mach corrected / Winds aloft	0111
Relative humidity	Water vapor data of TAMDAR	0011
Static pressure	Pressure altitude	0001
GPS	lat/long/alt/time	1000

So entire computer programs are evolved to certain fitness criteria. The hypotheses that are represented by bit strings can be easily manipulated by genetic operators such as mutation and crossover. The new population is then used in the next iteration of the algorithm.

Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached. According to single point crossover in equations (1) and (2) below:

(Appear = Air v Temp) ^ (Wind = Weak) <=> 0111 1000 (1)

IF Wind = Weak THEN FlyAircraft = YES <=> 0111 1000 0010 (2)

After choosing initial values, each individual in the population is evaluated according to the fitness function. This process repeats constantly. Then best-ranking individuals are selected to reproduce. The individual finesses of the next generation are evaluated. Finally, worst ranked part of population with next generation is replaced until terminating.

As a result, this generational process is repeated until a termination condition has been reached. Commonly, terminating conditions are

1. A solution is found that satisfies minimum criteria,
2. Fixed number of generations reached,
3. Allocated budget (computation time/money) reached,
4. The highest ranking solution's fitness is reaching or has reached a plateau such that

successive iterations no longer produce better results.

In Figure 2, the overall structure of the system flow is shown obviously.

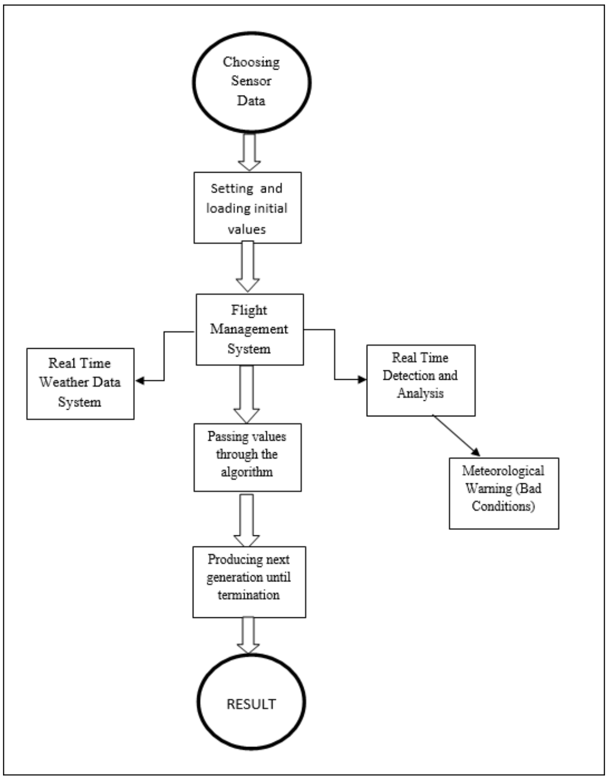

Figure 2. System flow

4. CONCLUSIONS

With dramatic increase of the amount of sensor data, putting it into service for a special purpose aircraft via smart interfaces gains in importance day by day. Because of the fact that weather can significantly affect aircraft operations, placing smart sensors and optimizing them during a flight operation gain in importance in relation with weather data.

Especially short-duration flights fly straight though the lower atmosphere, taking on the rain, wind, snow, ice, and other conditions that are very similar to what we feel on the ground. With global features of TAMDAR sensor system, it becomes possible to automate data collection and communication with other aircraft. Hourly and daily reports are regularly collected and displayed via a smart interface relating with real-time global aircraft position.

In this system, we search the hypothesis space by generating successor hypotheses which repeatedly optimize parameters of the aircraft weather data sensor. As a result, this generational process is repeated until a termination condition has been reached. This shows that our system is capable of preventing problems while weather data is being shared among different devices.

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Conflict of interests

Authors declare no conflict of interest.

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