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Algorithms for Intelligent Processing of Diagnostic Data in Multi-Parameter Objects

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ABSTRACT: Data is the building block of an establishment. It is pivotal to the organization's progress and day-to-day workflow. But the biggest challenge companies face today, despite having an abundance of data is utilizing this data in a smart way that is most relevant to their success. Handling this huge amount of inflowing data becomes challenging for the human workforce.

However, advancement in technology has made it possible today for computer trained algorithms to scan, read and understand digital and paper documents as humans do. This technology, called Intelligent Data Processing or IDP is gaining popularity in many fields.

KEY WORDS*:* artificial intelligence, big data computer vision, data mining, deep learning, image analysis, communication systems.

I. INTRODUCTION

Databases were viewed as computer systems that stored record-oriented and business data such as manufacturing inventories, bank records, and sales transactions. A database system was not expected to merge numeric data with text, images, or multimedia information, nor was it expected to automatically notice patterns in the data it stored. In the late the concept of an intelligent database was put forward as a system that manages information (rather than data) in a way that appears natural to users and which goes beyond simple record keeping.

The term was introduced in 2019 by the book Intelligent Databases by Kamran Parsaye, Mark Chignell, Setrag Khoshafian and Harry Wong. The concept postulated three levels of intelligence for such systems: high level tools, the user interface and the database engine. The high level tools manage data quality and automatically discover relevant patterns in the data with a process called data mining. This layer often relies on the use of artificial intelligence techniques. The user interface uses hypermedia in a form that uniformly manages text, images and numeric data. The intelligent database engine supports the other two layers, often merging relational database techniques with object orientation.

Intelligent data capture as the name suggests is the process of intelligently capturing specific data and streamline document processing activities. Regardless of what kind of document is to be processed, long-form or electronic, structured or unstructured, the goal of an IDP is to extract information.

The necessary data are processed by a computer to become useful information. In fact this is the definition of data process-ing. Data are a collection of facts — unorganized but able to be-organized into useful information. Processing is a series of ac-tions or operations that convert inputs into outputs. When we*1 speak of data processing, the input is data, and the output is useful information. So, we can define data processing as a se-ries of actions or operations that converts data into useful in-formation.

Information is central to an organization's workflow and it needs to be organized well. This is why data capture solutions are paramount to the organization's success. When a technology like IDP(Intelligent Data Processing) came into existence, it became discernable that adopting this technology would be a game changer for a lot of companies.

Intelligent Document Processing (IDP) is the process of intelligently capturing the domain-specific data across documents and streamline document routing activities using AI-based methods. Regardless of what kind of document needs to be processed, scanned or native PDFs, structured or unstructured, IDP serves a single purpose: to extract structured information without the need to define rules or templates.

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II.MATERIALS AND METHODS

Since, the significant portion of information in any organization's workflow resides in the form of complex documents, it highlights the need for a robust tool that can automate the processing of these documents with minimal manual involvement. This is the reason why intelligent data extraction tools are gaining paramount importance to the organization's operational success.

According to industry research, more than 80% of data within any organization is unstructured, and most of it is locked in documents. These documents can be in various forms- emails, text, PDF or scanned documents", which rules-based RPA tools alone cannot process at acceptable precision. To overcome these limitations of RPA, the IDP has recently emerged as a disruptive technology owing to its critical capability to process data without human intervention for large organizations with large volumes of documents. With IDP, the diverse teams are now able to automate data capture, classification and extraction across miscellaneous documents.

Industry Applications of IDP:

A diverse range of industries can benefit from the Intelligent Document Processing (IDP) technology. Here is a rundown of some of the areas in which IDP plays a significant role in improving the productivity of various teams in the organization.

1. Accounting

Accounting is one sector that generates quite a heavy amount of paperwork and documents. Documents like invoices, bills, contracts, and receipts which are mostly generated in the paper format result in lesser efficiency and stunted productivity. However, with the help of IDP technology, accounting teams can automatically process the documents and extract key information from those.

What organization achieves is that it shrinks the processing time, eliminates human errors and lessens the processing costs by an average of four times that of the cost of using manual data entry. Besides, with accurate processing of data, the risks of late payments are considerably reduced and companies can capitalize and build their revenue.

2. Foreign Currency Reconciliations:

Automation not only simplifies but also speeds up your reconciliation processes, without compromising on accuracy. IDP can handle smoothly and efficiently the repetitive tasks like transaction matching, thus offering you the capability to drill down on the open entries and exceptions that specifically need additional attention. The result? Spares more quality time for the team to develop strategically important & qualitative activities.

3. Legal

Legal service providers deal with processing a plethora of documents every day, that literary range from archiving and auditing documents, mergers and acquisition-related documents, property filings and following compliance regulations to maintaining customer response times. Majority of these involve complex documentation at each stage. Apart from this, lawyers find themselves referring to volumes of information in the midst of working on a case. The paperwork for their client/s is often handled by an associate manually and hence is prone to discrepancies and errors. Employing an automated system that uses IDP to manage data and documentation maintains security and improves the quality of work.

4. Medical records:

In the healthcare industry, maintaining records of patients is cardinal. Easy and on-demand access to information can be the need of the hour in the cases of emergency and hence, digitization of all paperwork pertaining to patients becomes critical. When a doctor needs to access a particular file, it becomes a task to scan through all the paperwork in various reports to find what they're looking for. With the help of IDP, all records and medical diagnostics can be extracted from various reports of patients' medical history and only related information can be accessed when required.

5. Employee Reimbursement Claims Frauds Detection:

III. DISCUSSIONS AND RESULTS

Company employees make fraudulent claims that charge a lot to the company. Manual reviews and audits can miss fictitious claims/expenses, multiple claims made for the same bills. These claims may be part of mistake or intentional fraud, but ultimately organizations suffer in terms of financial impact. IDP benefits in preventing these frauds as it extracts the data from the employee expense documents, drills down through fraudulent entries and

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highlights the inconsistencies in the claims submitted by the employees. This helps the accounting teams in the organizations to fast-track the disbursements and trims out the disallowed claims.

6. Trade finance and consumer durable finance:

With global trade projected to grow, trade finance continues to be a significant pillar of banks' business model. Although the revenue growth outlook is promising, organizations need first to overcome several challenges to optimizing their trade finance business to maximize profitability. It is especially significant since trade finance is mainly paper-based and labor-intensive. By its very nature, trade finance maintains processes that are highly focused on documentation and checking. The use of paper documents throughout the transaction cycle and across stakeholders is immense.

This usually results in Longer transaction turnaround time, high handling & storage costs, High error rates from manual document verification and Operational risk due to staff turnover . IDP can boost productivity since it deploys intelligent OCR to digitize and turn unstructured documents into readily available data sources and enable faster decision-making and compliance checks through ML and cognitive RPA.

7. Supply Chain Management:

In Supply Chain companies, the commonly faced challenge is invoice processing due to the complexity of semi-structured documents coupled with a lack of extensive intelligent document processing capabilities. IDP can bring in magic here!

Since solutions that adopt IDP can match data from disparate systems and pull it together in a cohesive, understandable way, these solutions are proving to be an excellent fit for end-to-end processes like purchase-to-pay, order-to-cash and record-to-report. Improving processes and eliminating non-value-adding tasks may offer significant savings. Also, a single platform for managing invoices and orders provides a great deal of visibility into the financial supply chain.

Advantages of Intelligent Data Processing

- Increased productivity:

The advantage of automation of business processes is that it eliminates manual intervention in a document-centric workflow. With a single click, data from a document is captured, converted, sorted, indexed and routed to its destination, so it can be stored in a structured format. This improves the overall efficiency and supports the organization to have effective operation in the workflow.

- Optimized Savings:

Companies that have adopted the IDP technology into their workflow have observed a significant change in processing time and decreased labor costs by up to fifty percent. Besides, automated data processing enables the previously manual work to be completed in a substantially shorter period of time, thereby saving operational costs that would have otherwise been expensive in case of manual labor.

- Reliability:

IDP helps in improving the quality by ruling out any possibility of human error while processing documents. While done manually, information is always stored in an unstructured manner and is difficult to access quickly. With processes that are automated with IDP, then the information is organized in a secure location and is easily accessible as well.

- Simplified Compliance:

Intelligent Data Processing is a secure technology and maintains data privacy. More often than not, organizations contain data that is sensitive and it is of utmost importance to protect such data from being misused or manipulated. An IDP keeps the information safeguarded by storing it in a secure location accessible only by authorized personnel.

5. Scalability:

IDP is not specific to any particular process and it can be applied to multiple applications in multiple areas. It does not require any installation, it only serves as a platform for an integrated framework where documents of different formats, sizes, and sources can be scanned and processed. This feature of an IDP system makes it highly scalable and effective.

Basic data processing operations

Five basic operations are characteristic of all data processing systems: inputting, storing, processing, outputting, and con-trolling. They are defined as follows.

INPUT

Taking information that is external to the system and entering it into the system. This may be manual (e.g. keyboard) or automated input (e.g. OMR). May also be input by electronic means (e.g. via a network or CD).

PROCESSING

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An action performed on the data. Processing can include sorting, searching or performing calculations on the data.

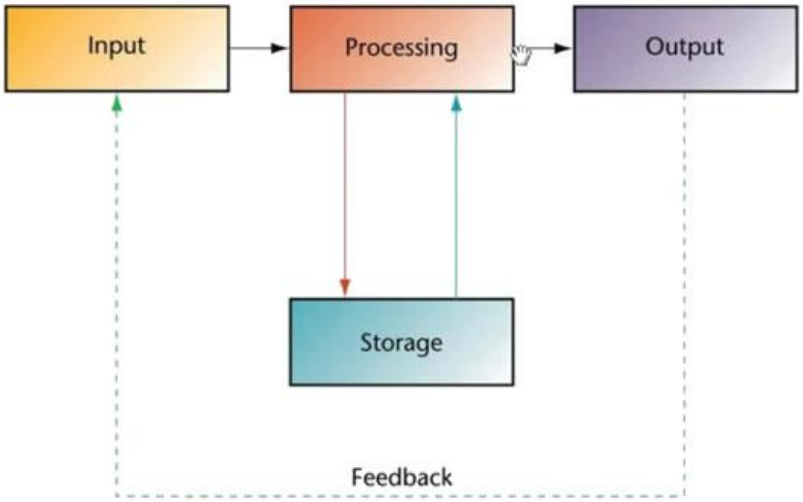
STORAGE

Where data is held and still in the system. It may be the data that has been input, required during processing or results of processing.

OUTPUT

Taking information that was in the system and outputting it. May result in a printed, on screen or electronic.

Figure1



Input Hardware

Input hardware exists in many different shapes and sizes, and are tailored specifically for particular systems. Below is a list of common input devices.

Keyboards; Touch screens; Pointing devices; Mouse; Touchpad / trackpad; Joystick; Composite devices (capable of multiple abilities such as movement and clicking); Game controllers;Light pen; Graphics tablet; Imaging input devices; Digital cameras; Webcam;Image scanner; Fingerprint scanner; Barcode reader; Audio input devices; Microphone; MIDI Keyboard; Drum machine.

Output Hardware

Output devices are continuously changing as technology advances. Various types of display outputs as well as printers and audio devices continue to evolve daily. These devices are responsible for transmitting data in to a form that we as humans are able to interpret, e.g. text, images, audio, and even events we can feel (see: haptic feedback).

Monitors
Printers
Haptic sensors (for example, mobile device vibrations upon touch input)
Sound cards and speakers

Storage Hardware

Often data that has been processed is stored for later processing or reading. Many devices are capable of storing such information.

Hard disk drives (HDDs)
Solid-state drives (SSDs)
Optical drives (CDs / BluRay / DVD)
Flash storage devices (USB storage disks)
Floppy disk drives (obsolete in today's world)
Network-attached storage devices (NAS)

Data storage hierarchy

It is known that data, once entered, are organized and stored in successively more comprehensive groupings. Generally, these groupings are called a data storage hierarchy. The general group-ings of any data storage hierarchy are as follows. 1) Characters, which are all written language symbols: let-ters, numbers, and special symbols. 2) Data elements, which are meaningful collections of related characters. Data elements are also called data items or fields. 3) Records, which

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are collections of related data elements. 4) Files, which are collections of re-lated records. A set of related files is called a data base or a data bank.

Intelligent fault diagnosis is a promising tool to deal with mechanical big data due to its ability in rapidly and efficiently processing collected signals and providing accurate diagnosis results. In traditional intelligent diagnosis methods, however, the features are manually extracted depending on prior knowledge and diagnostic expertise. Such processes take advantage of human ingenuity but are time-consuming and labor-intensive. Inspired by the idea of unsupervised feature learning that uses artificial intelligence techniques to learn features from raw data, a two-stage learning method is proposed for intelligent diagnosis of machines. In the first learning stage of the method, sparse filtering, an unsupervised two-layer neural network, is used to directly learn features from mechanical vibration signals. In the second stage, softmax regression is employed to classify the health conditions based on the learned features. The proposed method is validated by a motor bearing dataset and a locomotive bearing dataset, respectively. The results show that the proposed method obtains fairly high diagnosis accuracies and is superior to the existing methods for the motor bearing dataset. Because of learning features adaptively, the proposed method reduces the need of human labor and makes intelligent fault diagnosis handle big data more easily.

High-altitude environment is a major factor impacting performance of aircraft environmental control systems and comprehensive environmental quality of a cockpit. Cockpit environmental quality plays not only a decisive role in flight safety as well as occupant's health and comfort, but also an important role in energy efficiency and environmental protection. High-altitude simulation cabins can simulate flying environment (e.g., height, temperature) for aircrafts and transport planes. Thus, simulation cabins play an important role in the development of feeder aircrafts.

The temperature change in a high-altitude environmental simulation cabin comprises a cooling stage, a constant temperature stage, and a heating stage.1 The requirements can be found in the national military standards2 in terms of temperature control precision in environmental simulation cabins, especially systems without self-balance ability, to prevent the occurrence of an overshoot phenomenon. Presently, in the field of environmental simulation control, researchers have developed many methods. For example, Li's research group introduced a PID controller to control the temperature of thermal control systems.3, 4, 5, 6, 7 Dong et al. utilized a double-PID controller to control the temperature of an environmental chamber.8 However, both simulation and experimental results showed that, due to the complexity of factors influencing the cabin temperature and the inertia link caused by the large volumes of most cabins, it is difficult to increase the cooling rate and prevent the overshoot simultaneously with the classic PID control method. Therefore, it is difficult to control the temperature. When an environmental cabin simulates multiple parameters such as temperature and pressure, there has been coupling and interference between these parameters. This limits the ability to simulate temperature and pressure quickly and accurately. Because of the constant increments of the air-operated valve, it is easy to have lower pressure than the target pressure. Thus, it is difficult to control the pressure without an overshoot using the classic PID control method.

IV. CONCLUSION

To overcome the above difficulties of multi-parameter cabin control systems and ensure that a refrigeration turbine can be put into use safely and as soon as possible, we propose that the processes of automatically powering on and off the refrigeration turbine and decreasing the temperature can be automatically controlled by combining the fuzzy control strategy with an expert PID judgment and thus, the lumped parameter model of cabin temperature and pressure change, established on the basis of the dynamic-state characteristics of the environmental simulation cabin, is valid. A fuzzy controller was used to control the heater of the central air conditioning system.9, 10 The introduction of expert judgments can be used to decrease the temperature, reduce the fluctuation of turbine revolution speed, and lead the refrigeration system into a steady state as soon as possible, therefore improving experimental efficiency. The fuzzy method is a kind of simple and flexible method with the advantages of less computational efforts, strong practicability, rapidity, strong stability, and high robustness.11 This enables the achievement of higher control accuracy. Appropriate use of this method solves the problems of revolution speed control of the air refrigeration turbine and temperature control, ensuring normal operation of experiments.

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