General

<table>
<tr><td>ID[1]</td><td colspan="4"></td></tr>
<tr><td>Use case name</td><td colspan="4">Information Extraction from Hand-marked Industrial Inspection Sheets</td></tr>
<tr><td>Context</td><td colspan="4">Manufacturing</td></tr>
<tr><td>Application domain</td><td colspan="4">Cloud services</td></tr>
<tr><td>Status</td><td colspan="4">PoC</td></tr>
<tr><td rowspan="2">Contributor</td><td>Name</td><td>Affiliation</td><td colspan="2">Contact</td></tr>
<tr><td>Lovekesh Vig, C. Anantaram</td><td>Tata Consultancy Services Ltd</td><td colspan="2">c.anantaram@tcs.com</td></tr>
<tr><td>Scope[2]</td><td colspan="4">Localization and Mapping of machine zones, arrows and text, to extract information from manually tagged inspection sheets.</td></tr>
<tr><td>Objective(s)</td><td colspan="4">To create a pipeline to build an information extraction system for machine inspection sheets, by mapping the machine zones to the handwritten code using state-of-the-art deep learning and computer vision techniques.</td></tr>
<tr><td rowspan="2">Narrative</td><td>Short description (not more than 150 words)</td><td colspan="3">Inspection Sheets are filled regularly to detect defects and maintain heavy machines. Sheets contains a lot of unstructured information and requires domain experts' intervention to read and digitize. We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques.</td></tr>
<tr><td>Complete description</td><td colspan="3">In order to effectively detect faults and maintain heavy machines, a standard practice in several organizations is to conduct regular manual inspections. The procedure for conducting such inspections requires marking of the damaged components on a standardized inspection sheet which is then camera scanned. These sheets are marked for different faults in corresponding machine zones using hand-drawn arrows and text. As a result, the reading environment is highly unstructured and requires a domain expert while extracting the manually marked information

We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques. The pipeline proceeds in the following stages: (1) localization of different zones of the machine, arrows and text using a combination of template matching, deep learning and connected components, and (2) mapping the machine zone to the corresponding arrow head and the text segment to the arrow tail, followed by pairing them to get the correct damage code for each zone.

The proposed method yields an accuracy of 83.2% at the end of the pipeline. The organization has 2 million such sheets which are manually processed. This project will enable considerable savings in terms of time and manpower as it takes roughly 5 minutes per sheet for the manual process. The AI system will process a sheet in 20 seconds and can be parallelized for further speed up.</td></tr>
<tr><td>Key performance indicators (KPIs)</td><td>ID</td><td>Name</td><td>Description</td><td>Reference to mentioned use case objectives</td></tr>
</table>

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	1	Accuracy	Accuracy of system to read the code and map it to the right Machine zone	
AI features	Tasks(s)	Recognition		
	Method(s)[3]	Deep learning		
	Hardware[4]			
	Terms and concepts used[5]	Deep learning, Template matching, connected components, mapping, pairing		
Challenges and issues	Challenges: 1. Quality of Images 2. Structural deformities of individual components(arrows, handwritten code) 3. Quantity of data 4. Cascading effect of error at each stage of the pipeline			
Societal concerns				

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Data (optional)

Data characteristics	
Description	a dataset of anonymized inspection sheets provided by a company
Source[6]	a company employing heavy machines
Type[7]	Camera scans with resolution of 3210 *2200
Volume (size)	330
Velocity (e.g. real time)[8]	
Variety (multiple datasets)[9]	Single source
Variability (rate of change)[10]	Static
Quality[11]	High

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Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition[12]	Post-condition[13]
1	Industrial Inspection	Physical inspection of heavy machinery	Scan of machine inspection sheet	Human inspected marked sheets	Digitized information from inspection sheets
2	Training Arrow Detection Model	Train a deep model to recognize arrows in an image	Arrow images	Synthetically generated arrow images	Trained detector with high > 90% accuracy
3	Training Regression model for arrow head and tail	Train a deep model for regressing to head and tail of arrows	Detected Arrow images	Arrow Images	Head and Tail Localization
4	Text Detection	Detect Text via deep model	Detected handwritten text	Handmarked image	Localized handwritten text
5	Reading Handwritten Text	Read text via deep model	Read handwritten text	Isolated handwritten text	Digitized text
6	Mapping of Zones	Zone Mapping	Map each text to a machine zone using arrow	Machine Zone to fault mapping	Final Mapping to database

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Training (optional)

Scenario name	Training				
Step No.	Event[14]	Name of process/Activity[15]	Primary actor	Description of process/activity	Requirement
1	Synthetic Arrow Dataset is ready	Train arrow detector	AI Solution Provider	Train a model to isolate arrows in an image	Needed for mapping text to zones
2	Handwritten text recognition	Train handwritten text recognizer	AI Solution Provider	Train a model to recognize handwritten text	Needed for fault identification
3	Text Detection	Isolate Handwritten text	AI Solution Provider	Train a model to isolate handwritten text	Needed for Text detection

Specification of training data[16]	

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Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event[17]	Name of process/Activity[18]	Primary actor	Description of process/activity	Requirement

Input of evaluation[19]	Manually annotated sheets, AI System
Output of evaluation[20]	Accuracy

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Execution (optional)

Scenario name	Execution				
Step No.	Event[21]	Name of process/Activity[22]	Primary actor	Description of process/activity	Requirement

Input of Execution[23]	
Output of Execution[24]	

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Retraining (optional)

Scenario name	Retraining				
Step No.	Event[25]	Name of process/Activity[26]	Primary actor	Description of process/activity	Requirement

Specification of retraining data[27]	Retraining data has to include recent data

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References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
1	Conference Paper	International Conference on Document Analysis and Recognition	Published		Tata Consultancy Services Limited	https://ieeexplore.ieee.org/abstract/document/8270293/

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Footnote

[1] Leave this cell blank.

[2] The scope defines the limits of the use case.

[3] AI method(s)/framework(s) used.

[4] Hardware system used.

[5] Terms and concepts listed here can be used to extend the work of WG 1 (AWI 22989 and AWI 23053) as necessary.

[6] Origin of data, which could be from instruments, IoT, web, surveys, commercial activity, or from simulations.

[7] Structured/unstructured Images, voices, text, gene sequences, and numerical. Composite: time-series, graph-structured

[8] The rate of flow at which the data is created, stored, analysed, or visualized.

[9] Data from a number of domains and a number of data types. The wider range of data formats, logical models, timescales, and semantics complicates the integration of the variety of data.

[10] Changes in data rate, format/structure, semantics, and/or quality.

[11] Completeness and accuracy of the data with respect to semantic content as well as syntactical of the data (such as presence of missing fields or incorrect values)

[12] Describe which condition(s) should have been met before this scenario happens.

[13] Describe which condition(s) should prevail after this scenario happens. The post-condition may also define "success" or "failure" conditions.

[14] The event that triggers the step. This might be completion of the previous event.

[15] Action verbs should be used when naming activity.

[16] Training data can be further specified.

[17] The event that triggers the step. This might be completion of the previous event.

[18] Action verbs should be used when naming activity.

[19] Specify input of evaluation.

[20] Specify output of evaluation.

[21] The event that triggers the step. This might be completion of the previous event.

[22] Action verbs should be used when naming activity.

[23] Specify input of evaluation.

[24] Specify output of evaluation.

[25] The event that triggers the step. This might be completion of the previous event.

[26] Action verbs should be used when naming activity.

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[27] Retraining data can be further specified.

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