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GERMIC: Application of Gesture Recognition Model with Interactive Correction to Manual Grading Tasks

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Motivation

- Work support system is widely investigated
 - Capture nurse's work and record nursing histories
 - Tutoring system for assembly workers

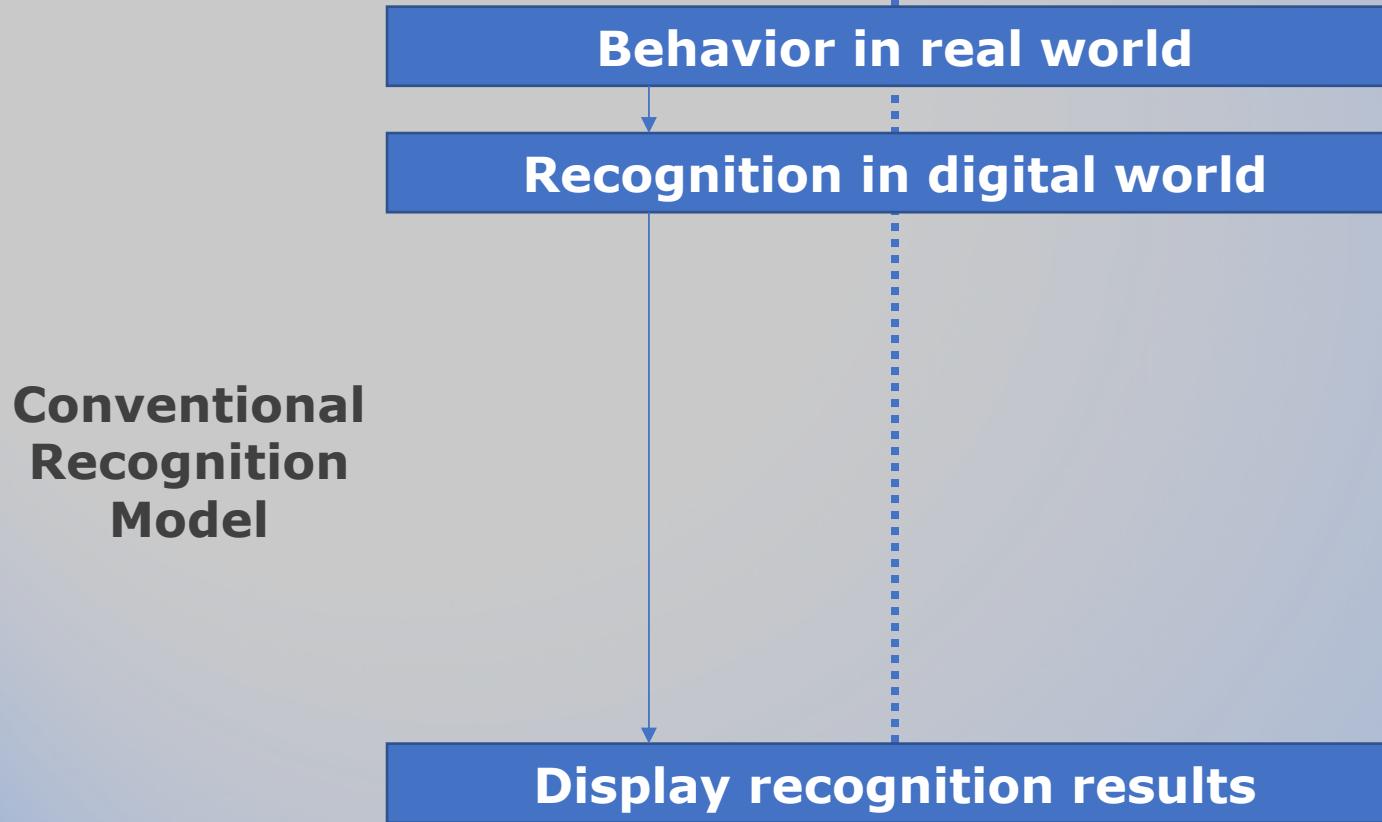


- Work support systems recognize human activities
 - **Misrecognition** is inseparable
 - Retrial and alternation are not acceptable

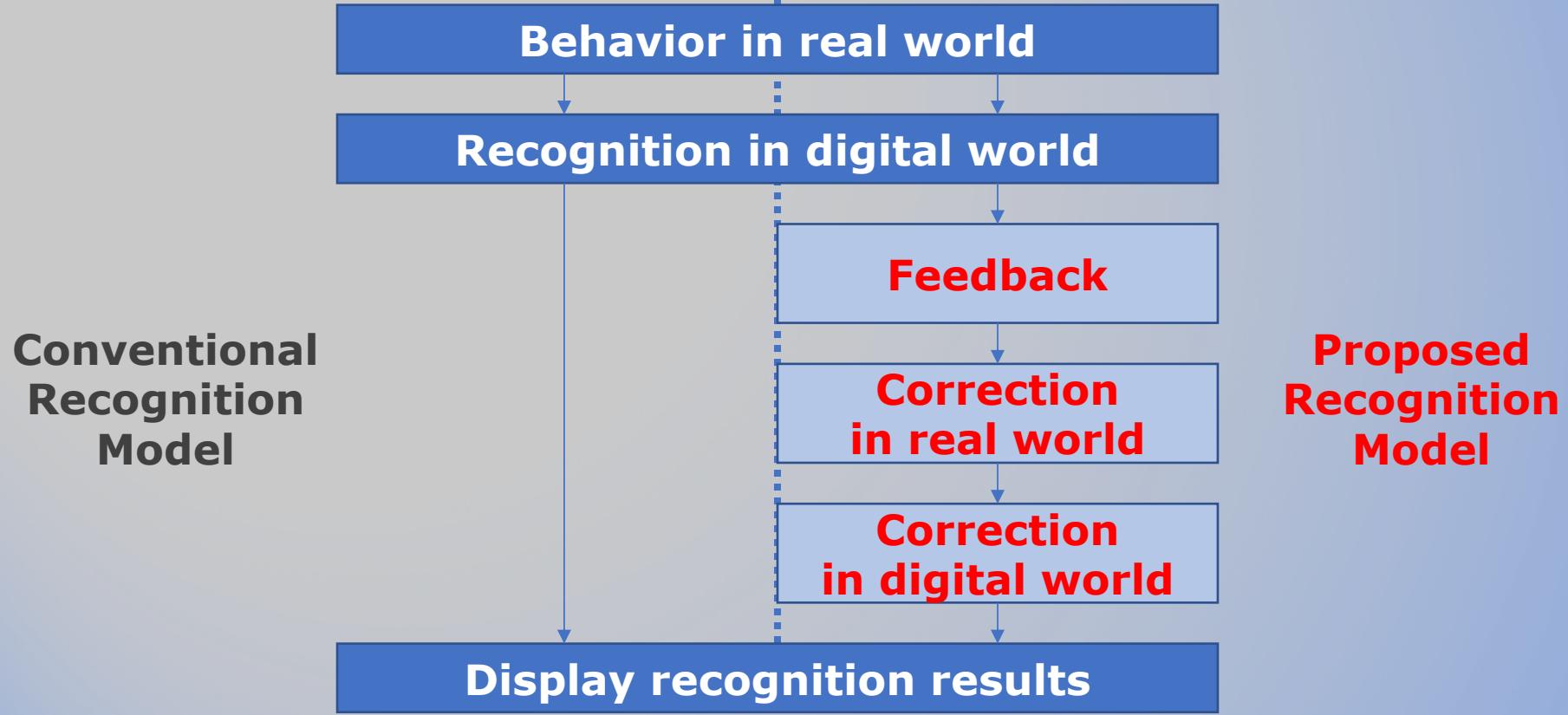


- **Interactive correction** mechanism without affecting real world

Model of Work Support System



Model of Work Support System With Interactive Correction Mechanism



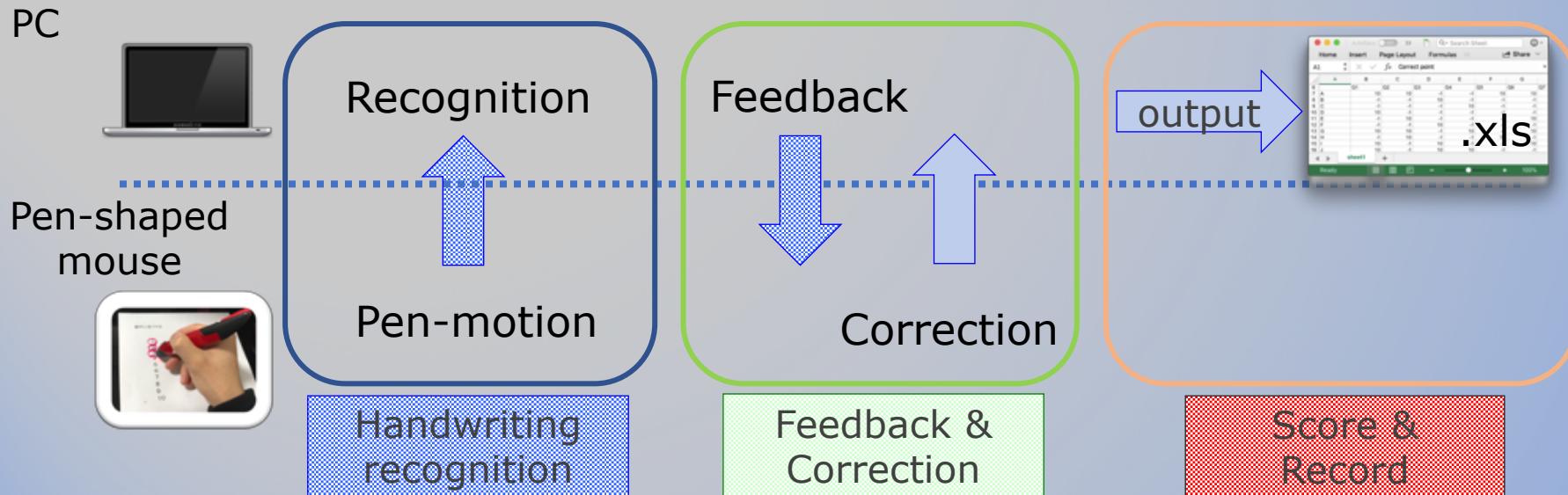
Objective

- Apply proposed model to **manual grading** scenes
 - Measure effects on grading results and usability
- Grading support system thus far
 - Online grading and marksheets are limited and high-cost
 - Drastically change graders' attitudes to grading tasks
 - Manual grading is still major
- Requirements
 - Graders perform grading **as usual**
 - **Correct** misrecognition **without affecting real world** (answer paper)



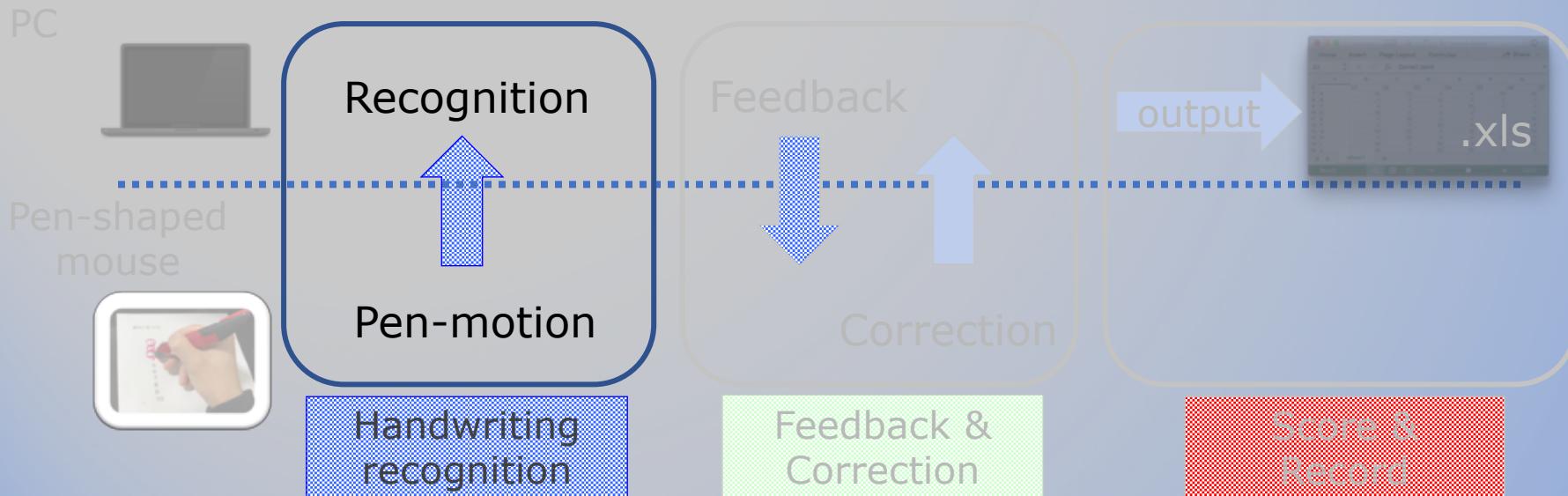
GERMIC (Gesture Recognition Model with Interactive Correction)

- Utilize a pen-shaped mouse with ink
 - Linked wirelessly with PC to record pen-motion and results
- System overview



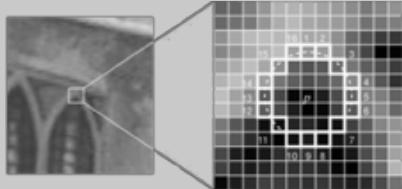
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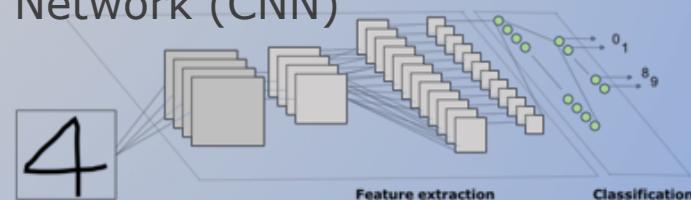
Handwriting Recognition

- Recognition objects
 - Shapes
 - 3 kinds of shapes: 「○」, 「△」, and 「/」
 - Classification by number of feature points (FAST algorithm)
 - Numbers
 - 9 kinds of numbers: 「1」 ~ 「9」
 - Classification by Convolutional Neural Network (CNN)



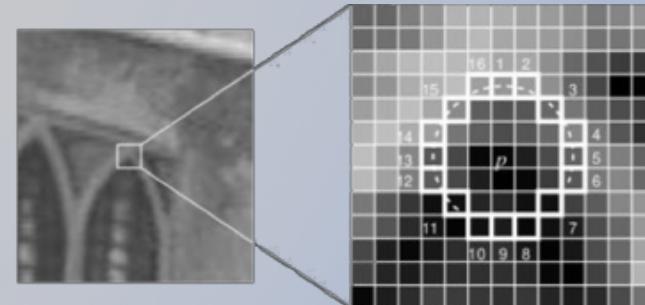
E. Rosten and T. Drummond, 'Machine Learning for High-Speed Corner Detection,'
in Proc. of the 9th European Conference on Computer Vision (ECCV'06), Vol. 1, pp. 430{443 (2006).

- Numbers
 - 9 kinds of numbers: 「1」 ~ 「9」
 - Classification by Convolutional Neural Network (CNN)



Handwriting Recognition 2

- Shape recognition
 - Feature point extraction by **FAST** algorithm
 - One of corner detection methods in image recognition
 - Number of feature points x :
 - $23 \leq x$ → 「○」
 - $8 \leq x < 23$ → 「△」
 - $3 \leq x < 8$ → 「/」
 - $x < 3$ → ignored

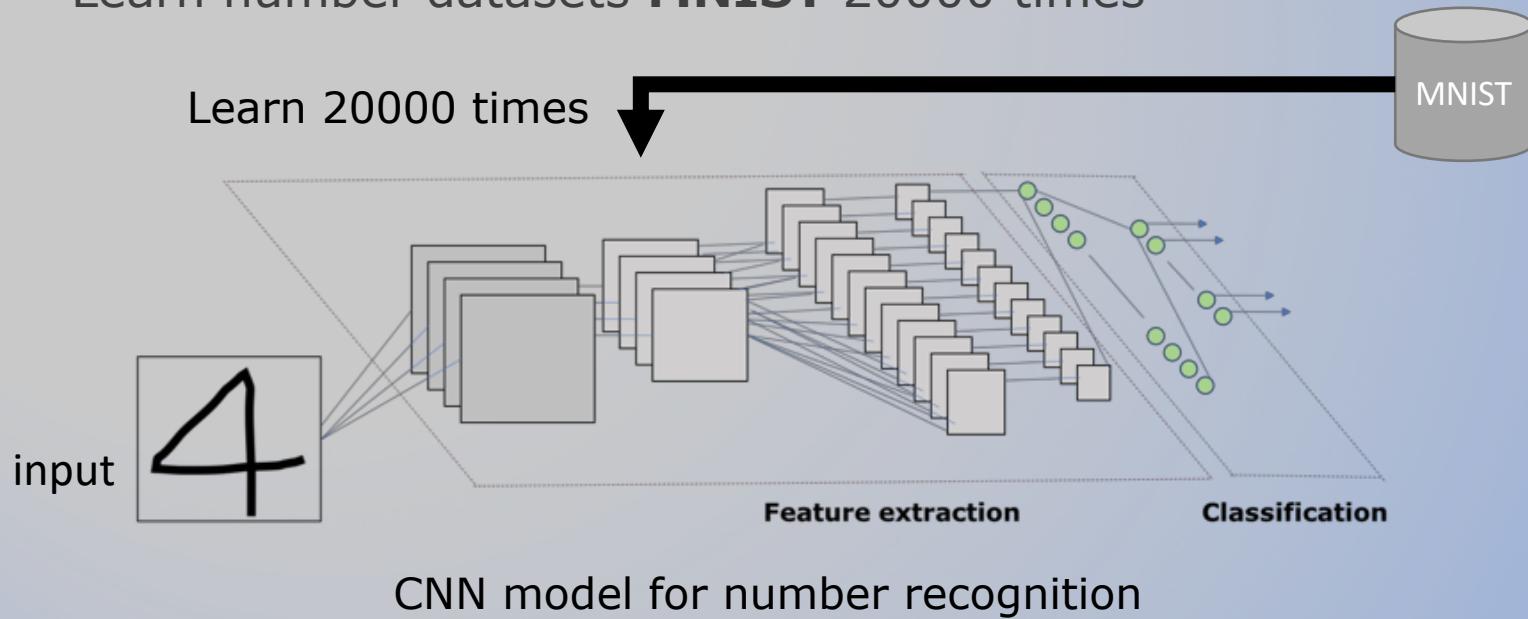


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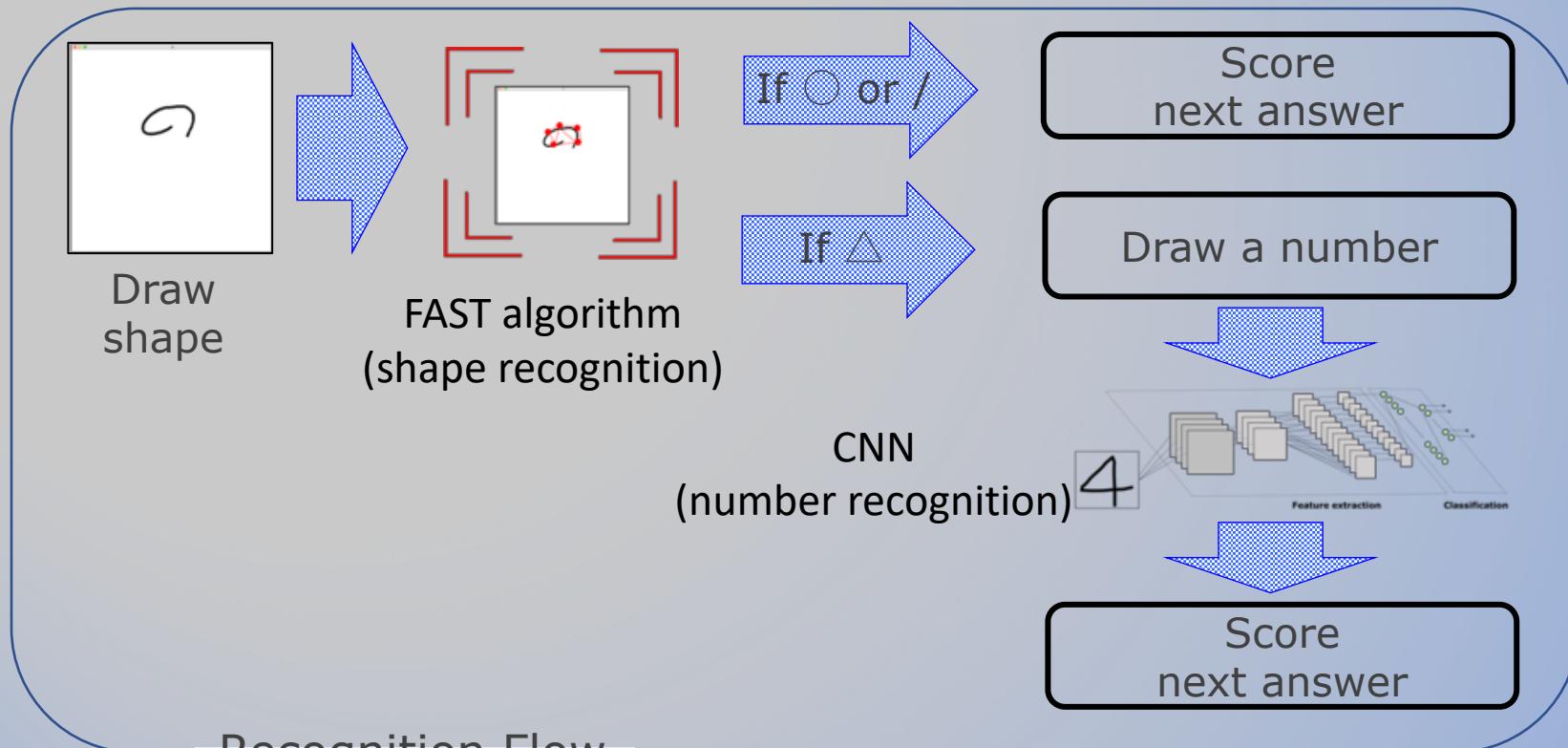
FAST algorithm

Handwriting Recognition 3

- Number recognition by CNN
 - Learn number datasets **MNIST** 20000 times

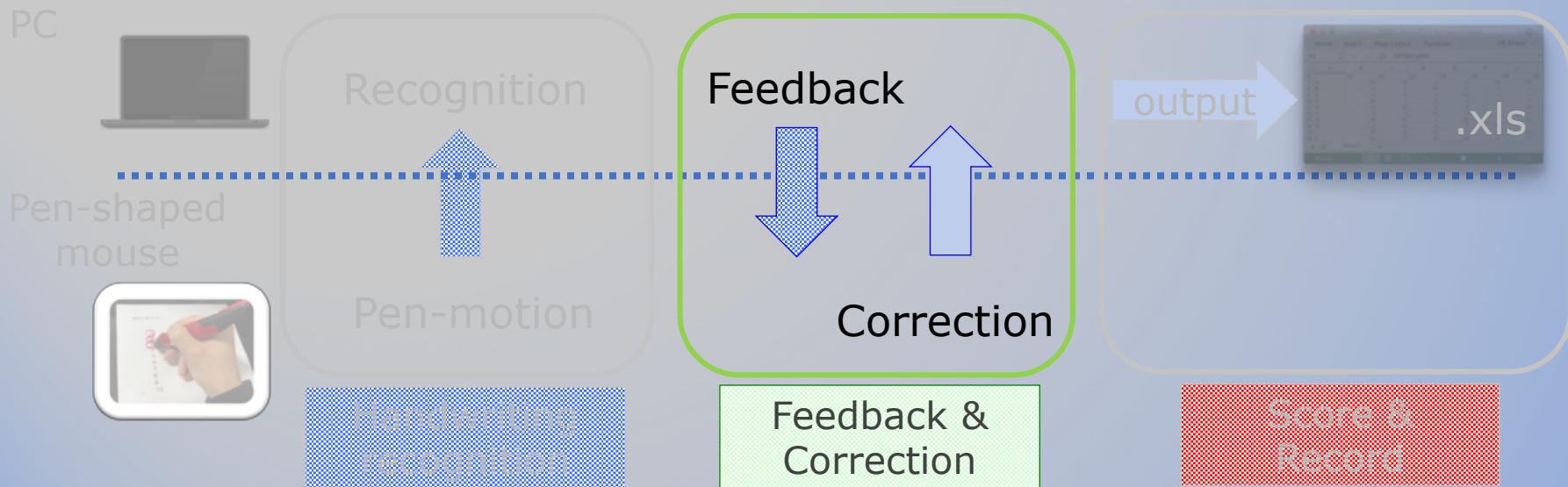


Recognition Flow



GERMIC (Gesture Recognition Model with Interactive Correction)

- Utilize a pen-shaped mouse with ink
 - Linked wirelessly with PC to record pen-motion and results
- System overview

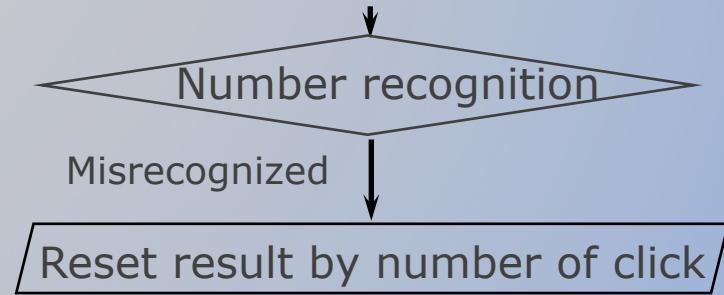
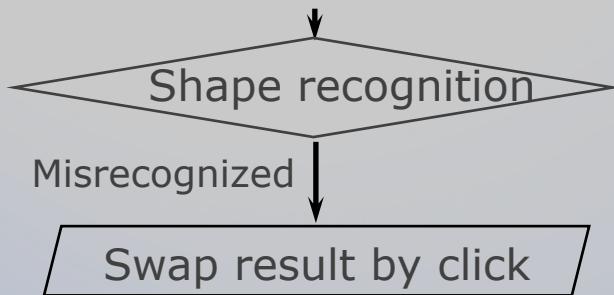


Feedback and Correction

- Voice feedback

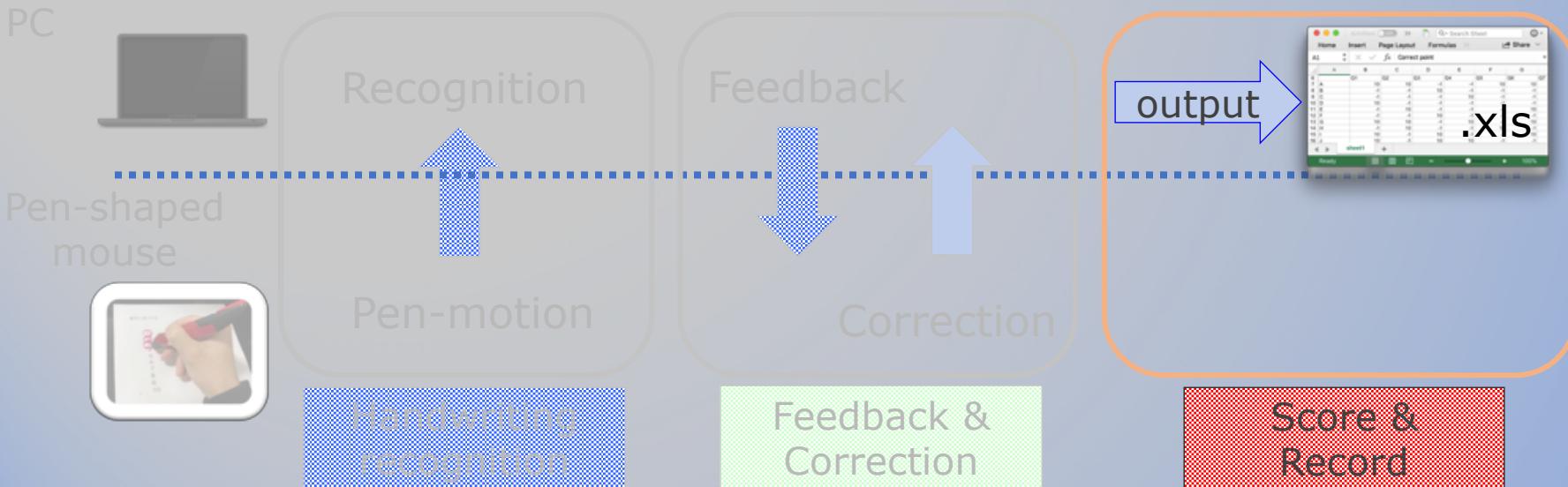
- Recognize 「○」 → Pronounce "maru" (meaning circle)
- Recognize 「△」 → Pronounce "sankaku" (meaning triangle)
- Recognize 「/」 → Pronounce "peke" (meaning slash)
- Recognize number → Pronounce number (「1」 ~ 「9」)

- Correction



GERMIC (Gesture Recognition Model with Interactive Correction)

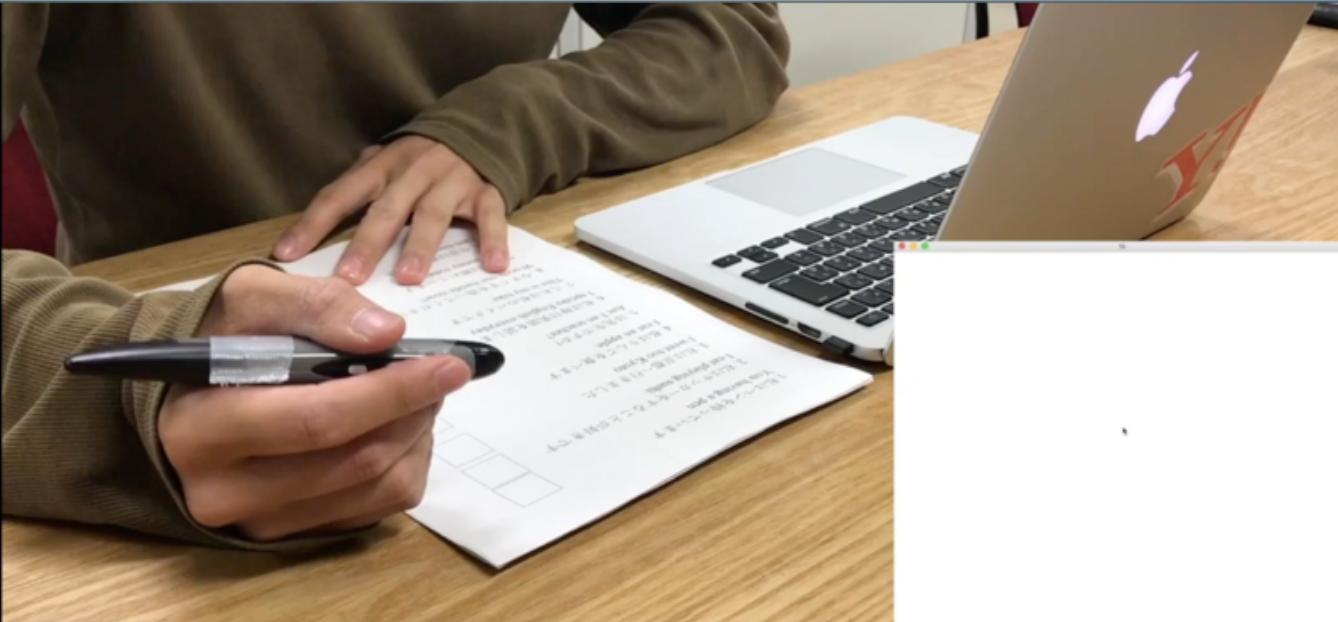
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Score & Record

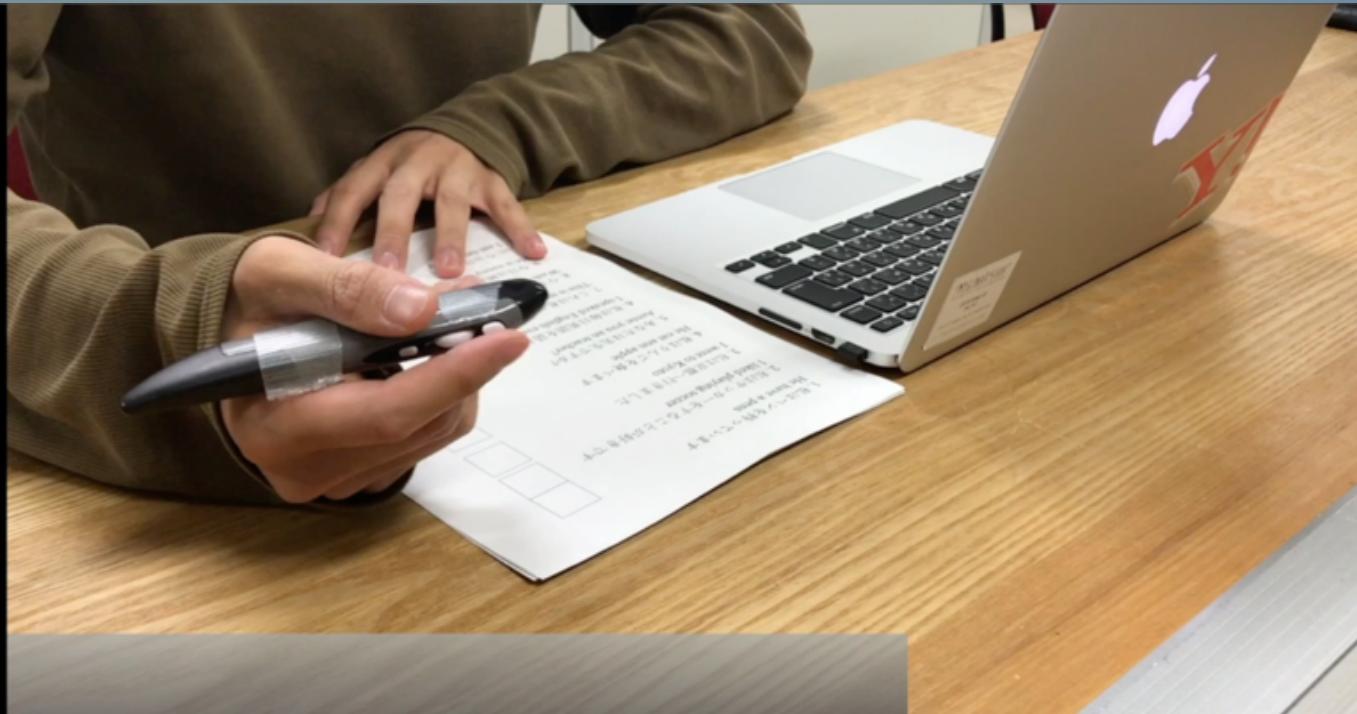
- Score
 - Read number of questions, answerers, and allotment of scores (「○」 and 「/」) from excel file at startup
- Record
 - Record corresponding score at each question
 - Output all results after completion of grading
 - As excel file
 - Score at each question
 - Total score by answerer

Demo – Draw Shape & Number



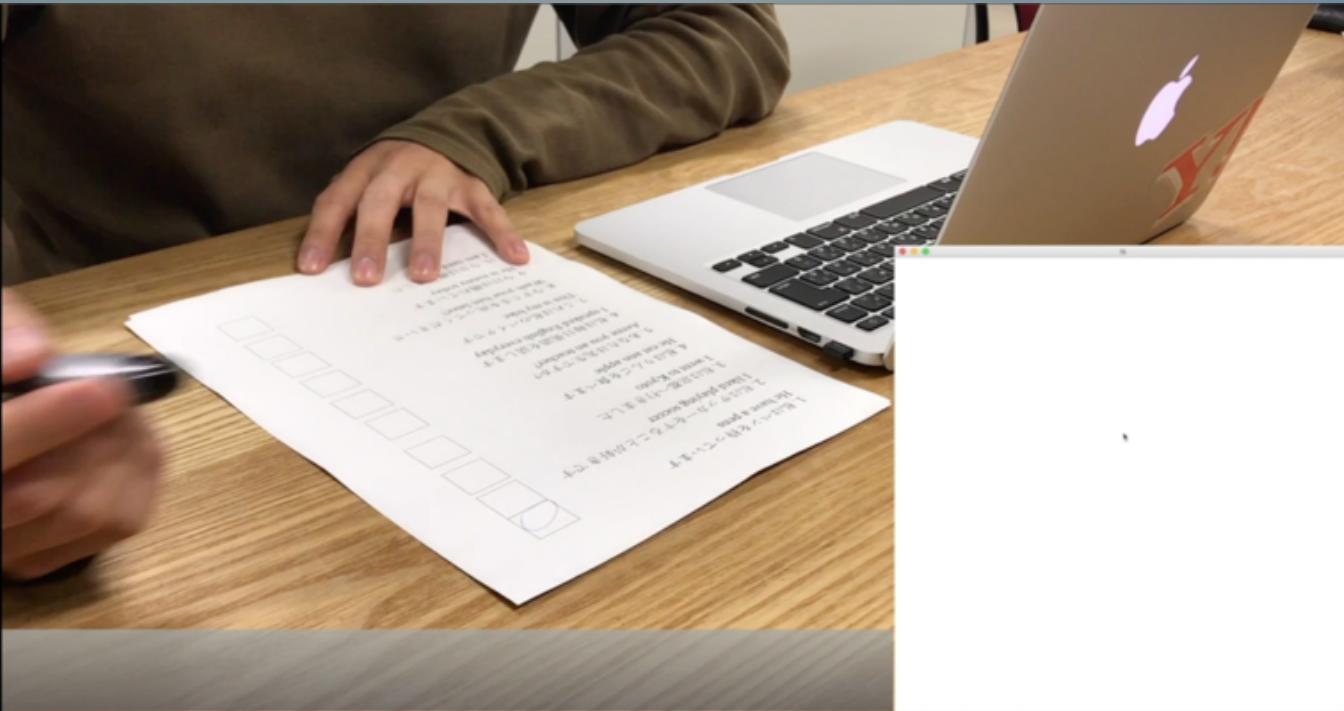
Draw 「○」 → Draw 「/」 → Draw 「△」 → Draw 「3」

Demo – Correct Shape Recognition



Draw 「○」 → Misrecognized as 「△」 → Correct to 「○」

Demo – Correct Number Recognition



Draw 「△」 → Draw 「4」 → Misrecognized as 「7」 → Correct to 「4」

Evaluation

- Settings

- 5 Subjects in twenties and thirties

- 1) Evaluate recognition rate of shapes

- Draw 「○」 「△」 「/」 repetitively 10 times

- 2) Evaluate recognition rate of numbers

- Draw 「1」 ~ 「9」 repetitively 10 times

- 3) Evaluation 3: Score papers with and without GERMIC

- With 「○」 「/」

- 4) Evaluation 4: Score papers with and without GERMIC

- With 「○」 「△」 「/」

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- 4) Evaluation 4: Score papers with and without GERMIC

- With 「○」 「△」 「/」

Evaluation 1

- Recognition rate of shapes by subject

I \ O	Subject 1			Subject 2			Subject 3			Subject 4			Subject 5		
	O	△	/	O	△	/	O	△	/	O	△	/	O	△	/
O	10			8	2		10			8	2		9	1	
△	2	8		1	9			10		1	9		3	7	
/			10			10			10			10			10

- 「○」 : 90 %
- 「△」 : 86 %
- 「/」 : 100 %

- Misrecognition occurs between 「○」 and 「△」
 - 「△」 is circular then misrecognized as 「○」 → 
 - 「○」 is small then misrecognized as 「△」 → 

Evaluation 2

- Recognition rate of numbers by subject

No.	Subject 1									Subject 2									Subject 3									Subject 4									Subject 5								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9									
1	10									10									8	1								10									10								
2	1	9									9	1								10										9	1								10						
3		10									2	7							1		10										10									1	8	1			
4			8				2					8				2	2			4		1		3	1				8	1									8		2				
5				1	7	2						1	9							2	5	2	1						10									1	1	8					
6					10							1	9								10										10									1		9			
7	1					8	1				1		8	1							8	2	2								8		1	1					7	1					
8							9	1						10							10											10									9	1			
9						1		2	7						10						10											1	9								1	1	8		

- 「1」 : 96% - 「2」 : 94% - 「3」 : 90% - 「4」 : 72%
- 「5」 : 78% - 「6」 : 96% - 「7」 : 70% - 「8」 : 96% - 「9」 : 88 %

- Misrecognition occurs among 「4」 , 「5」 , and 「7」

- Unfamiliar to draw with one-stroke

1 2 3 4 5 6 7 8 9

- Line gets squiggly

Evaluation

- Settings

- 5 Subjects in twenties and thirties

- 1) Evaluate recognition rate of shapes

- Draw 「○」 「△」 「/」 repetitively 10 times

- 2) Evaluate recognition rate of numbers

- Draw 「1」 ~ 「9」 repetitively 10 times

- 3) Evaluation 3: Grade papers with and without GERMIC

- With 「○」 「/」

- 4) Evaluation 4: Grade papers with and without GERMIC

- With 「○」 「△」 「/」

Evaluation 3 and 4

- Grade 10 papers by comparing (②) against (①)
 - Each sentence consists of 4 words
 - Evaluation 3
 - Grade with 「○」 「/」
 - Match all → 「○」
 - Other than above → 「/」
 - Evaluation 4
 - Grade with 「○」 「△」 「/」
 - Match all → 「○」
 - One word does not match → 「△」
 - Draw any of 「1」 ~ 「9」
 - More than one word do not match → 「/」

1. 私はペンを持っています I have a pen	<input type="checkbox"/>
2. 私はサッカーをすることが好きです I like playing soccer	<input type="checkbox"/>
3. 私は京都へ行きました I went to Kyoto	<input type="checkbox"/>
4. 私はりんごを食べます I eat an apple	<input type="checkbox"/>
5. あなたは先生ですか? Are you a teacher?	<input type="checkbox"/>
6. 私は毎日英語を話します I speak English everyday	<input type="checkbox"/>
7. これは私のバイクです This is my bike	<input type="checkbox"/>
8. 今すぐ手を洗ってください!! Wash your hands now!!	<input type="checkbox"/>
9. 今日は晴れています It is sunny today	<input type="checkbox"/>
10. 今日は疲れました I am tired today	<input type="checkbox"/>

① ②
Correct answer sheet Student answer sheet

1. 私はペンを持っています I have an pen	<input type="checkbox"/>
2. 私はサッカーをすることが好きです I like playing soccer	<input type="checkbox"/>
3. 私は京都へ行きました I went at Shiga	<input type="checkbox"/>
4. 私はりんごを食べます I eat an apples	<input type="checkbox"/>
5. あなたは先生ですか? Are you a teacher?	<input type="checkbox"/>
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7. これは私のバイクです This is my bike	<input type="checkbox"/>
8. 今すぐ手を洗ってください!! Wash your hands now!!	<input type="checkbox"/>
9. 今日は晴れています It are sunny yesterday	<input type="checkbox"/>
10. 今日は疲れました I are tire today	<input type="checkbox"/>

Evaluation 3

- Grade papers with 「○」 「/」

	Without GERMIC			With GERMIC
	Scoring (sec)	Tallying (sec)	Total (sec)	Scoring (sec)
Subject 1	258	216	474	309
Subject 2	243	197	440	277
Subject 3	248	148	396	385
Subject 4	183	230	413	284
Subject 5	204	139	343	301

- All subjects completed scoring faster without GERMIC
- In total time, they completed faster with GERMIC by **24.7%**
 - Results are automatically outputted

Evaluation 4

- Grade papers with 「○」 「△」 「/」

	Without GERMIC			With GERMIC
	Scoring (sec)	Tallying (sec)	Total (sec)	Scoring (sec)
Subject 1	593	238	831	694
Subject 2	407	353	760	555
Subject 3	395	259	654	651
Subject 4	467	268	735	608
Subject 5	417	212	629	563

- All subjects completed scoring faster without GERMIC
- In total time, they completed faster with GERMIC by **14.9%**
 - Results are automatically outputted

Feedback from subjects

- For
 - They would not have completed their grading tasks as quickly without GERMIC
 - They did not feel burdened by the interactive correction mechanism once they became familiar with using it
- Against
 - One subject felt he had to wait a little while for voice feedback
 - Continue improving GERMIC to reduce delay time
 - Another subject would have preferred voice over manual correction of a recognition error
 - Look for a better interface to perform corrections

Summary

- Motivation
 - Work support system is inseparable from misrecognition
- Objective
 - Proposed model with interactive correction and applied it to manual grading scenes to measure effectiveness
- Method
 - Propose GERMIC to support grading tasks with interactive correction using voice feedback
- Evaluation
 - Shortens total time to complete grading by up to 24.7%
 - Without affecting real world
 - We have shown effectiveness of proposed model

Summary

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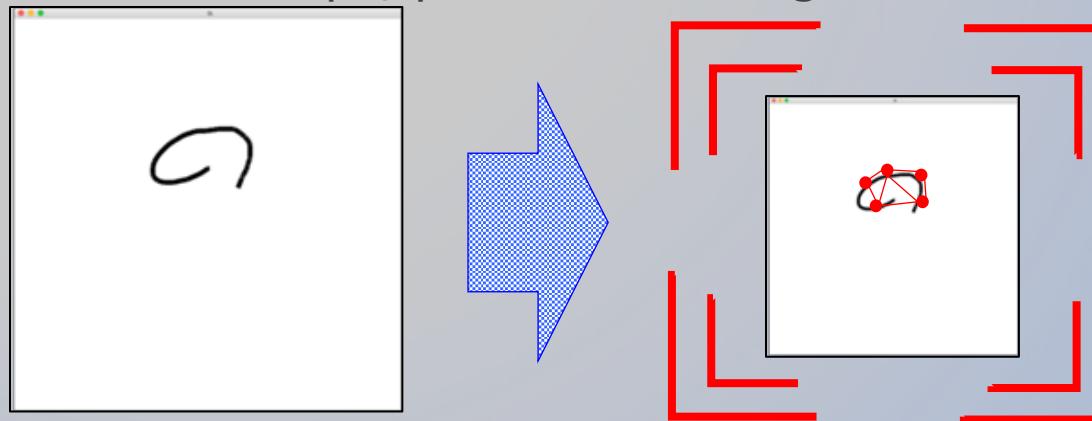
Thank you

<http://koheiyamamoto.net/>

Supplements

Handwriting recognition 1

- Read trail of pen-mouse as image data
 - Draw on window
 - Unconscious for users
 - Graders grade as usual
 - When cursor stops, proceed to recognition



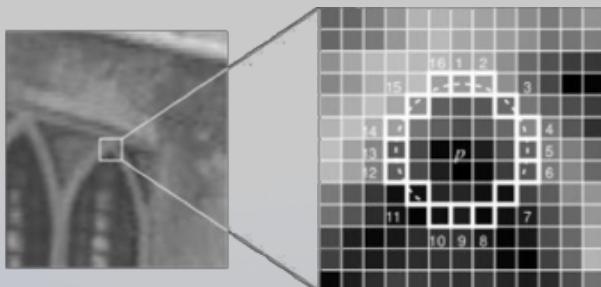
Flow from reading trail of cursor to recognition

@Kohei Yamamoto, Ubiquitous Computing and Networking Lab

Handwriting Recognition 2

- Shape recognition

- Feature point extraction by **FAST** algorithm
 - One of corner detection methods in image processing
 - Number of feature points x :
 $3 \leq x < 8 \rightarrow \text{「/」}$, $8 \leq x < 23 \rightarrow \text{「\Delta」}$, $23 \leq x \rightarrow \text{「○」}$
 $x < 3 \rightarrow$ ignored as noise



FAST algorithm

Condition that pixel p is corner :
Surrounding 16 pixels have

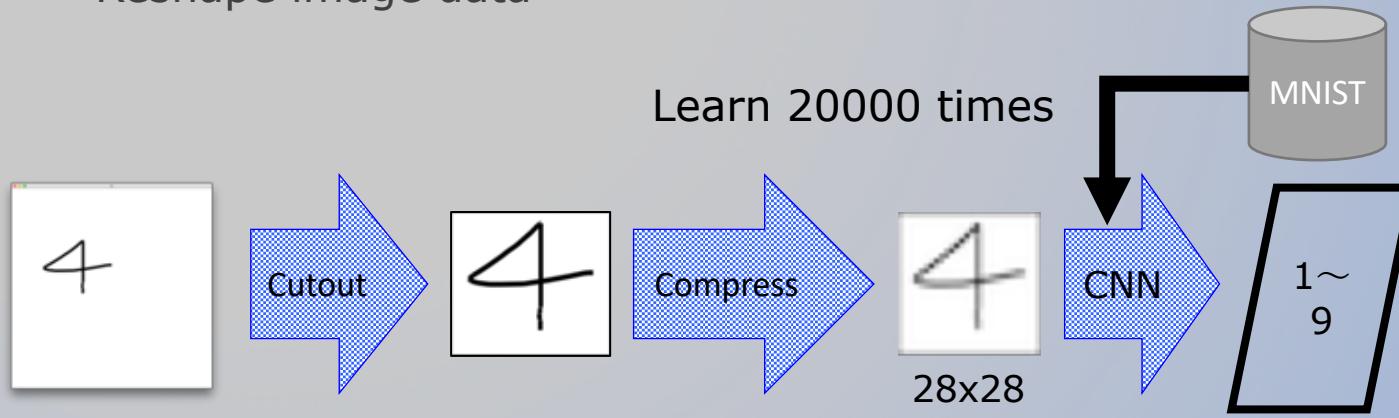
- Adjacent n pixels lighter than $I_p + t$
 - Adjacent n pixels darker than $I_p - t$
- (I_p : pixel value of p)

We determined $t = 10$, $n = 12$ from pre-experiment

E. Rosten and T. Drummond, "Machine Learning for High-Speed Corner Detection," in Proc. of the 9th European Conference on Computer Vision (ECCV'06), Vol. 1, pp. 430-443 (2006).

Handwriting Recognition 3

- Number Recognition by CNN
 - Learning datasets: **MNIST** 20000 times
 - Cutout number drawn by grader
 - Reshape image data



Flow of number recognition