COMP6733
IoT Design Studio

Recap


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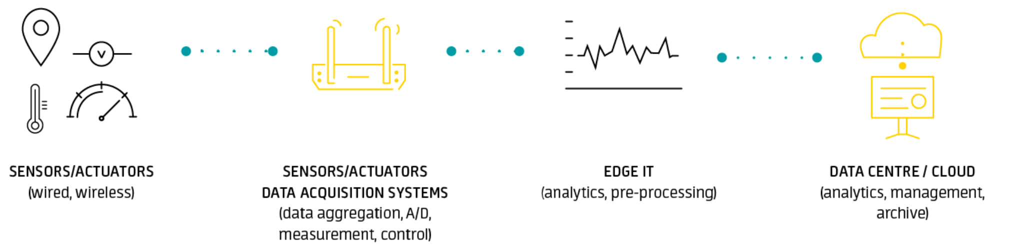
Recap: Weeks 1 to 7

We've covered many aspects of Internet of Things

- Low power communication primitives: IEEE 802.15.4, BLE, LoRaWAN, RPL, 6LoWPAN, CoAP/MQTT
- IoT system architecture: embedded devices (sensor and actuators), gateway (edge), Cloud (AWS)
- IoT service: time and space synchronization, light weight signal processing, machine learning.



What was the main reason you chose to do COMP6733? What do you want to learn after taking the course?

- Interested in IoT (sensors)/curious and want to try to use IoT
- IoT will be a trend in the future
- Jarvis:) ,application of IOT
- Industrial IoT and its applications
- Facility framework e.g., smart home
- Programming physical objects
- Embedded dev, hardware/software
- Doing a project, learn more networks
- Improving practical skills.

What you have accomplished

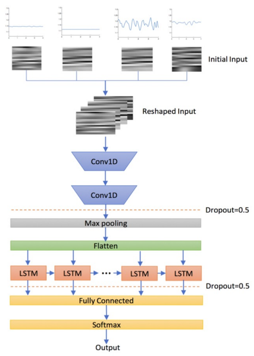
- Comprehensive overview of the low power protocol stack (except PHY layer)
- Key principles
  - Embedded devices, edge, cloud, time and space synchronisation, signal processing and machine learning etc.
- Key design issues
  - Low energy consumption
  - Resource constraint
  - Light weight
- Hands-on practical laboratory experiments with Arduino Nano BLE
- A major project and a problemset
  - Design and implement an IoT system.
  - IoT system design, communication and localisation
- Guest lectures
  - Local start up, Scientific research organisation.
  - Reef ecosystem (star fish) monitoring, blue carbon (sea grass) monitoring, smart grid.

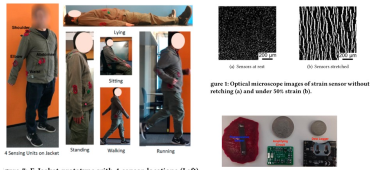
Read the syllabus in course outline. Is there any topic(s) beyond those listed that you would like your lecturer to teach in this course?

- N/A, nope, Not sure, Not yet, no idea, no, since I'm a beginner
- IIOT protocols like MQTT
- Protocols used in IoT industry
- Distributed systems in IoT
- More on smart IoT

ML sensing and Combining IoT & computer vision

Workflow (Deep Learning)

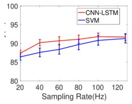




gure 7: E-Jacket prototype with 4 sensor locations (Left). ve different postures and activities to be recognized by E-cket (Right).

gure 1: Optical microscope images of strain sensor without retching (a) and under 50% strain (b).

re 6: A sensing unit comprises of a strain sensor with an lification circuit and a SensorTag as the data logger.



9: Recognition accuracy vs. sampling rates.

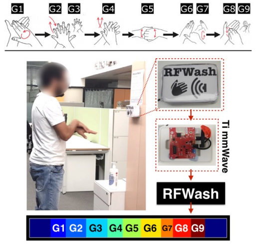
Table 3: Confusion matrix of 5 activities including 3 static postures without hand movements.

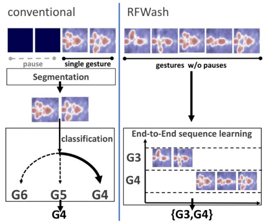
	Stand	Sit	Lie	Walk	Run	Recognition rate
Stand	87.6%	1.4%	8.1%	1.9%	0.9%	**87.6%**
Sit	0%	98.4%	1.4%	0.2%	0	**98.4%**
Lie	4.6%	2.7%	91.2%	0.9%	0.5%	**91.2%**
Walk	3.3%	1.2%	0.2%	93.4%	1.9%	**93.4%**
Run	1.6%	1.9%	1.5%	13.2%	81.7%	**81.7%**
Overall						**90.9%**

Figure 5: The CNN-LSTM model structure of E-Jacket.

- Q. Lin *et al.*, "E-Jacket: Posture Detection with Loose-Fitting Garment using a Novel Strain Sensor," *2020 19th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN)*, Sydney, Australia, 2020, pp. 49-60,.

Example, Weakly learning





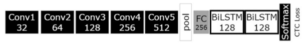


Figure 11: RFWash Network Architecture. All convolutions are 3 × 3 (the number of filters are denoted in each box).

Table 5: Recognition accuracy for different deep models

Gesture	C3D	C3D(p)	DSoli	DSoli(p)	RFWash
G_{No}	92.5%	95.1%	92.5%	94.6%	**97.8%**
G_1	69.3%	72.4%	41.6%	40.9%	**92.1%**
G_2	68.3%	76.7%	88%	**89.8%**	85.4%
G_3	84.2%	**92.9%**	76.1%	77.8	87.2%
G_4	82.2%	83.9%	77.5%	80.8%	**89.7%**
G_5	84.4%	86.4%	33.1%	34.9%	**87.7%**
G_6	48.2%	43.7%	20.3%	18.8%	**71.4%**
G_7	70.4%	69.3%	74.1%	77.2%	**79.6%**
G_8	56.7%	66.3%	76.6%	**80.6%**	77.7%
G_9	66.1%	75.9%	42%	42.1%	**84.2%**
Accuracy	73.33%	77%	63.15%	64.79%	**85%**

- https://www.youtube.com/watch?v=AHIsOOl6aLI&feature=youtu.be
- https://youtu.be/hwEDIya5bx0?t=45
- "RFWash: A Weakly Supervised Tracking of Hand Hygiene Technique", A. Khamiss, B. Kusy, C.T Chou, M. Mclaws, W. Hu. The 18th ACM Conference on Embedded Networked Sensor Systems (SenSys 2020), November 2020,

Generative Adversarial Network (GAN) Example

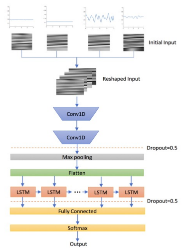


Figure 5: The CNN-LSTM model structure of E-Jacket.

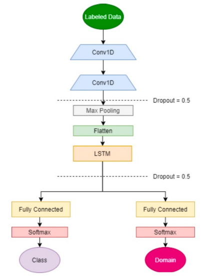


Fig. 9. The adaptive CNN-LSTM model struct

Fig. 2. Prototype with 4 sensor locations (Left). Five different postures and activities to be recognized by the smart garment system (Right).

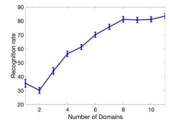


Fig. 11. Impact of number of domains on recognition accuracy.

No.	Without domain discriminator path	CNN-LSTM with domain discriminator path
1	76	96.9
2	72.8	82.8
3	73	85.9
4	68.6	85.7
5	66.9	74.7
6	75.7	72.1
7	73.9	87.9
8	77.3	85.8
9	68.2	80.8
10	73.8	71.2
11	78.6	88.1
12	76.6	82.3
Overall	73.5 ± 3.8	82.9 ± 7.4

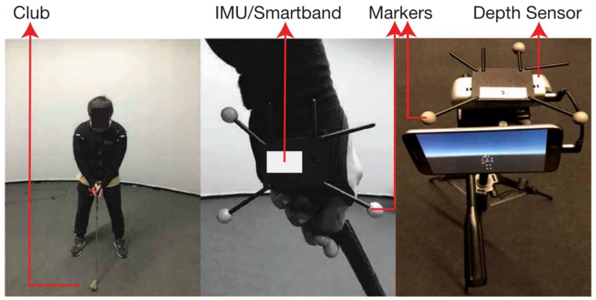


Fig. 8. A setup of the SwingNet framework evaluation. Analysis was completed by placing an IMU sensor on a subject' wrist and an Intel RealRense or a Kinect depth sensor face-on. Markers are used to calibrate the depth sensors.

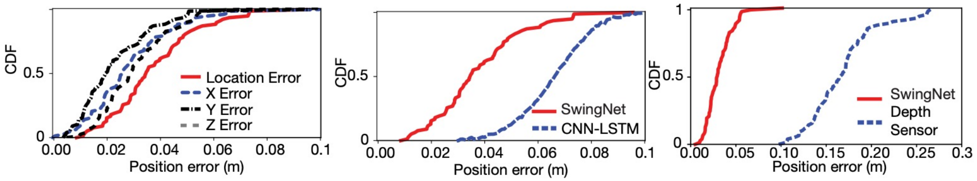
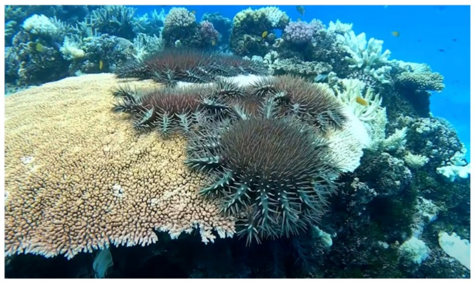
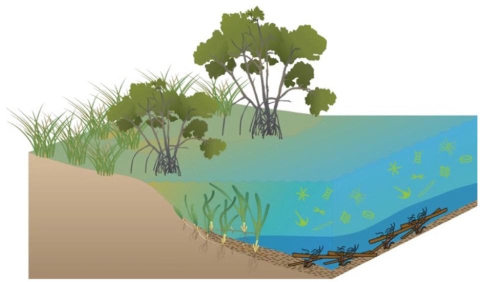


Fig. 9. The performance overview of SwingNet. (a) The overall position error; (b) compared to CNN-LSTM; (c) compared to raw depth sensor output.

Case Study: Surveys of Coastal Ecosystems





Crown of Thorns Starfish (Acanthaster planci) : a large starfish that preys on hard coral, leaving behind white carbonate skeleton

COTS population outbreaks are a major cause of coral decline.

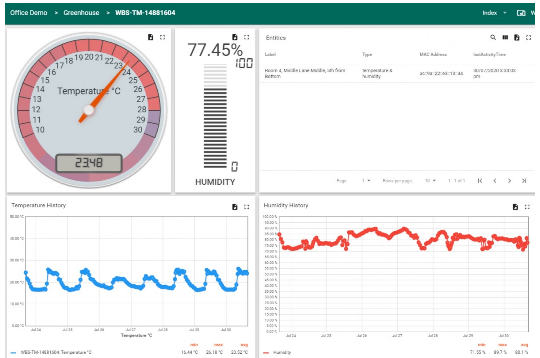
Government-funded COTS control program actively controls starfish populations on the Great Barrier Reef, the program involves 4-5 vessels and costs $10M+ per annum.

Blue Carbon coastal ecosystems provide important ecosystem services linked to sustainable livelihoods: they can sequester carbon for millennia, provide habitats for fish, filter nutrient runoffs from land, etc.

New scalable mapping and monitoring methods can provide a step change in our ability to tackle climate, prosperity, and livelihood challenges.

What can you learn next?

- UG-Honours Thesis
- PG course project (COMP9596, 12uoc, COMP9945, 18 uoc)
- PhD (funded by scholarships)



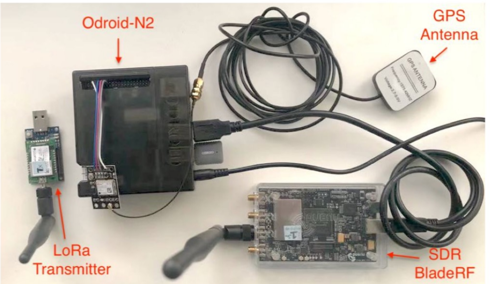
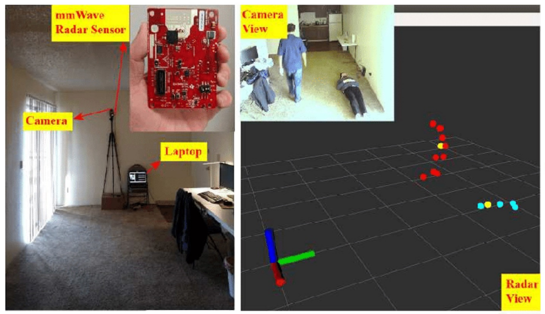


Figure 8: ***Nephelai*** **gateway and a LoRa transmitter**

Figure 12: Outdoor evaluation. Red squares marked with A/B/C/D and antenna direction indicate the APs. Green circles indicate the ground-truth of transmitter's locations.



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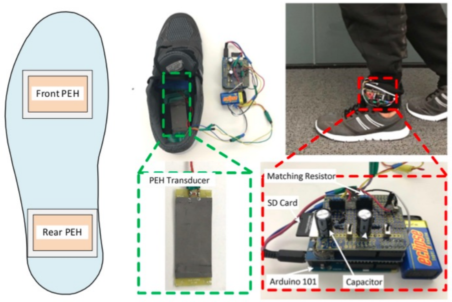


(a) Insole (b) Circuit design and placement of the prototype when subject is walking

Fig. 7: The design and appearance of the SEHS prototype.

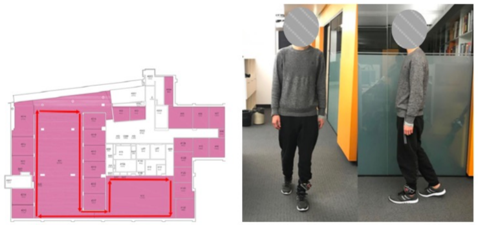
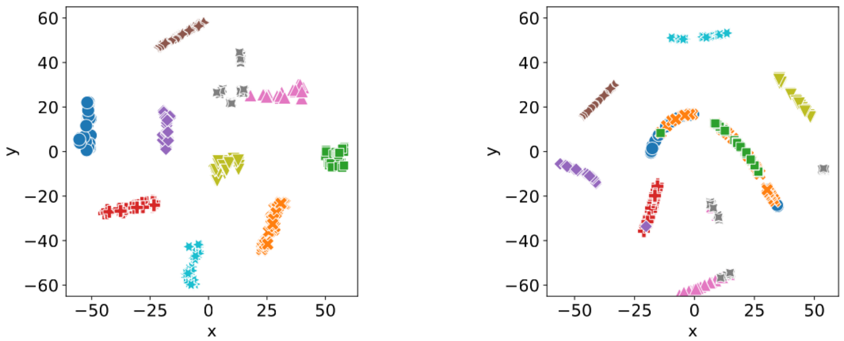
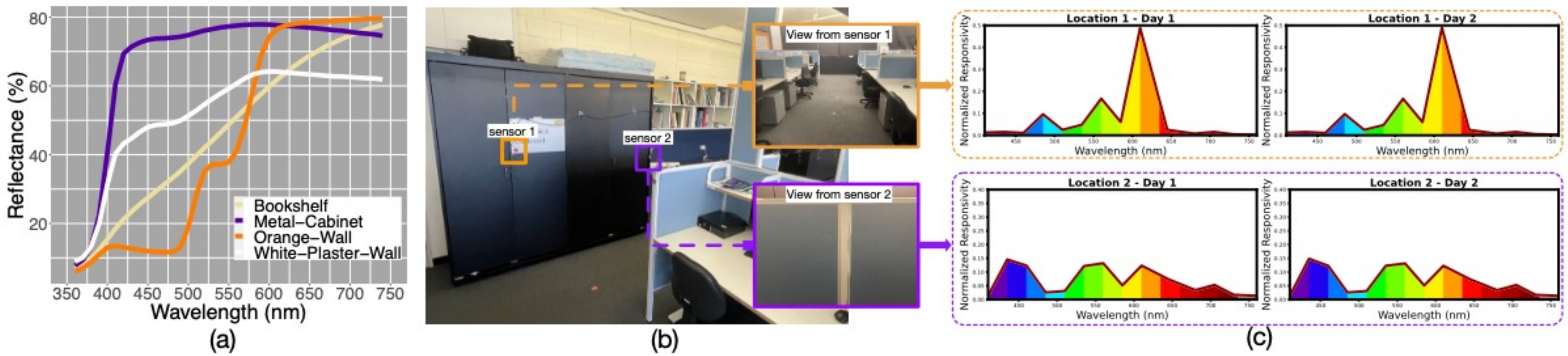

(a) Experiment environment (b) Subject Walking

Fig. 8: Data collection setup.



(a) Spectrum (b) Intensity

Fig. 2. t-SNE visualization of spectral vs. intensity data collected from 10 different locations within a meeting room. The average distance between two clusters is 29.88 and 27.35, respectively, for spectral data and intensity data.



Week 10

- Consultation and Lab run as usual.