AI & IoT-powered Precision Livestock Farming

Andri Yadi
CEO, DycodeX

CBC-ILA - Jun 16, 2020
About Me

Andri Yadi
Co-founder & CEO of DycodeX
Vice Chairman, Indonesia IoT Association (ASIOTI)
Microsoft MVP, Azure

a (at) dycodex.com | andriyadi.com | github.com/andriyadi

Physicist, Developer, Maker, Community Guy, Entrepreneur

Microsoft Most Valuable Professional (MVP) for 12 years
Code for food & passion for 20 years
Break & make electronic stuffs for 22 years
Trying to change the world through entrepreneurship, 15 years now
My Company

Our vision is to solve big problems with technology.

We’re 5 years tech startup, pioneering and leading in developing end-to-end in-house Artificial Intelligence (AI) & Internet of Things (IoT)-powered products & solutions in Indonesia.

As seen on

[Logos of various publications and companies]
Approach

We approach our solutions to be powered by AI + IoT, end to end

IoT is about automated data collecting, storing, visualisation, and reacting, in massive scale

“Data Supplier”

AI is about making sense of the massive data, providing insights & recommendation, and predicting the future outcome

“Data Miner”

Combining AI + IoT (AIoT) enables a lot of opportunities!
In 11 years

8.5 Billion
Human in planet Earth

Production needed

1.2 Billion
Tons of milk

400 Million
Tons of meat*

From

1.8 Billion
Cattle*

“Livestock sector is one of the fastest growing parts of the agricultural economy, contributing 40% of the global value of agricultural output and support the food security of 1.3 billion people”

“Indonesia will be self-sufficient in beef in the next 10 years”

Ir. Joko Widodo, President of Indonesia

*FAO
Program Strategis Kementan

Mempercepat peningkatan populasi sapi di tingkat peternak
Memperkuat aspek pembenihan dan pembibitan
Penambahan indukan impor
Pengembangan Hijauan Pakan Ternak
Penanganan gangguan reproduksi
Penyelamatan sapi betina produktif
Penanggulangan dan pemberantasan penyakit hewan

Our Challenges...

Indonesia’s beef supply is still less than 60% out of demands

Cattle farming still has real world problems

“We have no reliable way to track feeding behaviour. Non-eating cows are often found dead after 2-3 days.”

A personal farm, Subang - Indonesia
Manages 400+ cows

HERD COUNTING
“We often lose count when a herd of cows moves between grazing areas”
A corporate farm, Indonesia, manages 8000+ cows

OPERATION EFFICIENCY
“We have to visit hundreds of cows every day, just to check if they still move. Active cows are the best breed”
Cattle Breeding Centre - Ministry of Agriculture
Manages 1400+ cows

FOOD SECURITY & TECH
“We have no reliable data to answer a simple question, can we feed the nation?”
“The best monitoring technology we’ve deployed is RFID-based ear tag”
Ministry of Agriculture, Indonesia
Other Problems

Ternak kerap keguguran di usia kehamilan tertentu. (Sumber: Merdeka Sapi Keguguran)

Ternak berpenyakit karena peternakan yang tak rutin dibersihkan, dan berisiko menyebar ke ternak lainnya. (Sumber: Sapi Bagus)

Sulitnya melacak lokasi ternak, khususnya di peternakan ekstensif.

Risiko kematian karena peternak terlambat mengidentifikasi penurunan nafsu makan.

Minimnya data akurat seputar sapi produktif (siap potong) yang dimiliki pemerintah, pribadi, dan swasta.
Let's solve the problems with the help of “Deep Tech”
But, what is “Deep Tech”?
Deep Tech

- Artificial Intelligence
- Blockchain
- Internet of Things
- Robotics
- Chemistry
- Green Energy
- Life Science
Data-driven management of livestock by continuous automated real-time monitoring of production/reproduction, health and welfare of livestock and environmental impact.
Introducing...

SMARTernak

Internet of Things & Artificial Intelligence-powered Cattle-Farm Assistance Platform

* “Ternak” in SMARTernak means “cattle” in Bahasa Indonesia
BASE STATION
5-10 km coverage, to connect devices with Cloud.

WEARABLE DEVICE
Cattle-wearable device contains plethora of sensors.

BARN SENSORS
Collection of sensors to monitor environment, water level, and more.

DRONE
Provide surveillance and help herding.

BASE STATION
5-10 km coverage, to connect devices with Cloud.

CLoud
Where the heavy-lifting happens.

SMART CAMERa

*optional*

VIRTUAL FENCE
Contain and move cattle without physical posts and wires.

SMART Camera:

*In development*

CARETAKER
One farmer/caretaker can easily handle hundreds of cattle, and vast grazing area.

FARM MANAGER / OWNER / INVESTOR
Monitor the farm and manage operation comfortably from anywhere in the world.

CARETAKER
One farmer/caretaker can easily handle hundreds of cattle, and vast grazing area.

SMART Camera:

*In development*
On-farm Smart Camera:
Monitor activity of 5 - 10 cattle - focus on group activity
Count herd & movement
Estimate weight

Cattle-wearable device:
Precisely monitor each cattle for:
Location (latitude, longitude, movement speed, direction)
Body temperature
Ambient temperature & humidity
Ambient light & sound
Movement (linear acceleration, angular velocity, direction)
Chest Circumference
Device removal status
Battery voltage & capacity

Barn Sensors:
Monitor ambient temperature, humidity, and air quality in barn
Monitor food & water level

Provide insights - powered by AI
farmer doesn’t really care about (raw) data
Cattle-wearable Device

**Dual IoT Connectivity**
- Short Range: Bluetooth v5. BLE
- Long Range: LoRa/LoRaWAN or NB-IoT, for 5-10km coverage area

**Powerhouse**
- Ultra low power Microcontroller with on-device Machine Learning capability

**Packed with Sensors**
- GPS / GNSS
- Accelerometer, Gyroscope, Compass
- Body Temperature
- Ambient Temperature & Humidity
- Barometric Pressure
- Ambient Light
- MEMS Microphone
- Device Removal Detector

**Actuators**
- Audio Alert via Buzzer
- Color LED

**Enclosure**
- Waterproof & submersible (IP67)

**Smart Energy**
- Battery Gauge
- Solar Energy Harvesting
- Smart Switching Between Main & Backup Battery
- Fast Charging from USB Type-C
- Firmware-optimised power consumption

*But SMARTernak is about platform. It’s open to 3rd party devices.*
Device Internals

Hardware is 100% designed in-house, mass-produced in Indonesia, by 100% Indonesian
Cattle Location Tracking

Precisely locate cattle
No need to check cattle physically, to increase productivity

Virtual geofencing:
Virtual and remote herding
Alert upon cow out of area
Precise herd counting, no cattle left behind
Less physical (electrical) fence
Cattle Location Tracking

Precisely locate cattle
No need to check cattle physically, to increase productivity

Virtual geofencing:
Virtual and remote herding
Alert upon cow out of area
Precise herd counting, no cattle left behind
Less physical (electrical) fence

Out of area alert
Cattle Grazing Activity

Grazing activity
Monitor & control grazing pattern, giving time for food to grow, ensuring sustain supply
See the distance walked over time compared to other cattle
Receive notifications when cattle hasn't moved for a while.
Animal welfare

Tracking - Benefits

Less or even no need physical fence, esp. electrical fence that may cause trauma
No risk of cattle stuck in fence
Missing/left cattle can be identified and found in no time
Tracking - Benefits

Productivity increase:
No need to visually check cattle. Existing care-takers can handle more cattle, no need to add more.

Grazing pattern is controllable:
Ensure food source is sufficient for healthy cattle. Give time for grass to grow.

No more missing cattle:
Prevent missing or stolen cattle

Less or not physical fence:
Reduce cost to install and maintain fence
Artificial Intelligence at The Edge

Learn & recognize cattle behaviours to tailor actionable insights & recommendation based on sensor data with the help of on-device Artificial Intelligence.

Motion captured by Inertial Measurement Unit (IMU) sensor inside cattle-wearable device.

Deep Neural Network Inference right on the device.

Activity Insights (standing, lying-down, feeding, and more)

Cattle 02
Age: 3 years, 5 months, and 7 days
Breed: Simmental
Gender: Male
Weight: N/A
Last updated at 10/11/2019, 1:27:04 PM

Device ID: smartfarm_a6610a3234239210
Battery Status: 41.16%, 4.06 Volt

Predicted Activity: lying

Activity Data
10/11/2019, 12:00:00 AM - 11:59:59 PM

Activity Durations in the last hour:

idle
lying
standing
feeding

App
Animal activity recognition
No need to visually observe the animal

Activity stats:
Activity count and duration statistic during certain timespan

Activity duration and switching. Can be used for determining symptoms of possible health issues.
Alert when animal has stopped moving, not feeding, not enough activity, in-heat, and more
On-device Activity Prediction

Using Artificial Intelligence and deep learning with Tensorflow, SMARTernak can detect and learn cattle behaviour and analyze the data into actionable insights and recommendations to improve efficiency and reduce loss.


Actual footage taken from SMARTernak field trial live feed at PT. Sumber Hijau Mandiri on September 9, 2018. SMARTernak smartphone app overlay is an illustration of real-life usage.
On-farm Smart Camera

Cattle Counting & Behaviour Analysis using on-farm camera with the help of Machine Vision & on-device Artificial Intelligence

Image/video stream from camera

Deep Neural Network
(Object Detection & Tracking, Instance Segmentation - inference right on the device)

Detected cows and predicted activity
(standing, lying-down, feeding, ...)

*In development
Smart Camera Use Case - Cattle Herd Counting

Demo Video: https://youtu.be/Yk3O_HlmSK8
Ministry of Agriculture’s Cattle Breeding & Food Center at Padang Mengatas, West Sumatera, Indonesia in collaboration with Ministry of ICT (KEMENKOMINFO), supported by Ministry of Agriculture.
BPP IBTSP Bunikasih, West Java Province
at Cianjur, West Java, Indonesia, Dec 2019
in collaboration with XL Axiata for 1st implementation of Desa Digital - Livestock
Ridwan Kamil, West Java Governor

IMPLEMENTASI “DESA DIGITAL” MENERIMA AWARD OF EXCELLENCE 2019 dari OpenGOV, institusi internasional di bidang inovasi pemerintahan.

INOVASI ini adalah salah satu yang mengangkat 537 desa naik kelas dari desa berkembang menjadi status desa maju dalam waktu 10 bulan.

Award ini dideklarasikan untuk semua pihak yang bekerja keras melalui kolaborasi Pentahelix.

MARI SEMANGAT, jika desa juara maka Insya Allah #JabarJuara.
Digital Village

Mind Map Desa Digital

- Pemancaan Sinyal + WiFi
- WA Grup Kepala Desa
- WA Grup Warga Desa
- Pemancaan Publik Desa
- Bisnis via Digital
- Promosi
- Komoditi
- Akses Medsos Desa
- Apps Perikanan Pertanian
- IRRI
- Kネタ
- Kompetensi
- Berita E-Fishery
- Desa Digital JABAR

Digital Village Partnerships

- Infrastructure
- Agriculture
- Education
- Waste Management
- Livestock
- Digital Literacy
- Tourism

- RUANG GURU
- EDUBOX
- TEACHCAST
- SMASH ID: smosh
- BAKTI
- TEACHCAST
- E-Fishery
- DYPADEX
- APXKAR
- Aksaramaya
- AKSARAMAYA
- TREYA
- TELKOM UNIVERSITY
- GENWIS
- ENWIS

- Global Urban
- Bukaapak
- SMEs
- Tokopedia
- BUKAPAK
- SME
- Tokopedia
- KUDO

- BUPATI
- GUBERNUR
- WA Grup Kepala Desa

- Ridwan Kamil, 2018
Digital Village - Livestock Farming
In progress to work with West Java Government - Digital Service Division, for an initiative of “Digital Village - Livestock” to tap the cattle farming potentials in West Java, which is the 2nd largest in Indonesia

Contact us for more detail on the program
Coverage by Metro TV in Ciawi, Bogor

Watch here:
https://www.metrotvnews.com/play/b3lUoePr-asli-lokal-kualitas-global-1
Cattle Activity Recognition

GPS & Compass

Notify Cattle Health-related Issues

Long Range Low Power IoT Connectivity

Activity & Performance Insights

On-device Artificial Intelligence

Virtual Geofencing Out of Area Alert, Herd Counting & Grazing Insights

Wearable

All-1/2-year Battery Life and some more, with energy harvesting from solar

Sense Surrounding Environment

Virtual Geofencing Out of Area Alert, Herd Counting & Grazing Insights

Smart Energy with Backup Battery & Energy Harvesting


https://smarternak.com

Sits firmly on cow’s neck

Device Removal Alert

Weight Progress Estimation*

Health Tracking Ultimate

3 variants for all farm types


3 variants for all farm types

CPU

AES Co-processor

NFC-A Bluetooth S

DC-DC Buck Converter

RAM 256kB

Crypto

1 MB Flash


## SMARTernak Variants

### Core features
- Cattle position tracking
- Virtual geofencing
- Herd counting
- Grazing insights
- Activity insights
- Behaviour insights
- Health insights
- Surrounding environment monitoring
- Weight gain insights (beta)
- Device removal alert
- Rich web-based dashboard
- Android & iOS app

### Additional features
- Energy harvesting from solar
- Additional battery lifetime (smart energy management + backup battery)

### Subscription features (Rp83K / month / cow)
- Access to web dashboard and mobile apps, and all future updates
- On-site training, assistance, support
- Device warranty and support

<table>
<thead>
<tr>
<th>SMARTernak Tracking</th>
<th>SMARTernak Health</th>
<th>SMARTernak Ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rp1.49M per cow, one time cost</td>
<td>Rp1.49M per cow, one time cost</td>
<td>Rp2.59M per cow, one time cost</td>
</tr>
</tbody>
</table>
LET'S DO FIELD TRIAL

We understand that before the real large implementation, customers often need to try out the solution first.

Let’s discuss.
Implementation Phases

Field Trial
Limited implementation to try out the solution, identify unique requirements, and key success indicators.
Device amount: 5 - 10 pcs
Duration: 1 - 3 months

Lessons-learned & Customization
Collect lessons-learned, key success indicators, feedbacks. Then decide the next steps.
Collect and new requirements, propose system design that accommodates customisation and improvement needed
Develop new system
Duration: 1 - 3 months

Real Implementation
Real and massive implementation
User assistance is provided
Device amount: upon request
Duration: 3 - 6 months
In the near future...

**SMARTernak is not only for cows**
It’s about precision livestock farming platform

- Ruminant Livestock
- Wild Animal Tracking
- Poultry
In the future...
DycodeX is much more than just SMARTernak and Agricultural space
Other Real-World Products & Solutions

AI & IoT-powered devices & platforms

- **DytraX**
  - General-purpose Asset Tracker Platform
  - Agriculture

- **SMARTernak**
  - Livestock-farming assistance platform

- **AlTrash**
  - Smart Trash Management

- **ALORA SENSOR KIT**
  - Industrial Environmental Sensing
  - Energy & Environment

- **IoT Prototyping Platform**
  - for Education, Makers
  - Maker Movement

- **smarterbike**
  - Bike Fleet Management
  - Asset tracking

- **PANIC BUTTON**
  - Personal tracker, emergency assistance, ...
  - Security

- **PowtraX**
  - Electricity Power Monitoring

- **Pressure Transmitter**
  - LPWA, 200 bar, liquid & gas
  - Industrial IoT

- **Machinery Health Sensor**

- **IoT Prototyping Platform**
  - for Education, Makers

- **Custom IoT Hardware Design**
  - Already helped 20 companies/startups
  - End-to-end AI + IoT Development
  - Firmware, cloud, AI, web & mobile

- **Design House**
A product out to fight COVID-19
Codename: “HeatraX”
IoT Prototyping Platform for Education & Makers

**IoT Prototyping Platform**

Optimized for learning STEM, coding & electronics, also for fast prototyping.

Already sold 1000+

**Hardware:**

ESPectro32: A development Board having highly capable, low-power dual-core Microcontroller, with built-in WiFi & Bluetooth connectivity

Extensible with Backpacks: NB-IoT/Cellular, LoRa, Sensor Kits, Motor Driver, and more

**Software:**

Arduino Software-compatible, supported by ready-to-use libraries

Learn to code with:

Visual drag-and-drop blocks*

Swift Playground*

IoT Cloud: to easily connect IoT devices

* in development

All products’ electronic board is designed & assembled in-house by 100% Indonesian
Local & Global Partners

Supported by
3 Ministries of Republic of Indonesia

Partnering with global brands for IoT R&D, component supply, mass production, and go to market

Local Partners:
Some Awards & Recognitions

The local winner & represents Indonesia to the 1st Google Demo Day Asia

Won Rice Bowl Award 2018 for IoT Maker Ecosystem Initiator

Champion of the 1st Intel Indonesia OpenVino Challenge (AI competition)

Won Merit Award in Asia Pacific ICT Alliance (APICTA) 2019 Awards for IoT Category

More Awesome Journey: https://dycodex.com/milestone/?data-value=192
SMARTernak terpilih sebagai satu-satunya produk dalam negeri yang mewakili Indonesia di ajang Google Demo Day Asia 2018

Perjalanan panjang Kami:
https://dycodex.com/milestone/
Desa Digital dengan SMARTernak

Sehatkan Sapi, Sejahterakan Negeri

hi@dycodex.com | https://smarternak.com
Keep in touch

hi@dycodex.com | https://dycodex.com

Bandung, Indonesia