

tinyML[®] for Good

Tiny technology for the world's biggest challenges

Offline Prediction of Cholera in Rural Communal Tap Waters Using Edge AI inference

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Offline Prediction of Cholera in Rural Communal Tap Waters- tinyML for good

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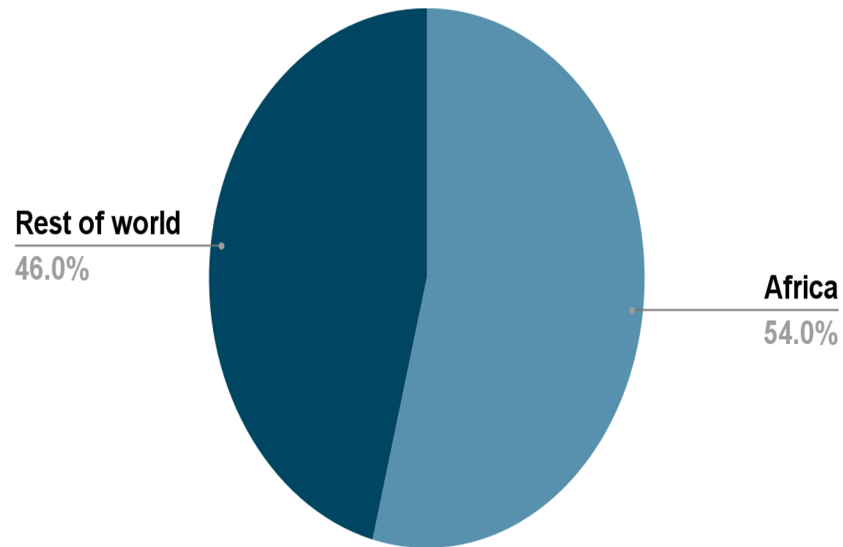
TINY AI SOLUTIONS
INTELLIGENCE AT EDGE



Motivation of the study

Societal Challenge

Cholera disease burden



- Cholera is a Water borne disease
- Kill up to 200K persons yearly

Existing Detection Technology



Are not Cost effective



Not scalable for mass Deployment



Long detection time
e.g APW takes upto 24h



Require lab settings
e.g use of APW

Our research basis



Edge AI Cholera pluggable detection device

Target: Communal rural water taps

Data: Water PhysicoChemical parameters

Cheap for mass deployment

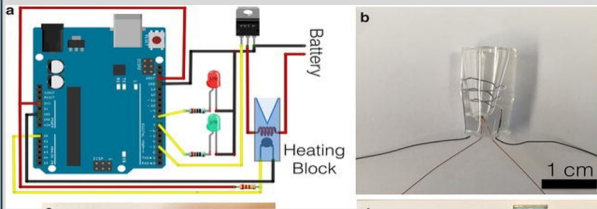
Edge AI because

Poor rural internet connectivity

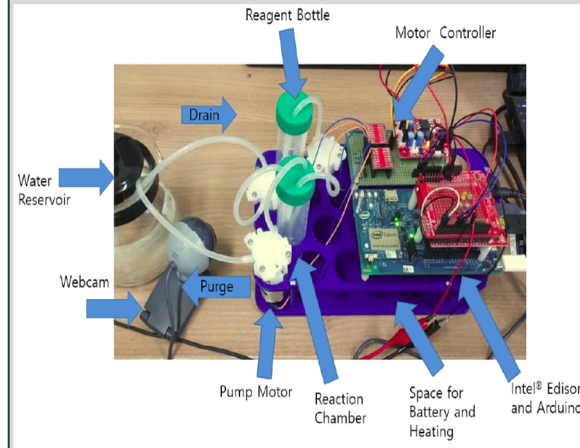
Fast response time

State of the Art

Lamp a chip



The heating block keeps a constant temperature of 65.5 ± 1.4 °C for the whole duration of the experiment



Sensor Node
for Remote
Monitoring of
Waterborne
Disease-
Causing
Bacteria(E.coli)



Uses an iPhone app
And particle
diffusometry to
detect cholera

10 studies that attempt to detect water quality/ waterborne disease are also reviewed. Propose use of climate data to detect cholera to perform ML, also use ML at the cloud to perform Water quality analysis, offline prediction without ML

Gaps

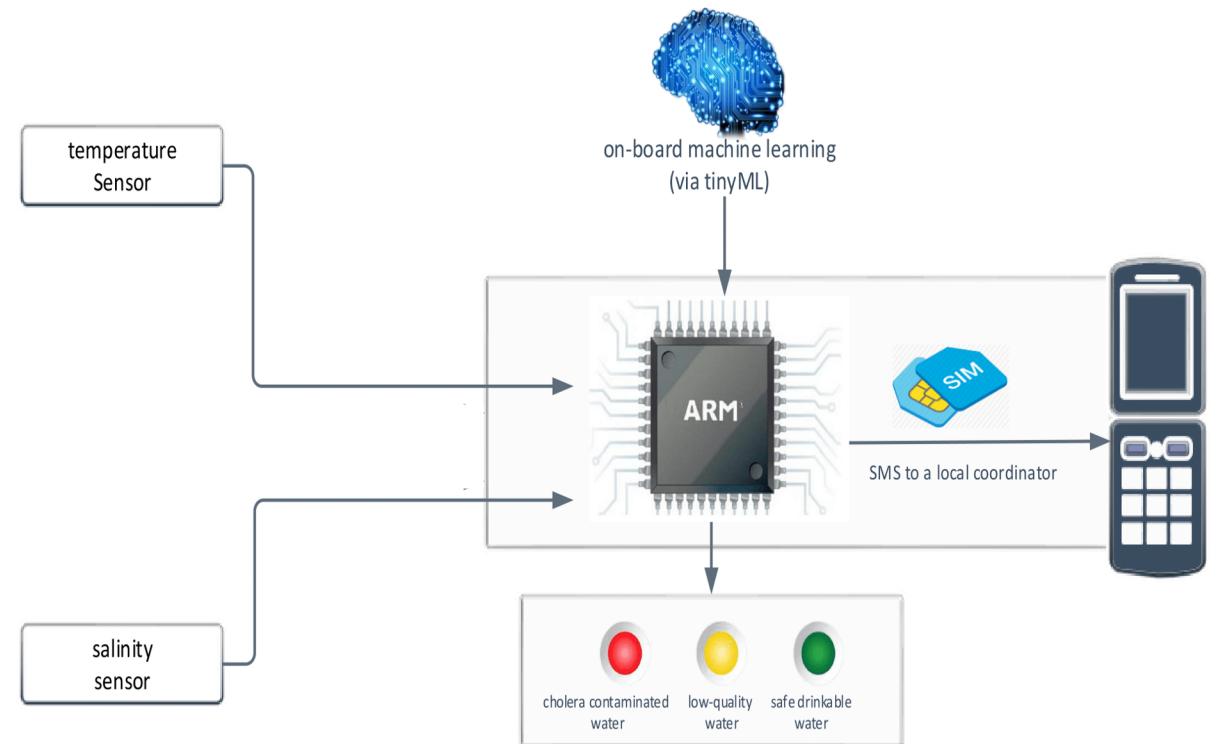
Solutions are expensive and rely on cloud based Architectures.

Waterborne detection without lab reagents

Limited studies detect water borne disease using ML at the edge

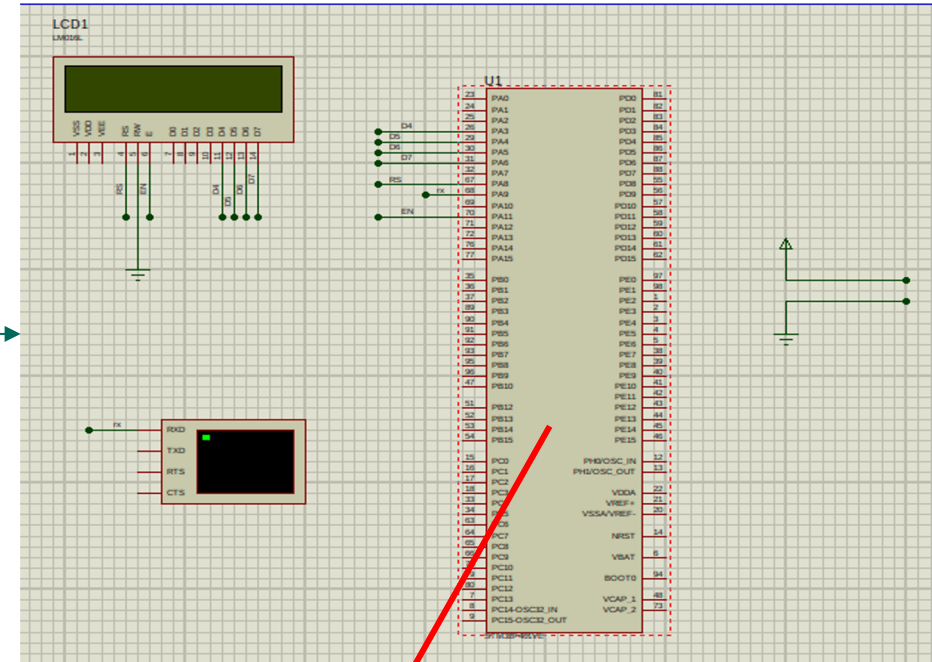
Solution

- A **pluggable** device at the communal rural water tap.
- Sensed data from sensor fusion on leaked water analysed using edge AI enabled MCU
- LEDs indicate for notifications:
green - cholera-free water :red - cholera infected water
- A wireless GPRS/GSM interface enables water notifications via SMS



Embedded Simulation

STM cube IDE

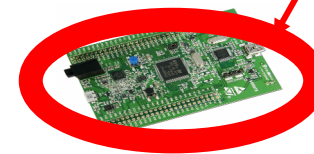


Proteus PCB layout components

LCD

Virtual terminal

Target board -Arm Cortex-M4 core with DSP
and FPU, 512 Kbytes of Flash memory, 84
MHz CPU



Embedded Simulation Result

A comparison of simulation results and cloud platform show that the edge AI model achieves similar inference accuracy when running on embedded processors as well as on the cloud.

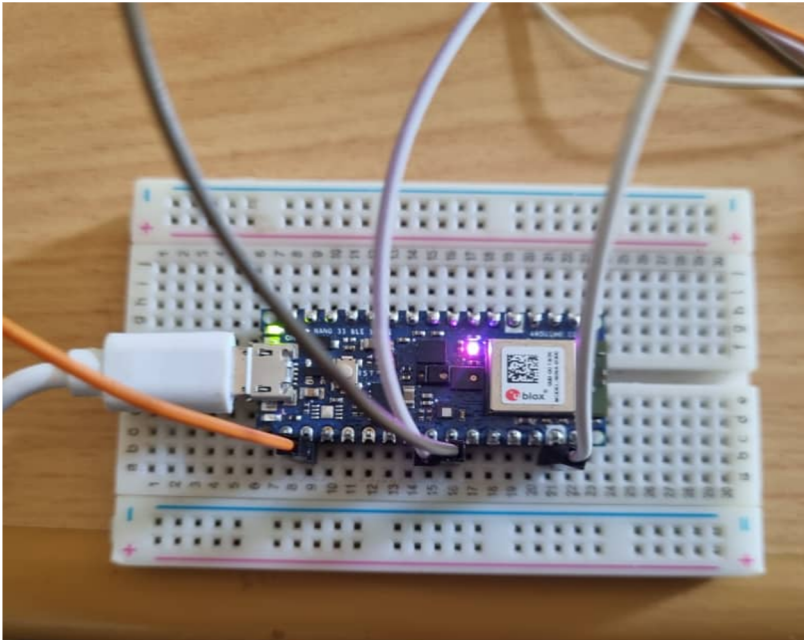
LIVE CLASSIFICATION

NO_CHOLERA	YES_CHOLERA	ANOMALY0
0.89	0.11	-0.15

PROTEUS OUTPUT

```
Virtual Terminal
Features[1 ms]: 25 0.887
Running Neural Network...
Predictions(8: ms.):
No_cholera:88.67187
Yes_cholera:11.32812
Anomaly score(time: 2 ms.):0.11186
Run_classifier returned: 0
Predictions (DSP: 0MS., Classification: 8ms.,
Anomaly: 2ms)
[88.67187, 11.32812, 0.11186]
```

Progress: Hardware set-up



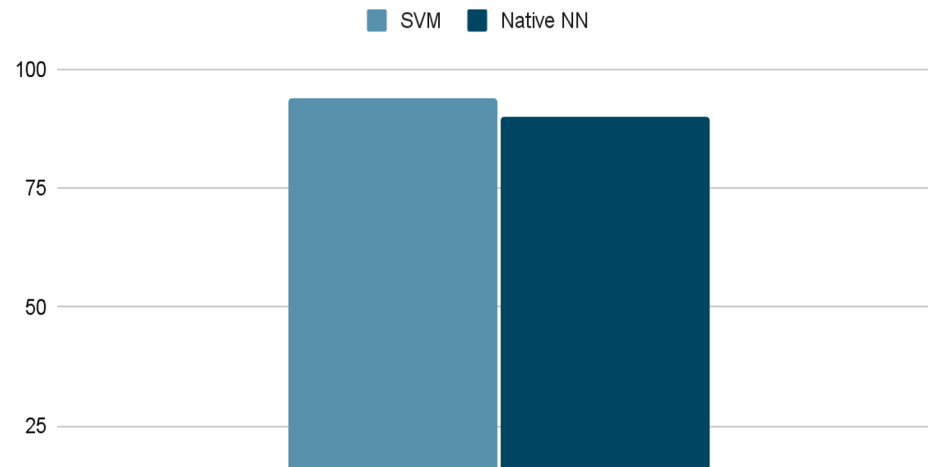
Real-time embedded processor specifications

Model Inference Performance

ACCURACY
94.03%



SVM and Native NN



On device real-time performance



Inference Time
1 Ms



RAM
1.5K



ROM
14.9K

Potential Impact



A solution that can report consistently will give a more accurate epidemiological view. An incomplete assessment due to lack of reporting by many countries risk the disease being more severe than speculated due to under reporting.

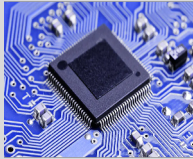


Public communal taps are still the main access points to water used for drinking and cooking. As an example for South Africa, in 2020 up to 7.5 millions of the population, meaning 13%, were still use public communal taps (SOURCE <https://www.sciencedirect.com/science/article/pii/S0957178720300382>).



Increased access to safe water. 1,567,038 in urban areas and 2,978,400 in rural areas will potentially benefit from having piped water analyzed at the tap (From WHO, online JMP data of 2017).

Call to Action



Extensive prototyping on
a real
embedded board.



VS



Lab controlled
comparisons

Grants and
investments to scale
production (PCB
designing,
patentiing, 3D
printing)



Explore more datasets for
different sensor fusion /
data collection



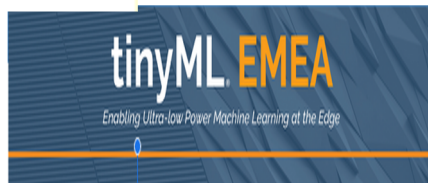
Scale to other
Embedded providers

- Board acquisition support
- Lack of tinML enabled board supplier in the region
- Support to carry out offline Trainings and workshops

Acknowledgements, Presentations, Partners & events



BEST ABSTRACT



Accepted to :



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7–11 December 2021 // Madrid, Spain // Hybrid: In-Person and Virtual Conference
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Thanks for your time

Comments and contributions

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