Smart-Log: An Automated, Predictive Nutrition Monitoring System for Infants through IoT

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Outline of the talk

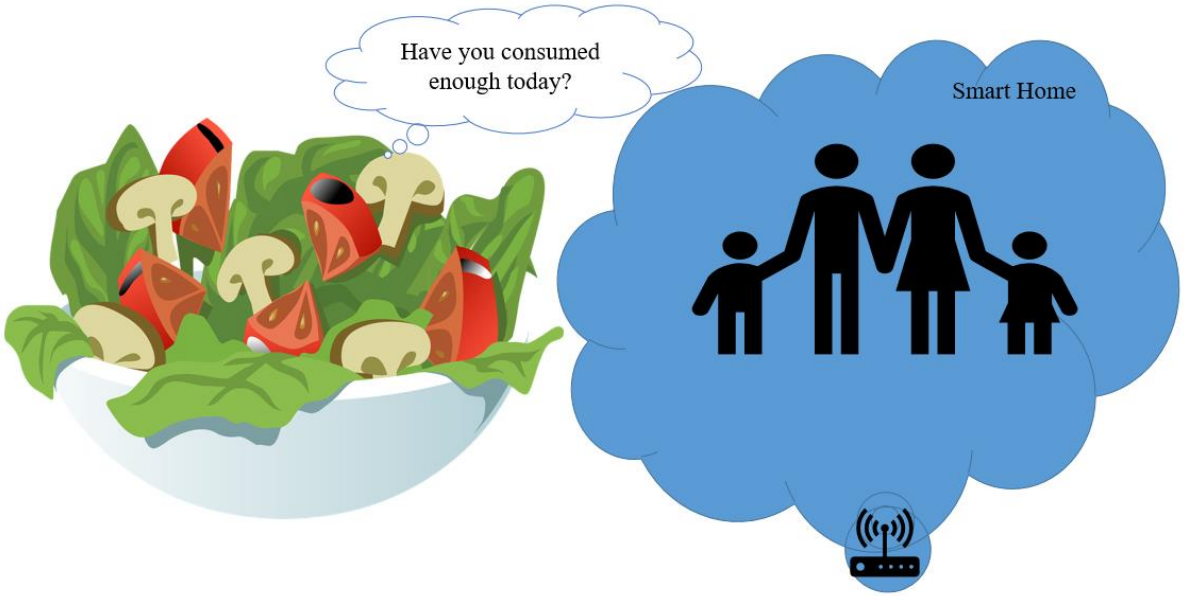
- Introduction
- Novel Contributions
- System level Modeling of Smart-Log System
- Implementation and Validation
- Conclusions and Future Research

Introduction

- Nutrition imbalances in infants
- Significance of Nutrition Monitoring System
- IoT in Smart Healthcare

Nutrition Imbalances

- Imbalances in nutrition can occur either due to undernourishment or over nourishment.
- Malnourished children tend to have weakened immune system.

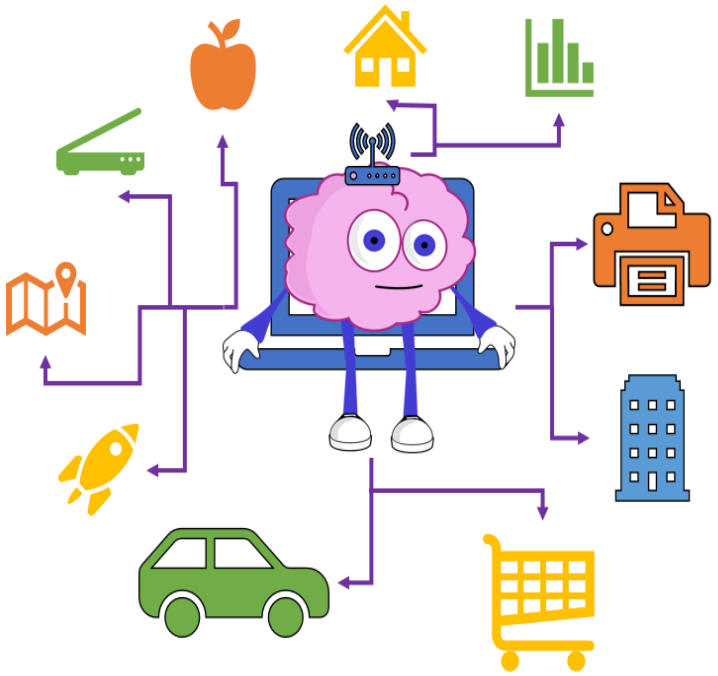


Significance of Nutrition Monitoring System

- Healthy lifestyle starts from having a well balanced diet.
- Many children tend to be fussy eaters where aversion of certain food stays forever.
- In such scenarios, finding potential replacement of the concerned food item is important to maintain a well balanced diet.

Internet of Things (IoT)

- The Internet of Things helps in connecting real world sensor data to cloud based solutions.
- The IoT acts as a virtual brain of wireless sensor networks which can be realized as mixed signal systems.



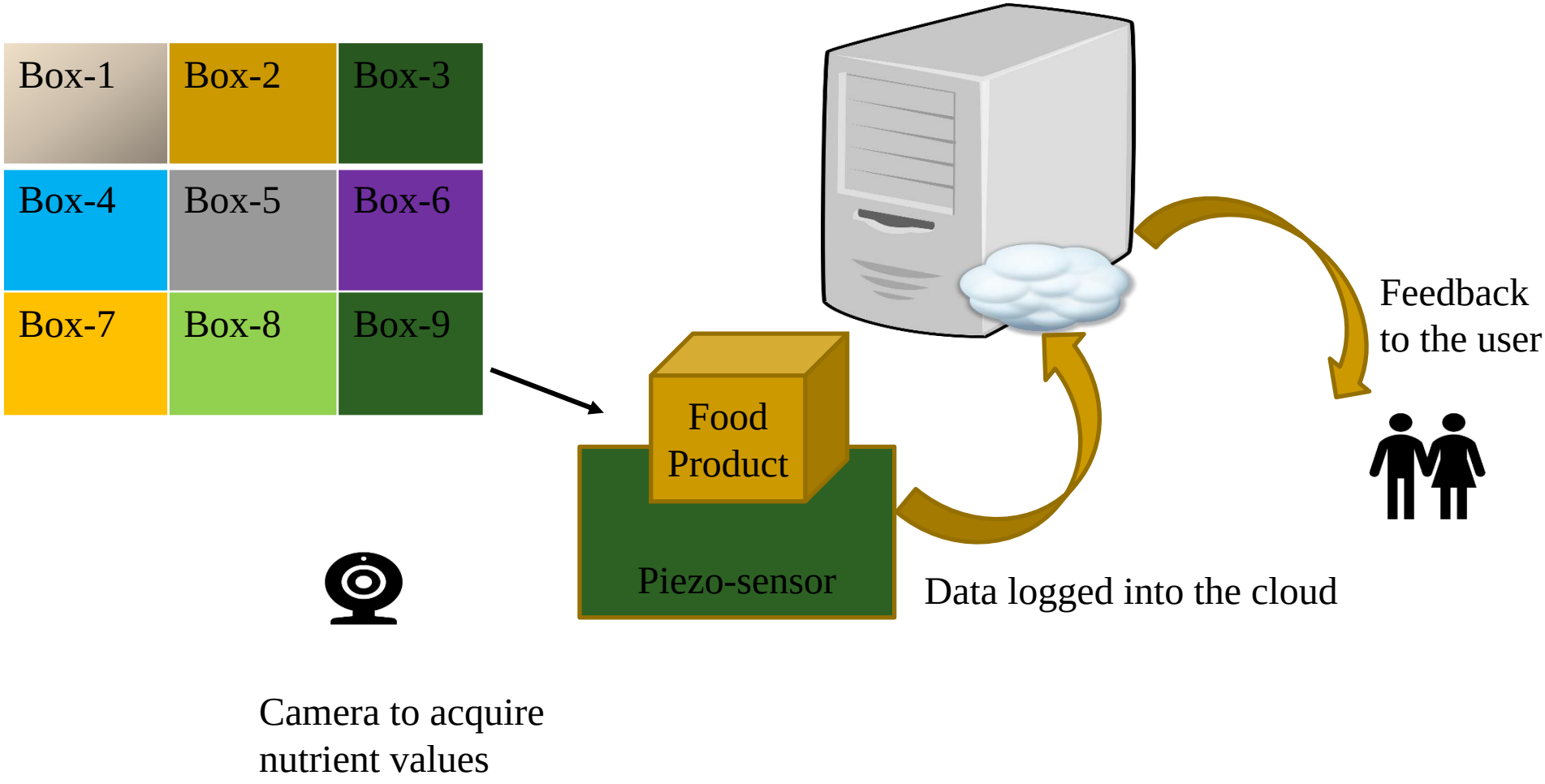
Novel Contributions

- An automated solution which keeps track of the amount of food consumed along with the nutrition facts.
- A prediction based method to analyze nutrient values of future meals.
- Feedback is taken from the user each time to customize the user's need.

System Level Modeling of Smart-Log System

- Smart Sensor Board
- Data Acquisition
- Future Meal Predictions

Overview of IoT based Smart-Log System



System level Modelling of Smart-Log System

✓ Smart Sensor board

- The proposed sensor system consists of piezoelectric sensors paired with a micro-controller.
- Piezoelectric sensors generate equivalent voltage signals for the applied weight or mechanical force.
- This equivalent voltage value can be read with help of micro-controller which saves the obtained value along with the timestamp.

System-Level Modelling of Smart-Log System

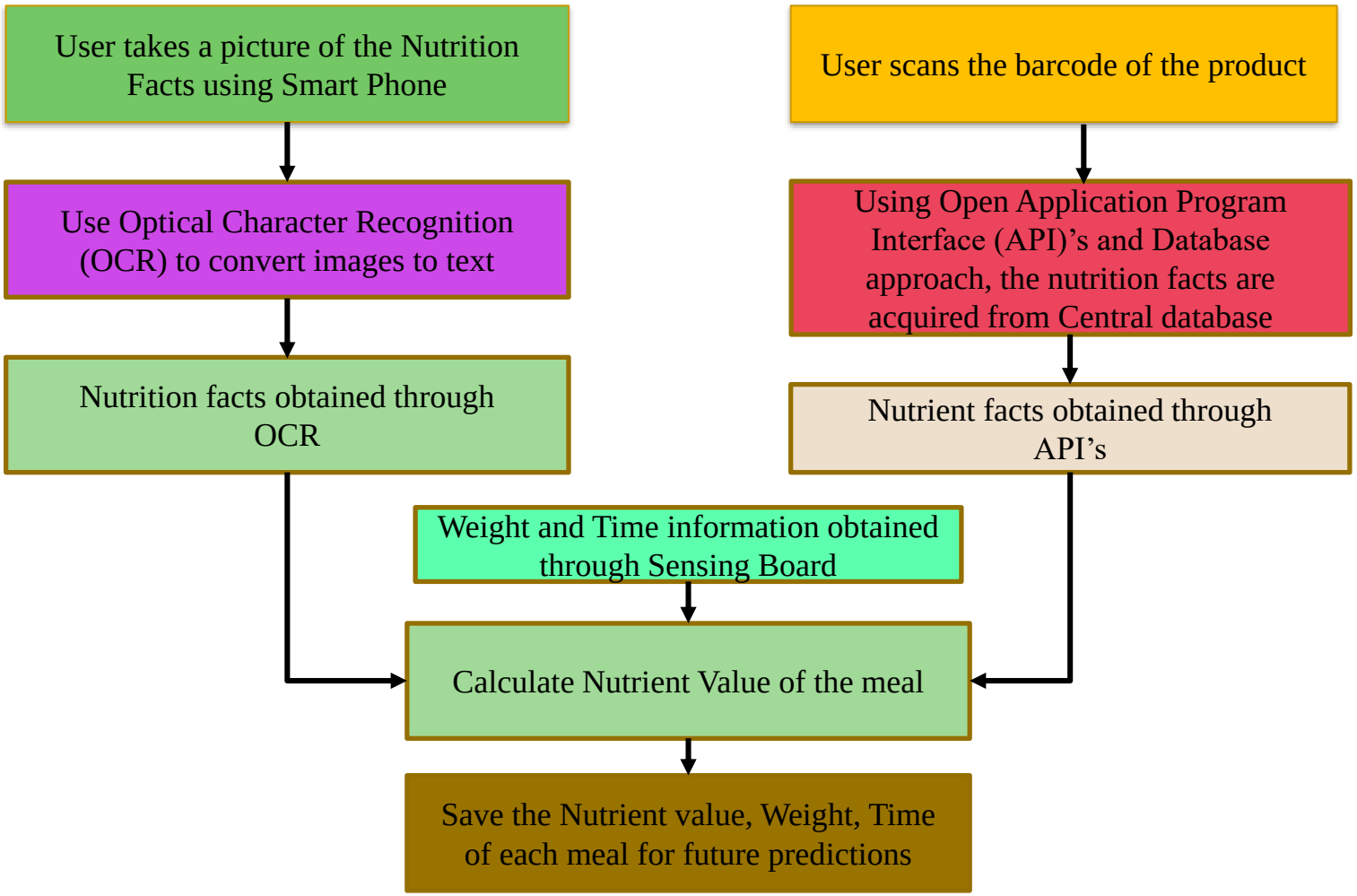
- ✓ Smart Sensor board
- Micro-controller helps in scheduling

- It helps in easier integration into wireless modules, which helps in connecting the prototypes to the internet for IoT based applications.

Data Acquisition in Smart Log System

- Optical Character Recognition
- Application Program Interface (API)
- Database Approach

Data Acquisition in Smart-Log System

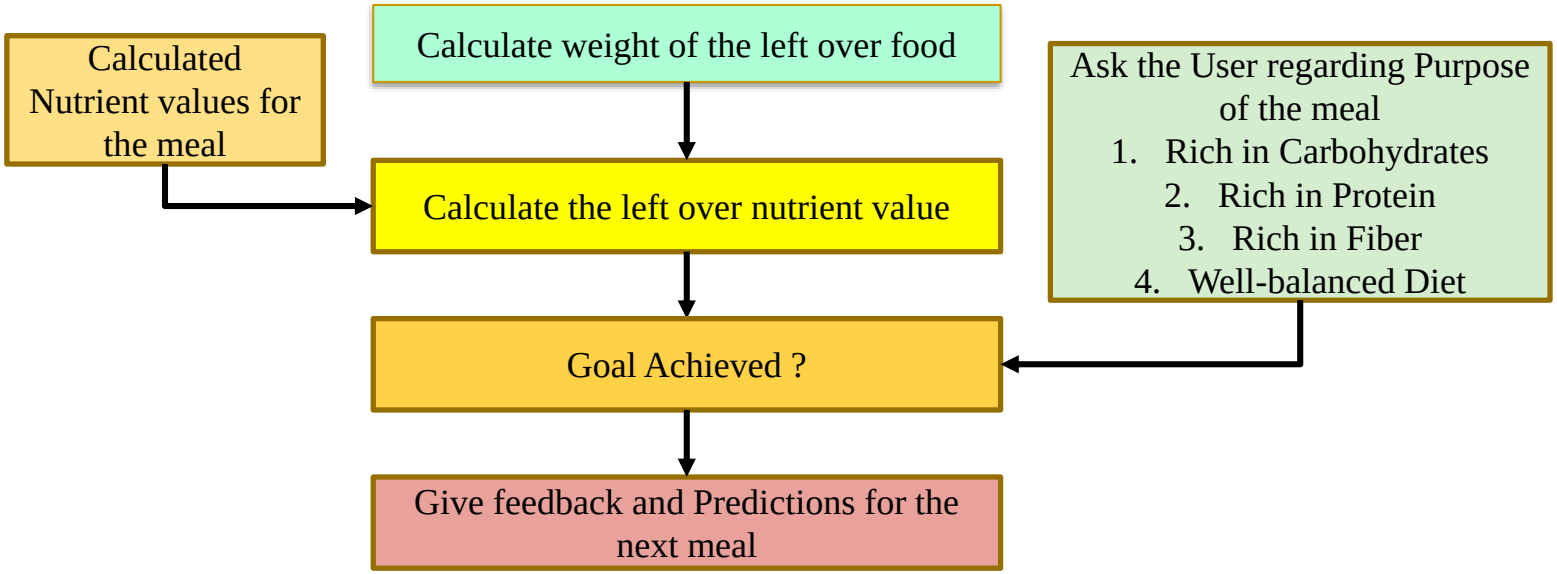


System level Modelling of Smart-Log System

✓ Future Meal Predictions

- The main concern in infants is the amount of food wasted after each meal.
- The purpose of each meal may vary from person to person.
- By considering the weight of the wasted food, the corresponding nutrient value is calculated.

Predictions for the Next Meal



Implementation & Validation

- Sensor Design
- Classifier evaluation using WEKA

Implementation of Smart-Log System

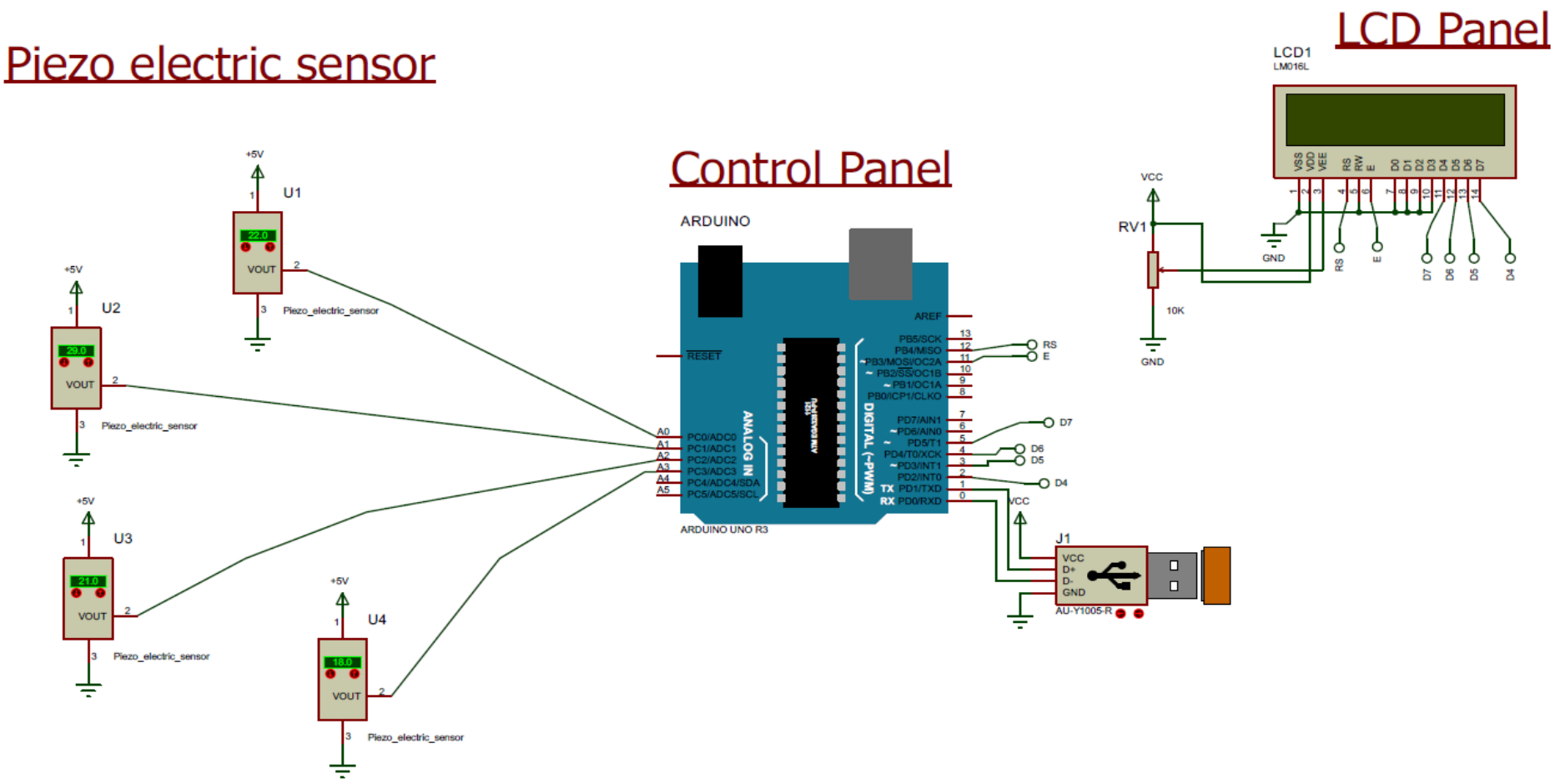
- The sensor system was implemented using Proteus and the data analysis to build an efficient prediction based system is done using WEKA.
- With help of a JAVA program, the input and output of the classifier was displayed in a webpage.

Implementation of Smart-Log System

The sensor system is required to possess the following functionalities:

- Calculate the total weight of the product placed on the sensor board.
- Calculate weight of the product after the user's consumption.
- Log the weight each time in order to give better predictions.

ARDUINO based Sensor Module



ARDUINO based Sensor Module

- ARDUINO board helps in faster prototyping and can be easily programmed using C and C++.

- A LCD module was used in order to read the variations in voltage value in accordance to the weight of the elements.

- Data logging was achieved through the USB port.

Data for the Sensor System

- A database of 8791 instances consisting of both readily available and raw ingredients for baby food was considered.
- This SR8 database is available through the US Department of Agriculture website, and can also be accessed using API.
- The unique NDB number is used to access the food item.

Classifier evaluation using WEKA

- Waikato Environment for Knowledge Analysis (WEKA) helps in evaluating the system using numerous algorithms.

- Whenever a user makes a data entry, an Attribute-Relation File Format (.arff) is created, which serves as input for WEKA.

Classifier evaluation using WEKA

Classifiers	Mean Absolute error	RMS error	Relative absolute error (%)	Root Relative Squared error (%)
Naïve Bayes	0.0106	0.0179	2.65	3.98
Bayes Net	0.0052	0.0055	1.3108	1.2236
Naïve Bayes Updatable	0.0106	0.0179	2.65	3.98
Multilayer Perceptron	0.0149	0.0179	3.72	3.99
Decision Table	0.0322	0.0363	9.06	8.63
Simple Logistic	0.1192	0.1192	33.55	22.28
Naïve Bayes Multinomial Text	0.0354	0.0419	4.78	5.06

Performance Comparison of Food recognition System

Research Works	Food recognition method	Efficiency (%)
Chen et al. [23]	Image based feature extraction	90.9
Maiti et al. [19]	Image based feature extraction	96.2
Joutout et al [12]	Image based classification using multiple kernel learning	61.34
This paper	Mapping nutrition facts to a database	98.4

Characterization Table for the Proposed System

Characteristics	
Sensor System	ARDUINO UNO, Piezoelectric sensor and LCD module
Data acquisition	OCR, API and Database approach
Data Analysis Tool	WEKA
Input Dataset	8172 instances
Classifier	Naïve Bayes
Accuracy (Worst case)	98.4%

Conclusion and Future Research

- This paper presents an autonomous food data logging system.
- Two approaches for data acquisition have been evaluated using WEKA in order to build a better prediction model.
- As a cost effective sensor system, with seamless data logging method, this system can be an essential consumer electronic device used in child care.

Thank You !!!

Slides Available at:

http://www.smohanty.org