

i-Ki: Intelligent kiosk to monitor child growth

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20 June 2018

Introduction

Having a balanced diet is important for general well-being. This is more so for school going children who are at a critical juncture of body growth. Governments all over the world have programs in place to monitor child growth and address any gaps. Most rely on manual interventions where a child care provider measures certain aspects of development. These can include weight, height, skin texture, or behavior patterns (stool frequency, playfulness, attention). These programs are also integrated with a nutrition distribution mechanism. A care giver is designated to manually hand out nutrition supplements to at-risk children. These systems have their advantages, but have suffered from a few shortcomings: variations in the training and dedication of caregivers, food products that cannot be locally manufactured, inability to track child growth accurately.

FaSL (Families for Sustainable Living Trust) plans to create AI enabled kiosks to monitor child health. The system can be optionally integrated with an automated vending machine to instantly disburse essential nutrients (Fig 1). Instead of using commercially manufactured kiosks, we plan to build a kiosk using locally available tools, and an easy to use embedded hardware platform based on Arduino. FaSL is planning a pilot program at 2 Rural Govt schools, and has already implemented a PoC vending machine that can hold 200 samples. The long term goal of this project is to enable an automated method for tracking child growth and scale the system to multiple locations. Apart from monitoring nutrition, a secondary goal of the project is to: (i) Encourage village-level manufacture of nutrition intensive food supplements, (ii) Employ local talent to maintain the kiosk.

FaSL is partnering with the Kshipra Ayurveda Foundation (KAF, <http://herbzalive.in/herbzalive-group-companies>) and Society for Administration of Tele-medicine and Health Care Informatics (SATHI, <https://www.sathi.org/>) to provide medical expertise on this project. KAF would be the partners to provide advisory on designing supplements fortified with ayurvedic medicinal components. KAF would also act as project partners to extend the kiosks to regions in coastal

Andhra Pradesh. SATHI would provide medical advise, assist in expanding the service to additional locations in Delhi, Maharashtra, and West Bengal.

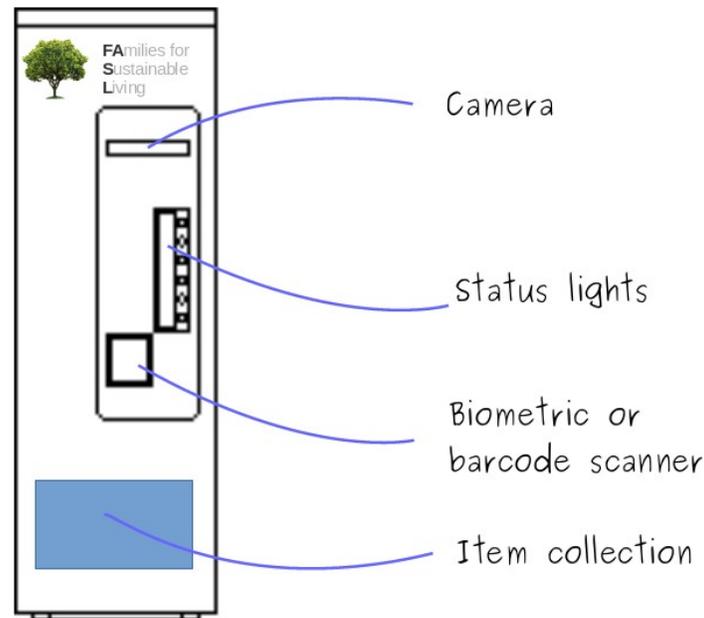


Illustration 1: Automatic nutrition vendor

The kiosk may have multiple features for user interaction:

1. Face recognition will be used to determine identity of user. Cancellable biometric hashcodes shall be used to ensure privacy compliance of data. Appendix E has a list of disorders. The eventual goal of this project is to detect as many disorders as possible. As part of this proposal, a subset of these would be detected using automated algorithms. Learnings from the project would be used to expand the scope of automated analysis.
2. The kiosk will be integrated with a vending machine to disburse essential nutrients. Items consumed by a user would be tracked by the system. The schedule and content of products shall be decided by a software that will encode rules given by a nutritionist / health practitioner. Appendix A provides an overview of the food items we are planning to integrate. The nutritionist may design different rules for different users, age groups, and gender. Lights, display such as LCD, or a touch screen will show system status and user choices.
3. An optional biometric scanner may be present to capture thumb, or palm print and integrate with Govt databases like Aadhar.

Proof of Concept

A PoC kiosk designed by FASL is shown in Fig 2. As proof of concept, we have built a kiosk that can disburse approximately 200 samples before needing a refill. Such a system would incur an upfront cost of ₹161,000.00 for the kiosk hardware and a monthly running cost of ₹16,800. These are guidance figures that would work for Telangana and the number may change based on local needs. Table 1 provides a breakup of capex and opex for one Kiosk. The kiosk is built using locally sourced material and can potentially be fixed/repaired by local craftsmen.



Illustration 2: Proof of concept vending machine. Video: <https://tinyurl.com/y679bma4>

Upfront costs	
Kiosk hardware	₹161,000.00
Total	₹161,000.00
Monthly running charges	
Food product (Rs 15 per child per day)	₹12,000.00
Refill and servicing staff (Rs 18000 for 10 locations)	₹1,800.00
Travel and fuel costs	₹3,000.00
Total:	₹16,800.00

Table 1: Running costs for an iKiosk with capacity to serve 200 students.

Budget:

As part of this proposal, FASL would like to test the solution at 10 locations. Major expenses involved in this have been documented in Table 2. Any ancillary expenses beyond the requested budget would be met by FASL internal funding.

Budget for 10 locations	
Vending machine hardware for 10 locations	₹1,610,000.00
Monthly food costs for one year, 10 locations	₹696,000.00
AI Engineer 12 months @ 48,000 per month (50% cost to be borne by FASL and partners)	₹288,000.00
Travel and fuel costs	₹36,000.00
Misc	₹12,000.00
Total:	₹2,642,000.00

Table 2: Budget to test the solution at 10 locations.

Appendix A: Nutrition Supply from Food

This section provides suggestions on food items that may be provided through the vending machine system. This is only a suggestive list. Over a period of time, the project will expand this list by conducting local surveys and adding items suited to local palates. We will broadly divide food items into two categories: (1) Supplementary, (2) Curative.

(1) Supplementary foods

Supplementary food items will ensure supply of micro-nutrients such as vitamins, minerals, calcium. While it is not a replacement for regular food, these supplements will slowly increase strength, well-being, and overall resistance of the body. This section describes the selection of food items and their actions on the body.

Peanut Chikki:

This ever popular Indian snack is primarily made with ghee, jaggery, roasted peanuts, and elaichi. **Peanuts** are an especially good source of healthful fats, protein, and fiber. They contain trace elements like potassium, phosphorous, magnesium and B complex. Peanuts with jaggery prevents folic acid deficiency.

Folic acid supplement during pubertal period helps in treating PCOD, which is a common issue in young girls nowadays

Anjeer and Ragi Halwa:

This halwa is made with Anjeer, Ghee, Jaggery, Pista, and Ragi.

Anaemia and calcium deficiency are commonly prevalent in school children, the reasons are either malnutrition or wrong nutrition. Anjeer and Ragi are nature's answer to these deficiencies. They provide organic calcium and iron which are easily absorb-able and readily assimil-able.

Minapa sunni (Urad dal laddoo)

Made from roasted black gram lentil ,jaggery and ghee. A very nutritious snack for girls in adolescent age.

This strengthens the uterine musculature, increases the haemoglobin count and folic acid levels. Very helpful in young girls to regularize their periods and prevent menstrual related absenteeism.

Putnala Pappu Laddoo / Fried bengal gram laddoo:

This laddoo is made with Ghee, Jaggery, Roasted yellow grams, and Sesame seeds. It is rich in Easily absorb-able simple protein which is essential for the proper growth of kids during adolescent years

Dry Fruit Laddoo:

This laddoo is made with Cashew, Dates, Pista, Sesame seeds, Jaggery, Ghee.

This is particularly for the kids who lack overall nutrition. A daily dose of this prevents malnutrition and allied diseases. Iron, calcium, vitamins and protein ,all rolled into one, this is easily absorbed by the system

(2) Curative foods



Curative foods are like nutraceuticals and medicines rolled into one. These can be taken regularly like a nutritional supplement, but it also acts like a medicine helping in clearing the symptomatic disorders among children. These products will help the body to fight against the symptoms and heal by itself. If a child is detected to have calcium /iron deficiency, he/she will be advised to take the corresponding nutraceutical. These are basically semi solid electuaries, which are tastier like a snack, and full of medicinal values. These are licensed Ayurvedic preparations which will be procured from a GMP certified Ayurvedic pharmacy. A brief list of these items is below:

Herb	Curative property
Ashwagandha lehyam	The miracle herb, which helps to improve and build the immunity of the kids. Useful for the kids who fall sick often. Controls recurrent infections and increases the energy levels. Reduces growing pains in children. Dosage: 1 tspn (3 gms) twice daily
Chyawanapraash lehyam	Very useful in improving Vitamin C. For kids suffering with regular colds and respiratory infections, a regular dosage of Chyavanprash helps preventing the infections. Dosage: 1 tspn (3 gms) twice daily
Drakshavaleham	Improves metabolism and helps in regulating the bowel movements. Increases the RBC count. Improves general stamina Dosage: 1 tspn (3 gms) twice daily
Haridra khandam	Acts as a de-worming agent. Helps in clearing out allergies and infections Dosage: 1 tspn (3 gms) once daily/ bedtime
Kooshmanda rasayanam	Helps in improving memory, strengthens intelligence and focus Dosage: 1 tspn (3 gms) twice daily
Suryarasayanam	This is for kids who have lack of appetite and do not eat properly. This electuary increases the appetite and helps in digestion and absorption Dosage: 1 tspn (3 gms) twice daily
Jeeraka lehyam	Gut inflammation is a common condition in kids, blame it on wrong eating habits or wrong foods. So kids have indigestion, bloating, erratic bowel movements, loose bowels, weakness and less growth. This helps in correcting those symptoms Dosage: 1 tspn (3 gms) twice daily



Appendix B: Background of Society for Administration of Telemedicine and Health Care Informatics (SATHI, <https://www.sathi.org/>)

S.A.T.H.I. (Society for Administration of Telemedicine and Health Care Informatics) – a non profit organization - is a group consisting of like minded highly trained and skilled Medical and Information Technology as well as Tele-Communication Professionals (see the list of governing body members) who think that Telemedicine can go a long way in providing affordable and quality healthcare to each and every person of our country. All of us are actively working to bring these thoughts to fruition.

Our Healing Touch Project after the Tsunami disaster provided Mental Health Support to sufferers from PTSD after the 2004 Tsunami. It was quoted to be the best example of eHealth during after extensive peer review and thereby published in a book

Our Telemedicine Supported Vision care project in Mizoram was voted the Best EHealth Project in the North East in 2014 (enortheast.in) and also was adjusted the best poster presentation during the 8th biennial APAMI 2014 meeting in New Delhi

Currently we are expanding into Filariasis control as well as trying to provide support to a range of related health problems in rural areas as well as B and C Class cities



Appendix C: Background of Kshipra Ayurveda Foundation

Kshipra Ayurveda Foundation (KAF) is an NGO registered in Chennai, TN. It is operated by an eminent team of doctors, under the guidance of Dr.Vijeyapall Jonnagaddala, Chief Medical director of Dr.Vijeyapal's Herbzalive Multispeciality Ayurveda, which has health centers in chennai, Hyderabad and Singapore. It conducts health camps for the under privileged in Chennai city and suburbs. KAF also conducts regular awareness lectures for the general public.

Visit www.herbzalive.in for more details about KAF.



Appendix D: Wellness Questionnaire

This is a questionnaire that we will use to get information about the well-being of school children. This information will be used to form a health profile that can guide our doctors to provide a suitable intervention in the form of diet change or supplements.

- How is the appetite? Waking and sleeping time?
- Does the child move bowels daily? If so, when is the time?
- Does the child complain of tiredness, weakness, body pains and stomach pain? If so, explain.
- Are there any rashes on the body, itching in the anal region?
- Is the child forgetful?
- How is the child faring in studies?
- For the girl child, has the menarche happened?
- How are periods? Any events during menstrual time?
- Is there any white discharge complaint?
- Is the child dull, morose and aloof?
- What is the weight / height, and how has it changed over a period of time?

Appendix E: Anthropometric expression of malnutrition

This section outlines disorders and the symptoms that can be detected using computer vision algorithms.

Clinical symptoms for a specific disorder	Symptoms that can be detected using computer vision
Iron deficiency (Anaemia)	
General fatigue, weakness, pale skin, Shortness of breath, dizziness, Cravings to eat items that aren't food such as dirt, ice, or clay. Tingling or crawling feeling in the legs. Tongue swelling or soreness. Cold hands and feet Fast or irregular heartbeat Brittle nails Headaches	Pale skin Shortness of breath (micromovements) Fast and irregular heart beat Tongue swelling
Iodine deficiency	
fatigue, weight gain, weakness increased cold sensitivity constipation dry, thin brittle skin, swollen and thick skin depression and anxiety abnormal menstrual cycle eyes protrude declined mental function thyroid enlargement (goiter) fetal hypothyroidism (improper functioning of the thyroid in unborn children leading to brain damage) autism cysts, soreness and heaviness in breasts	weight gain (*may need long time duration) dry, thin brittle skin, swollen and thick skin eyes protrude thyroid enlargement (goitre)
Vitamin A deficiency prevalent with protein energy malnutrition	
Night blindness Xerophthalmia (condition where eyes do not produce tears) severe vitamin A deficiency Keratomalacia (eye disorder that results from vitamin A deficiency) night blindness due to rod dysfunction Vision loss/blindness Dry conjunctiva Corneal ulcers Bitot's spots (areas of abnormal squamous cell proliferation and keratinisation of the conjunctiva, causing oval, triangular or irregular foamy patches on the white of the eye). Corneal perforation. Dry skin, dry hair, pruritus. Broken fingernails. Follicular hyperkeratosis secondary to blockage of hair follicles, with plugs of keratin	Night blindness Xerophthalmia Bitot's spots Corneal perforation

Clinical symptoms for a specific disorder

Symptoms that can be detected using computer vision

Protein malnutrition

Poor weight gain
 Slowing of linear growth (Stunting)
 Behavioral changes irritability
 Loss of weight (wasting)

poor weight gain
 slowing of linear growth
 loss of weight (wasting)

Kwashiorkor

Change in skin and hair color (to a rust color) and texture.
 Fatigue.
 Diarrhea.
 Loss of muscle mass.
 Failure to grow or gain weight.
 Edema (swelling) of ankles, feet, and belly.
 Damaged immune system, which can lead to more frequent and severe infections.
 Irritability.

change in skin and hair color (to a rust color)
 loss of muscle mass.
 failure to grow or gain weight.
 edema (swelling) of ankles, feet, and belly

Marasmus

Shrunken wasted appearance,
 Loss of muscle mass
 Loss of subcutaneous fat mass
 Buttocks and upper limb muscle loss
 Hypothermia, pyrexia
 Anemia
 Edema
 Dehydration (as characterized with consistent thirst and shrunken eyes),
 Hypovolemic shock (weak radial pulse, cold extremities, decreased consciousness),
 Tachypnea (pneumonia, heart failure),
 Abdominal manifestations (distension, decreased or metallic bowel sounds, large or small liver, blood or mucus in the stools),
 Ocular manifestations (corneal lesions associated with vitamin A deficiency),
 Dermal manifestations (evidence of infection, purpura, and ear, nose, and throat symptoms (otitis, rhinitis)

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