Nimär: An infantometer to combat child stunting

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Child stunting is detectable early, but community health workers in rural Guatemala will name the same culprit: the continuous monitoring that would catch it is expensive, fragile, and reserved for trained staff. Guatemala holds the highest stunting rate in Latin America and 7th highest in the world, concentrated in rural Indigenous Maya communities of the Altiplano Occidental. Existing low-cost screening devices were designed to flag severe acute malnutrition rather than the chronic malnutrition that drives stunting and are used and manually recorded by health workers when and if they visit these communities. They capture a moment in time instead of the day to day cycle that is critical to monitor healthy growth and to get infants support exactly when they need it. To act on this, I am designing a low-cost home infantometer that captures weight, length, and age in a single short interaction operable by a nonspecialist, with Z-scores synced to a continuous monitoring database via Bluetooth or a mesh network. This device aims to close the monitoring gap that limits stunting interventions in these communities.

I. Introduction / Background (Sytle: Heading 1)

Stunting, defined by the WHO as low length-for-age, is the clinical signature of chronic undernutrition during the first 1,000 days of life [1]. Unlike acute malnutrition, it develops over months and requires repeated longitudinal measurement to detect.

Image 1: Indigenous mothers with their children. (image from Prensa Libre)

Rural Indigenous Maya communities of the Altiplano Occidental routinely exceed Guatemala's national stunting prevalence by fifty percent or more [2] and are an extreme outlier in the Americas as a whole. A community-based quality improvement study in this population reduced stunting from 42.4 to 30.6 percent on a select group of participants over two years through structured monitoring, electronic worklists, and feedback to frontline workers, without changing the underlying nutrition package [3]. The Saqmolo' randomized controlled trial subsequently found that adding a daily egg to standard nutrition care produced no growth benefit beyond standard care alone [4]. Together these results point to continuous growth monitoring itself as the most underserved step of the malnutrition response in the region.

Local healthcare nonprofits, like Wuqu' Kawoq (the Mayan Health Alliance) can primarily attest to how the amount of trained technicians they can fit in their budget directly correlates to the volume of patients they can treat per month. Telecommunication infrastructure is also a major barrier for coordinating home visits, with manual recordings of length and weight measurements used to track patient progress across time.

Many of the existing tools were specifically designed to combat severe or acute malnutrition, but fail to prevent stunting for the following reasons:

- They are **operated by trained staff exclusively.**
- They are **expensive or frail to transport and deploy** to hard to reach areas.
- They are **not built to digitally store and upload measurement data** and when it does get recorded is generally viewable by the single collecting party with any immediacy.
- They **don't allow caretakers to track their own infant's growth** in an accessible and continuous manner.

Between scheduled clinic visits, weeks or months may pass before an infant is measured and recorded again, delaying essential individualized action steps that can treat stunting early and fast. I propose a low-cost home infantometer, operable by a single nonspecialist user, that captures length, weight, and age in one interaction and feeds the resulting Z-scores into a continuous monitoring database accessible to local nutrition programs and government authorities.

II. Related work

Existing instruments do not support more frequent monitoring. Components that form part of UNICEF's Anthropometric Nutrition Kit, like MUAC tapes, are excellent at detecting acute wasting [5], however, they falter at detecting growth issues. Other components on the kit include length boards and Salter scales, which are all recommended to be operated by two people at a time. In a personal interview with Wuqu' Kawoq, they mentioned that they use a Zeco 210 stadiometer and a hanging scale for their measurements. Perhaps the greatest weakness with any of these tools is the fact that they don't continuously monitor infants and have no way of quickly sharing measurement data on a daily basis, especially when field work in the Altiplano can have monthly intervals.

A recent IEEE-published prototype tested an Arduino-based infant weighing and length-measurement device in Indonesia [6], validating the component architecture I propose. Programmatically, SESAN's Conéctate platform attempted to coordinate Guatemalan nutrition data nationally before being discontinued [7], leaving no active pipeline that captures household-level growth data and feeds it back to authorities or implementing partners. Maya Health Alliance research results [3] and my own conversations with their team have validated that the key lies in measurement frequency and feedback, both of which require data the current toolset does not generate.

Major census studies have been made by SESAN around nutrition and particularly stunting [8]. The largest issue with this is that they depersonalize and agglomerate results into map lines, are slow to be gathered and presented (the most recent version was published in 2025 for the 2024 census), and are done mostly on schoolchildren, who are unfortunately out of the 1,000 days window and proper nutritional care is significantly less effective than on in infants. [9]

Numerous infant growth tracker apps where users manually input measurements, like AnthroCal, already exist, indicating a strong demand even outside this niche space on the wider market. Researchers at Wuqu' Kawoq have also experimented with implementing mobile apps to remotely deploy nutrition consultations to caregivers, and although most have access to a smartphone, few have mobile data that allows them to use said tools consistently.

Finally, mesh networks like Meshtastic and MeshCore, which are used to share text-based communication across long distances using long distance radio (LoRa), have virtually zero presence in the region. Healthcare organizations and caretakers alike resort to existing (yet scarce) mobile data infrastructure for communication.

III. Imagined or existing prototype sketches/drawings/photos

A. Concept

Nimär, "to grow big" in Kaqchikel, is a low-cost infantometer device that an untrained user can operate intuitively, that captures the three measurements needed to compute WHO Z-scores in a single interaction, and that exports those measurements digitally to mobile devices and onward to a continuous monitoring database. Cost is a meaningful constraint at the component level, but the device is a specialist instrument and is not expected to undercut institutional kits such as UNICEF's length board. The interface is meant to be language-agnostic, relying on physical cues and visual feedback rather than written instructions since most intended end users speak a Mayan language as their first language and may not read Spanish or English fluently.

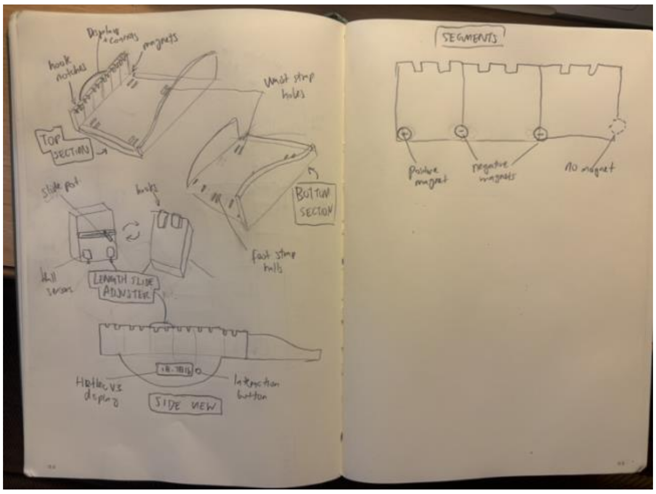

Image 2: Initial sketch of concept parts and assembly

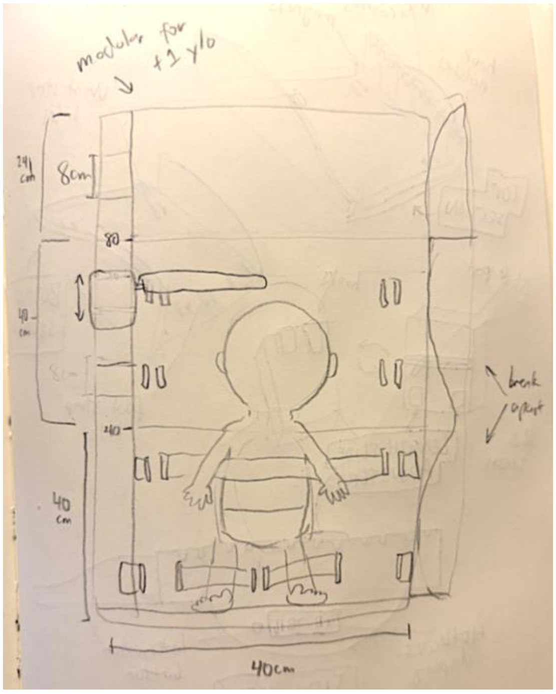

Image 3: Top-side view of the assembled concept

B. Build

After discussions with Design Informatics staff at the University of Edinburgh, I arrived at the following architecture. The device consists of two 3D-printed sections, each 40 cm long, hinged together to form an 80 cm measurement bed sized for the 0-18 month growth range. An optional modular extender adds three 8 cm segments to extend the range to 104 cm, kept as an add-on to preserve the device's low baseline cost for the age range where stunting screening has the highest impact. The infant lies supine across both sections, with their heels braced against a fixed footboard at the base of the lower section and their body secured by soft Velcro straps that pass through slots cut into both platforms. Sidewalls prevent the infant from rolling out laterally.

Length is captured by a Length Slide Adjuster (LSA) that the user positions at the crown of the infant's head. The LSA seats into one of five 8 cm notched segments along the upper section's measurement rail, identifying which segment it occupies via two onboard bipolar hall-effect sensors that read a magnetic polarity configuration encoded into the rail. A 100 mm linear slide potentiometer integrated into the LSA provides millimetre-resolution refinement within the selected segment, with 10 mm of overshoot at each end for precision into adjacent segments. The magnet pockets are designed for field replacement to support long-term repairability.

Weight is captured by four 20 kg load cells distributed two per section at the outer corners of the assembled device, connected via a Wheatstone bridge (not pictured in the block diagram below) into a single HX711 ADC. A Heltec V3 microcontroller aggregates the readings and displays the current measurement on its onboard OLED. A single tactile button and a piezo buzzer handle user interaction: the button tares the scale and confirms a measurement, with audio feedback distinguishing between successful captures, errors, and sync events. Submitted measurements are calculated into Z-scores against the WHO Child Growth Standards.

Age is supplied through a paired smartphone app over BLE, or preconfigured before delivering to a home when smartphone access is not possible. The platform calculates Z-scores against the WHO Child Growth Standards, presents an interpretation to the user, and retains the full numerical results for the database. The device operates in three connectivity tiers:

1. BLE Smartphone sync to a custom app where available.
2. Meshtastic LoRa mesh network when cellular data is absent, the device will relay results and get picked by nodes that will transfer the data to a proprietary database.

The mesh fallback distinguishes the design from existing solutions, since it directly addresses the structural connectivity gap in the Altiplano rather than assuming it away. This ensures that not only do health organizations get immediate access to tracking data, but it can also pair to already-owned smartphones and perhaps provide nutritional consulting directly to caretakers without the need of mobile data reception. The device would be able to provide a base for highly context-aware companies and organizations to build upon by pairing the device to any proprietary software.

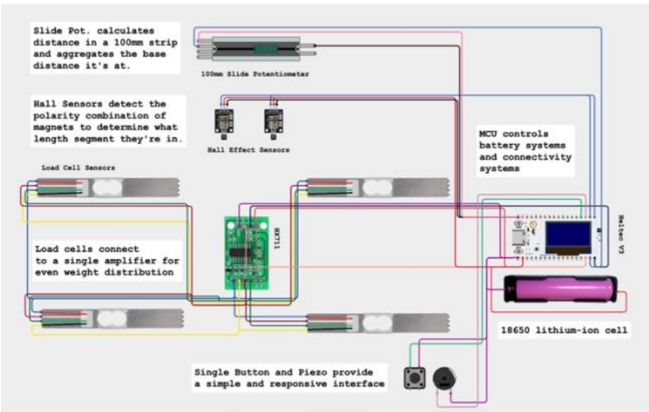

Image 4: Block diagram of electronic components

TABLE I. PROTOTYPE COMPONENTS

Subsystem	**Components**
Microcontroller, Battery Management System, LoRa	Heltec V3
Weight Sensor	4x load cell (20kg), HX711 ADC module
Length Sensor	2x bipolar hall effect sensor, 100mm slide potentiometer
Physical Interface	12mm tactile switch button, piezo buzzer
Power	18650 lithium-ion cell

IV. LIMITATIONS AND POTENTIAL IMPROVEMENTS

A question that might immediately come to mind is, "why not train caretakers to input measurements into a platform using existing measurement tools?" The answer to that is twofold. First, the vast majority of existing tools already have wide margins of error, and are notorious for being hard to use and inaccurate when operated by less than two people, never mind one person without formal and ongoing expertise. Second, data collected with existing tools could be uploaded into a mobile platform, however, this is subject to device connectivity to mobile data, and an existing mobile device in the first place, which has proven to be a challenge in the region. A Meshtastic network can answer those concerns being able to quickly relay data at the necessary speed to meet the goal of week to week updates. The mesh network might even prove useful for other iOT related projects.

The device could use solar charging as a reliable source for power given both its household usage and how the device will deep-sleep between measurements. Another alternative would be powering on these devices via a direct USB connection to a mobile device. However, these would get resolved after more research is done on habits and electricity consumption across these communities. Finally, ergonomic improvements to the weight distribution of the design could help lower the load cell count.

V. RESPONSIBLE INNOVATION

Accuracy, intuitiveness, portability, ease of repair, and low-cost assembly were the main priorities when designing this device. Portability in particular was a driver for the hinge design, as it allows for easy storage at homes with limited space and also allows for it to be easily packed on health visitor missions if used that way. Repairability is also important for third parties to be fully in control of their own devices.

Data privacy is also highly important. Ethics around this project specifically targets children's growth data. While the dire situation may outweigh the perceived need for data protection by current authorities, I'd like to ensure that data is managed, stored, and shared in a secure and above all, a consenting way for all participants.

VI. Established Connections

The most significant constraint at this stage is the validation environment. Prototyping at the University of Edinburgh is appropriate for hardware reliability and sensor calibration but cannot generate evidence of clinical accuracy or field performance under the conditions the device targets. Access to infants aged 0–2 for testing is constrained by ethical timelines and recruitment difficulty. This is addressed through partnership with Wuqu' Kawoq, who have already supported anthropometric research for Emory University and Arizona State University [3, 4] and have confirmed both the unmet need and a willingness to explore the early stages of the iteration cycle.

Access to the *Secretaría de Seguridad Alimentaria y Nutricional* (SESAN), the Guatemalan government body responsible for national nutrition strategy and the originator of the discontinued *Conéctate* platform [7], is mediated through the *GuateFuturo* network described below. SESAN remains the natural institutional destination for the household-level growth data this device is designed to produce.

VII. Author bio(s) / experiences

I am a Design Informatics student at the University of Edinburgh and student representative for the programme, set to graduate in 2026. I hold an undergraduate degree in Entrepreneurship with a concentration in Social Entrepreneurship, and I am a fully-awarded *GuateFuturo* Scholar, a Guatemalan academic scholarship that provides funding and direct access to senior leaders across Guatemalan government, civil society, and academia. As a Guatemalan, I bring the linguistic context, cultural familiarity with the rural Altiplano communities the device is designed to serve, and the long-term commitment that responsible innovation in this setting requires.

I bring a decade of experience as a User Experience designer across projects for major organisations like Microsoft and Johnson & Johnson. I have also worked in backend and frontend developer roles directly relevant to the embedded firmware, mobile app, and data-sync layers of this project. I have deployed electronics-based projects at the University of Edinburgh in the United Kingdom and the Carl Benz School of Engineering at KIT in Germany.

My social-impact work includes leading the digital programme tools for Chicago's SGA Foundation and involvement with Habitat for Humanity's Guatemalan chapter.

VIII. Acknowledgements

I thank Wuqu' Kawoq, for the conversations that confirmed this project's premise, and the University of Edinburgh Design Informatics staff whose feedback shaped the initial architecture. The GuateFuturo Foundation has financed my academic trajectory and provided the institutional network through which Guatemalan government access is being pursued.

IX. Refernces

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