

# IoT Healthcare System for Mother-Child Health and Early detection

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**Abstract**—Infants, young children, and females are more prone to rapid physiological deterioration. Regular measurement and documentation of clinical (physiological) observations are essential for patient assessment and early recognition of clinical deterioration. The dominant orientation of our country according to the presidential initiative is females and newborns healthcare, the previous research highlighted the size of problems that this society category Suffered from based on cross-sectional data, that's why we observed different trials to solve these problems based on the collected data from different governments. Our intervention is different from previous trials, we will use the power of technology to support this society category. [1] Our project is an integrated IoT Healthcare System for Women and newborn Healthcare, the system aims to publish awareness about suitable nutrition, vitamins, early detection tests, vaccination, psychological health, family planning methods, and health service centers that provide it for pregnant women to control and reduce the problems that females suffer from, in addition, Our IoT Kit helps also women and doctors to monitor a child's vital signals remotely to take a fast response at emergency time.

## I. INTRODUCTION

### A. Motivation

Egypt is one of the most populous countries in the Middle East and the third most populous country in Africa; the current female percentage is 48.8% out of the total population, Forty percent of Egypt's population are under the age of 18. Egypt recorded the highest fertility levels in 2014 since it reaches 3.5. Females and newborns are considered half of the Egyptian population and one of the most important categories in our society, at the same time they suffer from different healthcare issues due to lack of awareness about the suitable nutrition system, vaccination, vitamins, and poor tracking for vital signals. [2]

### B. Background

Egypt was one of six countries that supported the 1990 Summit Conference for the Protection and Development of Children, which strongly endorsed safe motherhood programs and strategies. In 1994, Egypt hosted the International Conference on Population and Development in Cairo. Reducing

maternal mortality has also been a key goal of the national five-year plans of the Ministry of Health and Population (MoHP) and women's and children's right to health is enshrined in Egypt's new constitution. According to recent UN maternal mortality estimates, Egypt has reduced its maternal mortality ratio (MMR) from 120 in 1990 to 45 in 2013, a 62.5% reduction. The updated estimates also produced a new MDG MMR target of 30/100. [3]

## II. MARKET RESEARCH

- Target audience:
  - Our target audience is females from 21 to 45 years old, we are interested in women before, during and after pregnancy.
  - Married males, they have huge responsibilities towards the wife and the children healthcare.
- Targeted location:
  - First stage: Cairo
  - Second stage: Upper Egypt
- Primary Research method:
  - Online campaign through online meetings to collect data from users and spread our application.
  - We will co-operate with Public Health Centers to install our system on the phones of the targeted patients and to make patients fill a form.
  - We will go to universities to spread our application and collect data from female students
- Computators:
  - 1) BabyScripts
    - [Babyscripts\(getbabyscripts.com\)](http://Babyscripts(getbabyscripts.com))
    - Provide mothers with three services (Follow Up with doctors, Pregnancy tracking remotely, IoT kit for measuring vital signals)
  - 2) Glow Baby
    - [GLOW. Baby Tracker & Feeding, Diaper, Sleep Log - Apps on Google Play](#)

- Keep track of everything from bottle feeds to sleep schedules and get valuable info about starting solids, developmental milestones and much more. Plus, get personalized parenting tips delivered daily.

### SWOT Analysis

<b>Strengths</b> <ol style="list-style-type: none"> <li>1. Ability to monitor baby remotely.</li> <li>2. Experience in medical field and its technologies.</li> <li>3. Good network with people who work in medical field.</li> <li>4. Good team in developing.</li> <li>5. Easy interface with mobile &amp; web applications.</li> </ol>	<b>Weakness</b> <ol style="list-style-type: none"> <li>1. Need good team in marketing.</li> <li>2. Poor healthcare infrastructure in Egypt.</li> <li>3. Possibility of poor service of doctor or hospitals.</li> <li>4. Limited Fund.</li> </ol>
<b>Threats</b> <ol style="list-style-type: none"> <li>1. There are startups provide some services like us.</li> <li>2. Challenges in adopting new technologies.</li> <li>3. Refusing of doctors and hospitals to use our application.</li> <li>4. Resistance from mothers to use our IoT Kit.</li> </ol>	<b>Opportunities</b> <ol style="list-style-type: none"> <li>1. Funded from different organizations or investors because we address a very important problem in Egypt.</li> <li>2. Lack of dominant competition.</li> <li>3. Integrate with other companies providing needed services.</li> <li>4. We will maintain highly responsive customer service.</li> </ol>

### III. LITERATURE REVIEW

There is a list of apps on Google play store and Apple store that divided into two categories:

- Tracking apps that allow parents to track babies' basic activities and movements.
- Information apps that provide parenting information such as infant feeding, age-appropriate activities, first aid, and more.
- Sleeping-aid apps that presented white noises and lullabies to soothe infants and induce sleep.
- Photo sharing apps that permitted parents to share baby moments privately with loved ones

Apps Comparison Fig 1.

### IV. MATERIALS AND METHODS

#### A. Security

We focused on the security in this project to learn concept and new technologies used in security, so we used spring security in spring boot to implement security. In next point we will take about spring security structure and role of each element in this structure.

##### 1) Authentication:

- Spring security authentication structure, elements and workflow Fig. 2
- Elements:
  - **Authentication manager:** Responsible for finding the correct authentication provider.
  - **Authentication filter:** Intercept request to authenticate it by delegating to authentication manager.

Author/ Date	Source	Methods	Results	Comments
Nancy Baby Monitor 2017	Baby Monitor <a href="http://www.babymonitor3g.com">www.babymonitor3g.com</a>	1. Mobile Application 2. IoT Kit	<ul style="list-style-type: none"> <li>• Live video stream</li> <li>• Unlimited reach</li> <li>• Baby Monitor 3G supports both Wi-Fi and cellular 3G/LTE networks</li> <li>• Baby Monitor 3G allows you to check, how often was your baby awake, discover its sleeping patterns and replay sounds from current or any previous monitoring.</li> <li>• Talk to your baby</li> </ul>	The system is effective in measuring the baby position and sleeping patterns.
Anila Virani Linda Duffett-Leger 2019	mHealth	1. Mobile application 2. parenting apps 3. Mobile App Rating Scale (MARS)	<ul style="list-style-type: none"> <li>• Baby Tracker has the most tracking options</li> <li>• as well as additional features such as white noise, lullabies, baby book, and information.</li> <li>• This app might be more suitable for parents who prefer a multifunctional app and would like to track more than just basic activities.</li> <li>• the Child Growth Tracker is solely designed for recording infants' growth such as height, weight, head circumference, and body mass index (BMI). Over time.</li> <li>• frequency of infants' basic activities reduces some parents only like to monitor their growth by years.</li> </ul>	Parenting can be challenging, and in this digital age, first-time parents actively access mobile applications to adjust to their new roles. Apps are now technologically- go-to tool for accessing information, tracking their babies' development, editing and sharing photos, and much more. While apps have the potential to make parenting easier, the abundance of low-quality apps makes the process of finding a reliable one arduous for parents

Fig. 1: Literature Review Matrix Template

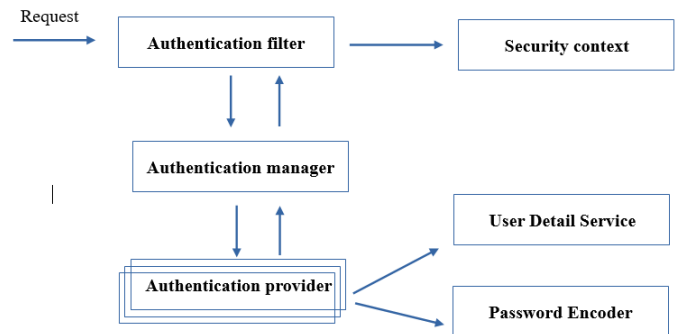


Fig. 2: Authentication Structure

- **Authentication provider:** Contain the logic of authentication that will be applied on the request.
- **User Detail Service:** Responsible for getting user credentials saved in database, LDAP or whatever.
- **Password Encoder:** Responsible for Checking if password is correct or not.
- **Security context:** Responsible for saving details of users logged in.

#### • Workflow:

- 1) Authentication filter intercept request and delegate

it to authentication manager

- 2) Authentication managers choose the convenient authentication provider and delegate request to it.
- 3) Authentication provider uses user Details Service and password Encoder objects to get user from data source and match the password with the one of the requests.
- 4) Result of authentication logic of provider return back to the filter.
- 5) Authentication filters save the user in security Context object if authentication succeed.

## 2) OAuth2.0

: It has many workflows which are called grant types as:

- Authorization code
- Password grant type
- Client credentials
- Refresh token

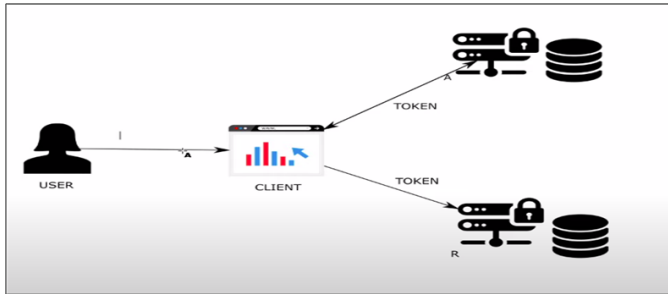


Fig. 3: OAuth2.0

## B. Baby monitoring

### 1) IoT kit

: We used esp32 which is system on chip microcontroller with WiFi module, Temperature sensor (DS18B20), heart rate and SPO2 sensor (MAX30105) and position and room temperature sensor (MPU). We used the layered architectural design pattern which consists of three layers which are:

- Microcontroller abstraction layer (MCAL)
  - Digital input/output module (DIO)
  - Network module
- Hardware abstraction layer (HAL)
  - HTTP module
  - MPU module
  - MAX30105 module
  - DS18B20 module
- Application layer

### Kit components

- MPU6050 (Position Sensor)
- MAX30105 (Heart rate and SPO2 Sensor)
- DS18B20 (Body Temperature Sensor)

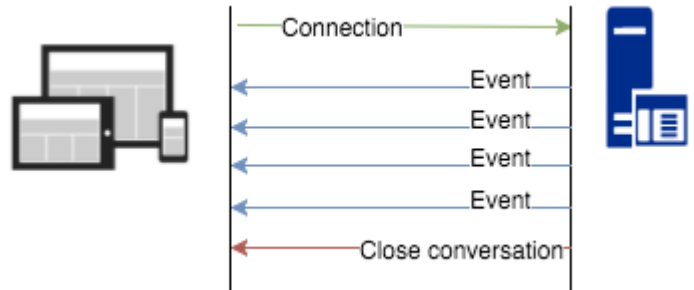
### Power consumption:

- Our IoT kit consume 5v and 128 mA.
- The battery lasts for 24 hours.

## 2) Server

: There are many ways for streaming data such as server-sent events (SSEs), polling, WebSocket etc..., but we have chosen server-sent events technology instead of others for more than one reason such as:

SSEs are sent over traditional HTTP and does not need a special protocol, It has automatic reconnection when connection is lost and It is unidirectional way for sending data from server to client according to our needs.



## 3) Clients (web and mobile)

### • Adding Devices

For receiving sensors data from the server, Clients must add the device by sending HTTP request with device id to the server to check if this device id is correct to that user or not. After Adding the device, the server sends back SSE object if the device is connected and the clients listening to it. The user can add multiple devices.

### • Displaying Data

For every connected device, there is data associated with it and the user can switch between them. The data is displayed by:

- Graph for each vital sign
- Value for room temperature
- Animated images for the baby position

## 4) Scheduler

: We have implemented scheduler for handling user important events and track the upcoming events with continuous update for them.

## 5) Notification handler

: the server can notify the clients with some events when happen, these events are:

- Anything wrong in baby vital signs.
- If any user device has connected to the server.
- Notify that user does not fill some information so it appears as popup window.

## 6) Awareness Information

: The information is divided into two categories:

- General information which is installed with mobile or loaded statically on web such as: *Covid19, Baby, Breast-feeding, Exercise, Labor and Delivery and Vaccination*
- Timeline blogs such as: *Doctor blogs and User blogs.*

## 7) Used Technologies:

- Server: **Spring Framework**
- Database: **Mysql**
- Wep app: **Angular**
- Mobile app: **flutter**

## V. RESULTS AND DISCUSSION

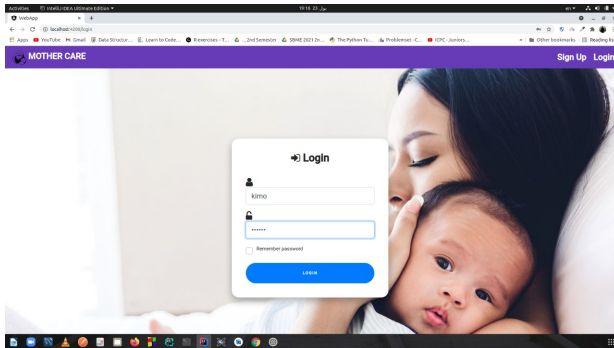


Fig. 4: Login and Sign Up page

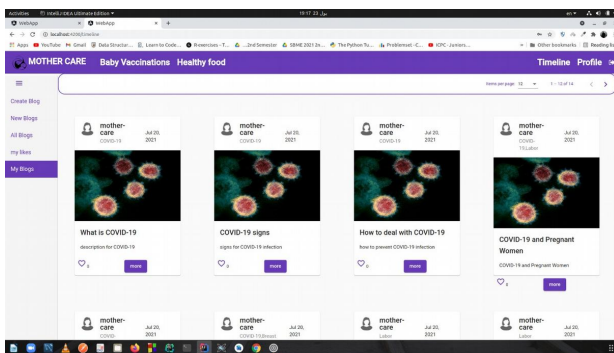


Fig. 5: Awareness blogs

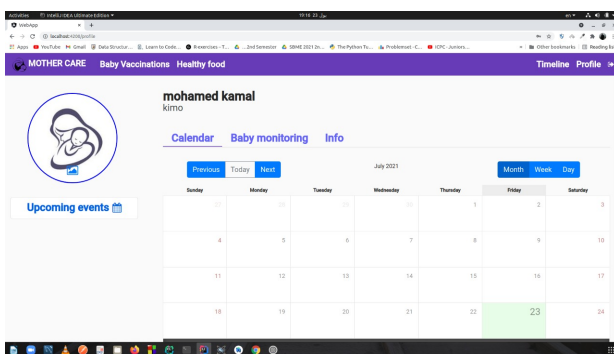


Fig. 6: Calendar

## VI. CONCLUSIONS AND FUTURE WORK

In conclusion, the current fragmentation in the health system needs to be examined and market failures in service delivery, quality and safety, and prevention. public health addressed

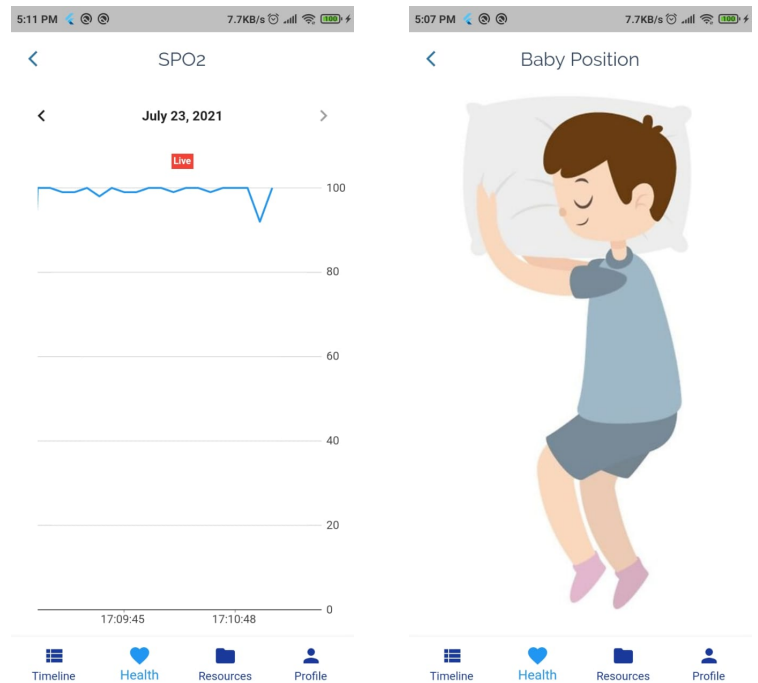


Fig. 7: Baby Vital Signals

if Egypt must achieve further gains in maternal and child health in Egypt. Mother-child healthcare it's one of the most important topics that we have to pay attention for it because of improving the well-being of mothers, infants, and children is considered as one of the most important public health goals for the any country. Their well-being determines the health of the next generation and can help predict future public health challenges for communities, families, and the healthcare system. The objectives of the Maternal, Infant, and Child Health topic area address a wide range of conditions, health systems indicators that effect on the health behaviors, wellness, and quality of life of families, women, and children.

### Future Work:

**IoT Kit:** • Live Streaming using camera and Computer vision model to detect baby up normal position. **Web & Mobile** • Developing Counseling System through adding doctors on the website. • Translate awareness content to Arabic.

## ACKNOWLEDGMENT

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