Project Name: Smart Vaccine Alert System using IoT and QRCode technologies

Introduction/Motivation:

There has been a significant improvement in the economic status and population health in India in the past few years. However, the child survival rate is not improving by standards. "The mortal rate for children age five and younger currently stands at 66 per thousand live birth, compared to 34 per thousand live births in the Philippines-a country with roughly the same per capita gross domestic product"[1]. The increased death rate in India particularly in rural areas is due to non-availability of vaccine stock.

Vaccines are used to prevent infections or diseases. These vaccines must be stored and distributed properly. However in some of the Government hospitals or hospitals in rural places, effective tracking the stock of vaccines is not done. Non-availability of vaccines can leads to death. Health hazards can also be caused due to incorrect dosage of vaccines. Hospitals must also keep track of the vaccines validity or else it may cause health issues.

Poor government policies can make vaccine monitoring less efficient. Even if IT enabled systems are provided usage may not be enabled for lack of training skills and knowledge. Low-quality vaccine may explain a shortage of trained personal to manage the program at both the national and state levels; the need to undertake innovations in vaccines, disease surveillance, vaccine procurement , and effective vaccine management; the absence of good data on disease burden to inform vaccination priorities;

Abnormality detecting in use of vaccine must be tracked. Tracking system must be automatic, easy to use and effective. It should consider place where it is deployed like power issues, internet etc. Vaccine analytics can help in proper distribution of vaccines to where it is really needed. Vaccines must be stored in proper temperature or else it may lead to some side effects.

Market Research / Literature Survey

An exhaustive market research has been made about the Vaccine stock monitoring and alerts and findings are presented as follows:

Survey-1: The mortality rate for children age five and younger currently stands at sixty-six per thousand live births, compared to thirty-four per thousand live births in the Philippines—a country with roughly the same per capita gross domestic product. Between 1990 and 2001, the probability of dying before age five fell more than twice as rapidly in Bangladesh and Indonesia as it did in India. [1]

Survey-2: Although child survival rates have improved since 2001, India will not achieve its own goal of reducing the number of infant deaths by half. It will not meet the goal that was set in the United Nations' Millennium Declaration of cutting the

mortality rate for children under age five by two-thirds between 1990 and 2018 [2,3].

Survey-3: There are twenty-seven million new births in India each year—the largest birth cohort in the world. However, fewer than 44 percent of these children receive the full schedule of immunizations. This level is only slightly better than it was in 1998, when the proportion was 42 percent. In contrast, in Bangladesh, on the northeast border of India, 82 percent of children are fully immunized by age two. In adjacent Nepal, 80 percent of children are fully immunized by age one. The 9.6 million unimmunized children in India today account for more than one-third of the 27 million unimmunized children around the world. India's spending on routine immunizations remains low at US$113 million per year in 2010–11, down from $137 million in 2009–10. [4].

Survey-4: Although the current immunization program targets twenty-seven million infants and pregnant women every year and is one of the largest immunization programs in the world, immunization rates through the national program are uneven across twenty-eight states in India. The proportion of children under age five who are vaccinated exceeds 70 percent in only eleven states; it drops below 53 percent in eight states that are also the most populous [5].

Hardware requirements

1. QR code scanner is required to scan the QR codes on the vaccines.
2. Raspberry PI Model B+ (IoT device) with USB webcam
3. DS18B20 Digital Temperature Sensor for monitoring vaccine temperature
4. HC-SR04 Distance sensor
5. WiFi based Internet Dongle
6. Breadboard, Resistors and Jumper wires
7. An Android Phone for testing the App

Software requirements

1. Python in Raspberry pi
2. Kotlin in Android Studio
3. Firebase/cloud store for storage

Implementation

The implementation of the proposed system is depicted in Architecture shown in Figure 1. , In this architecture following modules are designed:

(i) Vaccine Scanner – This module will scan vaccines to be used for patient. A QR Code scanner software in Raspberry PI based IoT device will scan the QR code attached in vaccines. The data extracted is used by Python program and will fetch all relevant details of vaccine from a cloud based storage. Expiry of vaccine, operating temperature and dosage required are displayed.

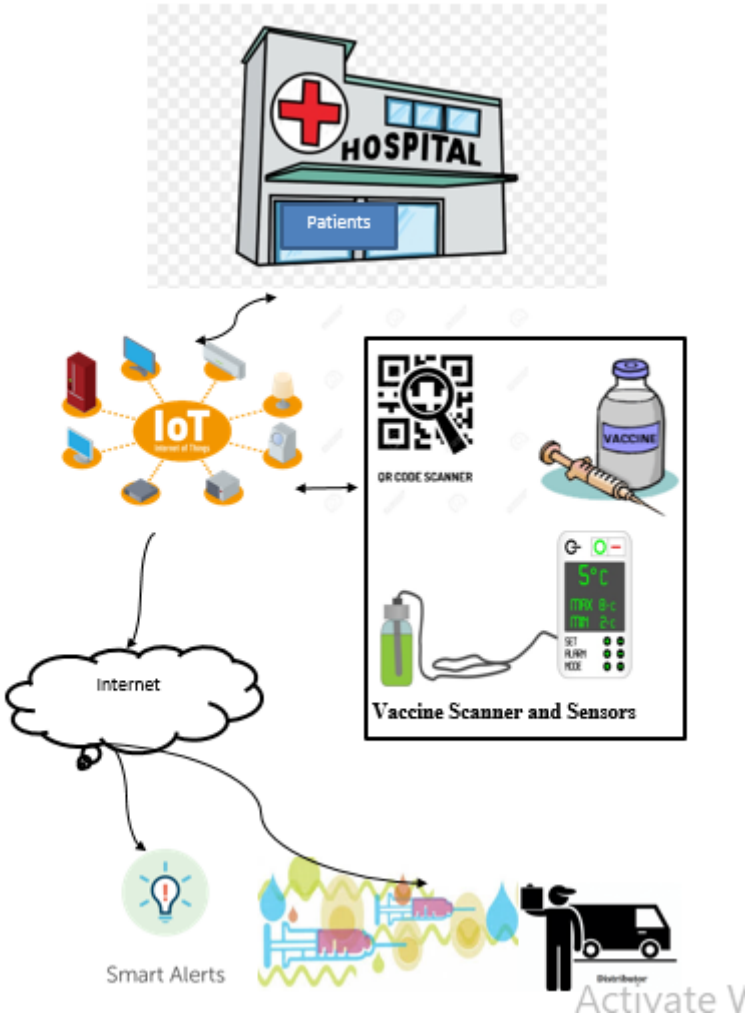

Figure 1: System Architecture

(ii) Dosage Monitoring- Once vaccine is declared to be usable, the amount of vaccine used is recorded using values of a HC-SR04 based Ultrasonic distance sensor. The dosage used is recorded into cloud storage and alerts are sent if abnormality is observed.

(iii) Stock Monitoring – each time vaccine exhausts (or about to be exhausted on a particular threshold) alerts and notifications are sent to prospective vendors.

(iv) Analytics – The overall use of vaccines in different hospitals is graphically represented with filter and drill down options. Visualization softwares like Kibana is planned to be used. Since vaccine overall data becomes big-data, an elastic search is used for analytics.

(v) User Interface: Android based Apps are developed to enable details of vaccines used for nurse, managers and others. Role based access is provided for different users of the App and details of vaccine stock and dosage can be observed in the App.

The following performance parameters are planned to be evaluated in proposed system:

- Stock Monitoring – measuring stock of vaccine available accurately (measured as

number of false positives/negatives alarms)

- Accuracy of Temperature data collected – measured as percentage of error in measurement
- Expiry time monitoring – measured as percentage of false positives and negatives alarms
- Dosage measurement – accuracy parameter measured as percentage of error in dosage value
- Number of possible health hazards avoided by implementing Smart Vaccines

Feasibility

Vaccine Inefficient/Unskilled monitoring will result in Out of Stock. In rural areas getting new stock may cause lot of delay. In Government hospitals getting stock may be negligent and process consuming. But in both cases we end up in either death or health hazard scenarios. Overdosage or wrong conditioned vaccines Vaccine dosage is important if proper dose is not given or not monitored, it may cause irreparable damage. Vaccines operate under specific temperature range. If not monitored it may also result in health issues. With consideration of all the factors like proper stock of vaccines, temperature of vaccines, dosage of vaccines, proper management of vaccines, getting the right quantity and quality of vaccines, we would like to introduce QR code being generated for each vaccine. QRcode could then be scanned for use of vaccine which would help in its automatic monitoring. Further at the other end the QRcode scanner could be connected to IoT device which could help in sending smart notifications

References

[1] Lopez A . Annex 2a . In: The global burden of disease and risk factors . Washington (DC), New York (NY) : World Bank and Oxford University Press ; 2006 . Crossref , Google Scholar

[2] National Family Health Survey . Child health . Chap. 9 in: Results of the National Family Health Survey 2005–2006 . Mumbai : NFHS ; 2006 [cited 2011 May 26]. Available from: http://hetv.org/india/nfhs/nfhs3/NFHS-3-Chapter-09-Child-Health.pdf Google Scholar

[3] Jha P , Laxminarayan R . Choosing health: an entitlement for all Indians . Toronto : Center for Global Health Research, University of Toronto ; 2009 .

[4] John TJ . India's National Technical Advisory Group on Immunisation . Vaccine . 2010 ; 28 (Suppl 1): A88 – 90 .

[5] Tate JE , Chitambar S , Esposito DH , Sarkar R , Gladstone B , Ramani S , et al. Disease and economic burden of rotavirus diarrhoea in India . Vaccine . 2009 ; 27 (Suppl 5): F18 – 24 .

[6] Deolalikar AB , Jamison DT , Jha P , Laxminarayan R . Financing health improvements in India . Health Aff (Millwood) . 2008 ; 27 (4): 978 – 90 .

[7] Black RE , Cousens S , Johnson HL , Lawn JE , Rudan I , Bassani DG , et al. Global, regional, and national causes of child mortality in 2008: a systematic analysis , 375 (9730): 1969 – 87

[8] Watt JP , Wolfson LJ , O'Brien KL , Henkle E , Deloria-Knoll M , McCall N , et al. Burden of disease caused by Haemophilus influenzae type b in children younger than 5 years: global estimates . Lancet . 2009 ; 374 (9693): 903 – 11