Design and Development of Infant Detection and Wireless Alarm Based Baby Bed- an electromechanical perspective

Ajit. N. N, Rakesh. K. M, Keshav Prakash
Department of Mechanical Engineering
NIE
Mysuru, India

K.S. Lakshmikantha, Dr. K. R. Prakash
Department of Mechanical Engineering
NIE
Mysuru, India

***Abstract*—Many children are being abandoned by their parents. They are being left, usually in front of orphanages. In this paper an effort has been made to design and deploy a smart baby bed which can alert orphanage authorities about arrival of new baby, without revealing the identity of the person leaving the baby.**

Keywords—Smart baby bed, Orphange

I. INTRODUCTION

India being fastest growing population in the world, and population under the age of 25-44 is highest in the world (27.6%), these two indicators along with increase in cost of living has posed the restrict the number of kids per family to 2. As per the statistics, India alone has absolute increase of 181 million in the country's population has been recorded during the decade 2001-2011, contrasting statistic is a reduction of 5.05 million in the population of children aged 0-6 years during the same period. The major reasons for this declining population of children in India are feticide, infanticide and abandonment by the parents because of bad health of infants. Expectation of male against female is one of the primary reasons for infanticide and feticide cases. On the other hand there are many couples facing infertility issues and are willing to adopt.

Indian government has taken several measures for the benefit of abandoned children. Along with government, several nongovernmental organizations have also pitched in to help resolve the rising issue. One of the major issues notices by these organizations are the process of surrendering the infant to the orphanages, there are many instances where the new born infant is placed just outside the door of orphanages have provided dedicated cradle and protective caging to safeguard the infant from stray dogs attack. The main reason for this type of surrendering is not to disclose the identity to the society. There are many cases where the new born infants are abandoned due to the health conditions like hole in heart, HIV, Down's syndrome etc. Every human in this world should have equal opportunity to live and the same is mentioned in our constitution as "No person shall be deprived of his life or personal liberty except according to procedure established by the law" Article 21 Chapter 3 of Indian Constitution.

Identify disclosure problem leads to abandon the infant in front of orphanage. Many a times, it had happened that the babies were left at midnight and by the time the orphanage authorities noticed it in the morning, the babies had suffered hypothermia and ant bites.

There is always a risk of even stray dogs eating away the baby. Hence to protect the infant from environment and harmful creatures an attempt is made in this paper to safeguard the infant and reach the orphanage intact.

TABLE I: INPUTS AND RATIONALE FOR WORK

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Input	Rationale
The electronics involved should be hidden properly and the communication between cradle and alarm should be wireless.	If wires and other electronics are visible, baby keepers may fear of disclosing identity.
Detection system should not appear costly.	Street walkers may steal the cradle. As, earlier they haven't spared even a piece of wooden plank.
The alarm inside the orphanage should trigger roughly after a delay of 5 minutes since the baby is kept.	Baby keepers should be given ample time to keep the baby and leave without being noticed.
The system should be capable of detecting the weight even below 1Kg.	The minimum weight of premature birth baby received there is 1.4Kg.Though UNICEF says the least weight can be 1.5Kg.
The casing for electronics should have Ingress protection. And the material of cradle should be weather resistant.	The cradle would be exposed to rain, sun, dust etc.

Previous table shows the inputs provided with their rationale to guide the tradeoff during the design.

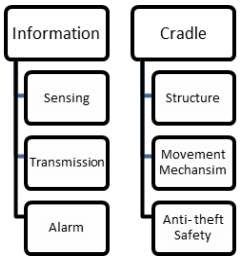
II. Objective of the Problem

To design a electromechanical system which can efficiently address all the requirements of the orphanage management.

III. Methodology

The mentioned requirements were addressed individually, by exploring multiple concepts and solutions though black box approach as shown in fig 1. The system could be broadly divided into the blocks of information system and cradle.

Fig 1: Black Box Approach



Various concepts were generated and tested for the blocks. Using Pugh selection matrix, the best concept was chosen and prototypes were built. After getting the feedback from orphanage management, and observation of performance of prototype, the final refined solution was deployed at the site.

IV. Smart Baby Bed Design

This baby bed is designed to detect the presence of babies of age group 3 to 2 years. The electronic design of the bed is such that once a baby is placed in the bed, signal are sent to orphanage office with a delay of 5 minutes which is followed by an alarm indication. The intention of delay is that person leaving the baby should not feel being watched or observed by others.

A. Assumptions made while designing

- Life span of bed – 3 years
- Age group of babies – 3 months to 2 years
- Battery Replacement- 3months

B. Concept generation and selection

Concept generation and selection was made by considering all the above assumptions and by using pugh selection matrix approach which is an follows.

TABLE 2: CONCEPT GENERATION

Concept	Structure	Movement Mechanisms	Anti -theft Safety
1	Swinging Cradle	Electronic detection through camera/PIR/IR	As the cradle is hooked to the support no additional locking is required
2	Roller Type Cradle	Actuation of pushbutton due to rolling of Cradle	Alarm indication for part removal
3	Plywood with metal base	Helical spring expansion/Compression	Clamping cradle to base support

TABLE 2: PUGH SELECTION MATRIX

Criteria	Concept 1	Concept 2	Concept 3
Low Cost	2	3	3
Environmental exposure	1	4	4
Anti-theft safety	1	2	5
Hidden Electronics	1	1	3
Time delay in indication	1	1	3
Ants and insect bite	2	3	4
Low Maintenance	2	3	4

Fig 2: Concept drawing 1 & 2

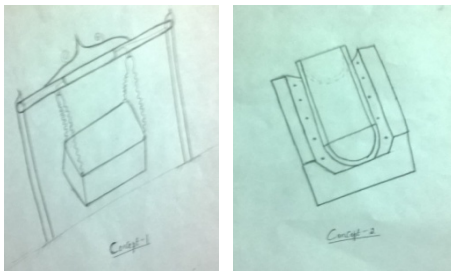
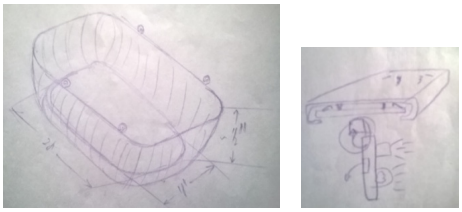


Fig 3: Concept drawing 3



Based on the observation from tables 2 and 3 concept 3 was found to be most appropriate and hence selected.

C. Sheet metal and wooden plate layout

Ms-sheet plate of thickness 1.2 mm with chrome plating of 10μ issued to hold the springs and limit switches as shown below in fig 4. The limit switches are held in position with the sheet using nuts and bolts. The maximum traverse of the limit switch used is 4 mm. At the center of the wooden plate provision is made for holding PCB.

Fig 4: Sheet metal with Limit Swithces

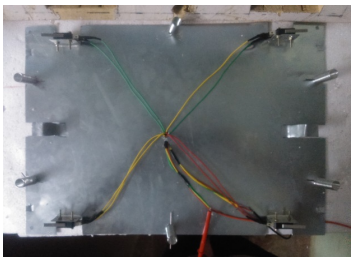
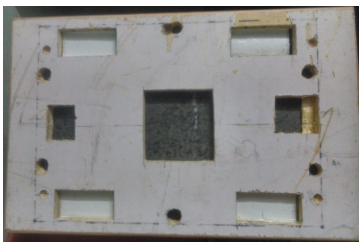


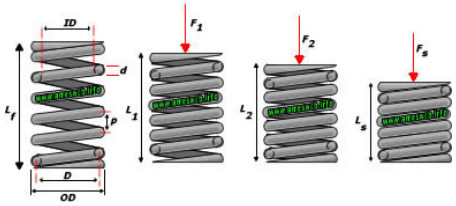
Fig 5: Top view of Wooden Plate



D. *Spring Design*

A helical compression spring, made of 302-stainless steel wire is used in this work. The spring is subject to only linear loading, as rest of the degrees of freedom of the springs are restricted. Calculations were made by considering following input parameters.

Fig 6: Spring design details



Input Parameters

Wire diameter (d) = 1.2 mm

Spring Outer diameter (OD) = 15 mm

Dead weight (F1) = 5 N

Spring deflection (L1) = 30 mm

Spring rate (k) =0.35 N/mm; G = 69GPa

Material: 302 Stainless Wire; E = 193GPa

End condition: Ends are fixed with a flat parallel surface

Results

Number of active coils (Na) = 19

Spring index (c) = 11.5

Spring Free length (FL) = 44 mm

Spring solid length (FS) = 24.5 mm

Pitch (p) = 2.17mm

V. INFORMATION SYSTEM

There were various options available for sensing, transmission and alarm.

Sensors: Passive infrared sensors, limit switches aided with spring support.

Transmission techniques: Modifying the available wireless bell and 433 MHz transmitter and receiver modules along with encoder and decoder.

Alarms: Turning ON all the interior lights and a simple buzzer. Following were the concepts generated.

TABLE 3: CONCEPTS FOR INFORMATION

Concept	Sensing	Transmission technique	Alarm type
1	PIR sensors	Modifying the existing wireless bell available in market	Switching ON the interior lights of the child home
2	Limit switches	GSM module	SMS or a missed call alert.
3	Limit switches with springs	433MHz wireless modules along with encoder and decoder.	Buzzer with 2 different tones for baby detection and low battery (of cradle) indication

TABLE 4: PUGH SELECTION MATRIX FOR INFORMATION

Criteria	Concept 1	Concept 2	Concept 3
Low Cost	4	1	4
Durability	1	3	4
Battery Power consumption	2	1	5
Resistance to ambient conditions	1	2	3
User friendly	2	3	5

Based on the observation from table 3 & 4, concept 3 was found to be most appropriate and hence selected.

Fig 7: Sensing and Transmission Circuit

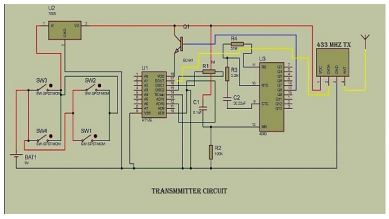
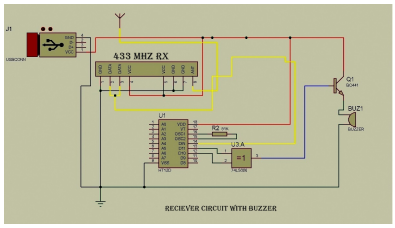


Fig 8: Receiving and alarm circuit



VI. Deploying information system

Four limit switches connected in parallel along with the spring support sense any weight greater than 0.5 Kg on the platform. This results in the powering ON of the whole circuit and the timing IC CD4060 activates the HT12E after 5 minutes. The encoder sends the data bits '1010' along with 8 bits address serially. Further, the transmitter module modulates (Amplitude Shift Keying) the digital data and the modulated wave is radiated through a telescopic antenna.

Antenna selection: For the frequency of 433 MHz, the quarter wavelength is 17.32 cm so any telescopic antenna greater than this height would do well.

At the receiver side, the modulated wave is received by the 433MHz receiver module which demodulates the wave and the digital data is sent to the decoder IC. The data bits input at the T^X reflected at the data pins of receiver. A XOR gate validates the data and the output of this gate drives the power transistor which in turn drivers the buzzer.

VII. Observation and results

The smart bed system was tested for its working and optimized accordingly, to achieve sensing for minimum weight of 0.5 kg. Usually, normal babies are born with a weigth of 0.8 kg to 1.5 kg, but in case of early birth (7months) weigth of the baby will be less. Hence, the design was made y considering such babies.

The optimization process was carried by considering 5 zones in the wooden bed (where baby will be kept) as shown in fig 4. The corresponding results are tabulated as shown in table 5.

Fig 9: Optimization Process (Zones)

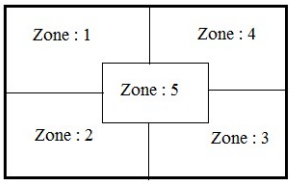


TABLE 5: OPTIMIZATION RESULTS

Weigth (kg)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
0.5	1	0	1	0	0	2
1	1	0	1	1	1	4
1.5	1	1	1	1	1	5
2	1	1	1	1	1	5
3	1	1	1	1	1	5
4	1	1	1	1	1	5

Earlier the transmitter was designed to transmit '1111' as the data. But during the due course it was noted that the receiver started to trigger by itself randomly. It was found out that this was due to the noise picked up by the receiver. And the data at decoder IC was "1111". To overcome this, the data transmitted was changed to "1010". And at the receiver side, two successive data pins are input to XOR gate. Even if the noise is picked up, the "1111' data at the decoder doesn't trigger the buzzer.

VIII. Conclusion

All the requirements posed by the orphanage authorities have been successfully addressed and the working system is deployed.

Acknowledgment (Heading 5)

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g." Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

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