Project proposal for DST & Texas Instruments Inc. India Innovation Challenge Design Contest 2018 Anchored by NSRCEL, IIM Bangalore

SMART INFINITY GLOVE USING HEURISTIC TECHNOLOGY

(S.I.G.H.T)

MANIPAL INSTITUTE OF TECHNOLOGY

NAME	COLLEGE ID	UG/PG	COURSE/BRANCH	SEMESTER
Bharath Chunduru	**160929024**	**UG**	**B.TECH/MECHATRONICS**	**5TH**
Vibhu Nagrath	**160929028**	**UG**	**B.TECH/MECHATRONICS**	**5TH**
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Project Abstract:

The human hand is the most versatile part of the body. We exploit its **dexterity** to provide a glove that can transcend today's wearables by giving an **organic feel** while interacting with technology. We feel today, the most important and difficult to procure resources are **time, money, health & safety**. S.I.G.H.T. will safeguard these resources.

The **Gesture Recognition Technology** is central to this product and uses on-board sensors and the processing power of the ubiquitous smartphones. It saves time and trees to take notes digitally by writing in the air, than search for pen & paper. The sensors on the gloves support fitness tracking for the fitness-conscious users. The glove can also substitute for a hand-held controller for drones, etc. Gestures empower the user to control IoT enabled devices, signal to the concerned authorities in case of a stroke or assault.

Team Members – Roles & Responsibilities

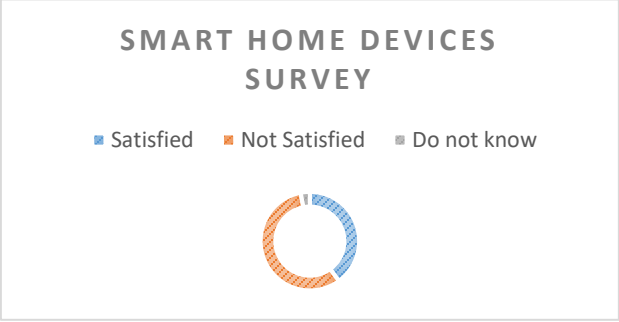
S.No	Student Name	Role	Justification
1.	Bharath Chunduru	Marketing	Good Creativity and Ingenuity
2.	Avneesh Mishra	Technical	Technical Oversight and Experience
3.	Vibhu Nagrath	Operations	Held positions involving work relevant to role

MARKET ANALYSIS

A. Customer Need Identification:

From our In-depth analysis, we found that:
Even though the worldwide wearables market is expected to nearly double by 2021 and India's consumers bought another 2.7 million units last year, the subcontinent's gadget buyers are showing signs of fatigue. **The One Main reason being the product dissatisfaction due to cost ineffectiveness.** Consumers feel the need of devices which can serve multi-purpose applications at low cost. But, the present Wearable market aims on Single-Application approach which makes customers think why they are going for heavy-cost device with just limited features.
Source: https://www.statista.com/outlook/319/119/wearables/india

Also, 57% Indian Consumers felt that there needs to be a better way of interacting with home devices than just with Apps and Voice Control.



And, 78% Consumers want a Faster and Easier way to call out Ambulance or Police when in emergencies. Also, some people wished they had something more reliable than Smart Phone and had even more unique features than existing Smart Devices.
(From statista.com)

B. Serviceable Addressable Market (SAM) Identification & Justification

Based on the use application of our product, the customer market can be divided into following segments:

- Upper and Middle Working class who would like to leverage our Wearable solution to make their life go easier.
  (https://www.forbes.com/sites/michaelrsolomon/2018/06/21/how-will-consumers-make-sense-of-wearable-technology/#2134733f6e9b **)**
- Early Adopters for our product when produced in market (Youth).
- Home Automation and Fitness Enthusiasts.
- Working Women who wish to have handy safety features.
- Customers with Elderly suffering from strokes to take care of and Blind people who wish to access their surroundings easily without any obstructions.
- Research Experts who wish to work on our product to make it more advanced than ever.

[Indian wearables market witnessed growth of 66% year over year and 40% sequentially in the second quarter of 2018, according to IDC India's report.] https://telecom.economictimes.indiatimes.com/news/indian-wearables-market-grows-66-in-q2-xiaomi-leads-idc-report/65607282

C. Product Differentiation w.r.t. Competition & Justification

The Wearable Market in India is still in the early stages of its production, with Smart Watches and Fit Bands ruling the Market. Smart Glove Startups are not yet well established in India. Presently, in India, the only Smart Gloves made are:

- Smart Glove converts hand gestures based on Indian sign language into spoken English, potentially paving the way for speech-impaired individuals to communicate more effectively with others. https://www.business-standard.com/article/technology/smart-glove-gives-voice-to-gestures-116072400209_1.html
- Smart Glove can be connected to a smartphone via Bluetooth. An app, called Smart Glove Connect, converts the sign language gestures into corresponding speech, taking just a second to process the signals. https://factordaily.com/speech-hearing-impaired-smart-glove-moradabad-students/

In Other Countries, Top Smart Glove Startups are:

- **BrightSign: Incredible Sign-To-Speech Smart Glove Startup Is Raising $1.4 Million.** https://www.forbes.com/sites/kittyknowles/2018/04/30/brightsign-incredible-sign-to-speech-smart-glove-startup-is-raising-1-million/
- ProGlove: First Smart Glove for Industries. https://www.proglove.de/

- ✓ **As you can see, none of the above Startups aim to use Smart Glove as an interacting tool to communicate with Smart Devices.**
- ✓ **All the above mentioned Startups are limited to single-functionality except ProGlove.**
- ✓ **Our product aims to address multiple pain points all at once with just a Gesture in the air, using Onboard Processing assisted by App from Smartphone which is not the case with the other Startups.**
- ✓ **We wish to provide Lifestyle, Fashion, Fitness, Smart Interaction and Communication, Security and Safety, all in one product with much more Reliability than Smartphones.**

D. Understanding of customer & user

When we are putting out our Product, it should pass through various stages like Prototyping, Data Administrators, Developers etc, before it goes to the public use. So, the people to whom we are intending to build the product are the Customers (People who will be buying our product) and the rest who use our product for Research and Development purposes but not fall into our main group (Data administrators, testers) are users. But mostly, our product addresses Customers as Users since it is a personal electronic product.

E. Distribution Channel Identification

Our Product has a B2C (Business to Customer) Distribution. And, our Product Distribution can be categorized into two segments:

- Physical Product Distribution: The Most preferred means would be to use Direct Sell strategy. Selling it Online in the Initial stages could be the most viable option for us.

Also, the early to the market products perform initially well in the Web based marketing according to our analysis. Later, we wish to expand our base through an established Dealer Network. Website based Product purchasing would be our high area of focus.

- Web-Based Distribution: The app software assisting the Gesture Recognition feature can be sold from the App Stores of respective Operating Systems (OS). The App then, needs to be installed on the user's Smartphone to establish communication between Glove and Phone.

INNOVATIVENESS OF THE PROPOSED SOLUTION

We redefine the word 'Innovation' with our product. Gesture recognition using Sensor feedback along with Machine Learning Processing (A Heuristic Approach) is one sure thing that has a humongous potential to shape human lives forever.

We create the opportunity to collaborate and make this idea *evolve* even more superior, with our product. Integrating multiple stupendous and utilitarian features into one Single Glove would bring us good response from customers and make our product distinguished from the single-application oriented products currently dwelling in the market.

Some distinguishing vectors:

- MATERIAL: Designed to be worn by user, with ultimate feel of comfort. The use of Sports Fabric would bestow some unique properties like Good thermal insulation and less Wicking.
- POWER: Set to use as a daily product, it embodies a functional circuitry which would require less power but outputs more promising features. Usage of simulated and carefully built components to offer low power but efficient performance application make this product work all day long compared to other products which require frequent Charging.
- PERFORMANCE: Powered by Efficient Performing functionalities, its response time and latency are no more a problem to the user. Multi-featured applications can all work at the same time as the user desires.
- COST: Built to provide mankind an opportunity to access advanced features with such ease would require moderate pricing. But, we promise, it would never stand high as such with other competitors whose sole aim is to make profits.

Proposed Project Design

Objective

The main objective of this project is to tap into the potential of smart wearables and their affect on our day to day lives. Here are a few goals we aim to achieve:

- Change the way people interact with IoT devices, providing a simpler, more human approach to controlling devices.
- Accomplishing tasks through simple gestures. Sending emergency notifications, making presentations more interactive and fitness tracker are a few noticeable applications.
- Opening a new dimension in the field of controllers by implementing a developer friendly SDK.

The ultimate aim of the project is to perform gesture recognition of hand and pose estimation of fingers using a *non computer vision* based approach. All the above features could be made available in form of a wearable glove that people can carry around easily.

Proposed Solution

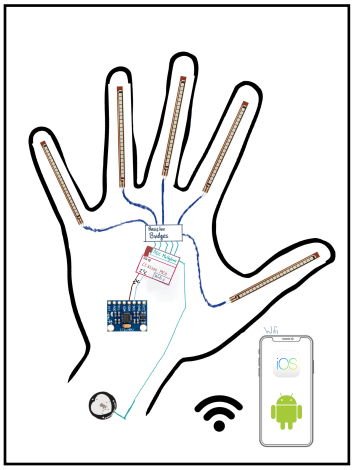
We aim to achieve our objectives and apply those principles in practice on three different types of communication media.

	WiFi	**Bluetooth**	**WiFi + SoC**
Brief Information	Uses the **SimpleLink CC3220S Wireless MCU** to communicate with an external device such as a smartphone through *WiFi communication*.	Uses the **SimpleLink CC2640R2F MCU** to communicate with an external device through *Bluetooth communication protocol*.	Uses the **MSP430FR2355 MCU** in coordination with **PocketBeagle** to perform some computations on board. This device can also send data to an external device such as a smartphone.
Extra information	Needs the **CD74HC4051** analog multiplexer IC because the MCU used has only 4 analog channels (which are too less for our application). Needs an external device connected through *WiFi*.	Needs an external device connected through *Bluetooth.*	Few features are available without the need of an external device, since there is a PocketBeagle SoC (*System on Chip*) on board.
Power source	AC (220 V to 240 V at 50Hz, main supply) and DC (3.7 V, 2200 mAh battery on board). Both designs are designed using Webench power solutions and are shown in the block diagrams section.		

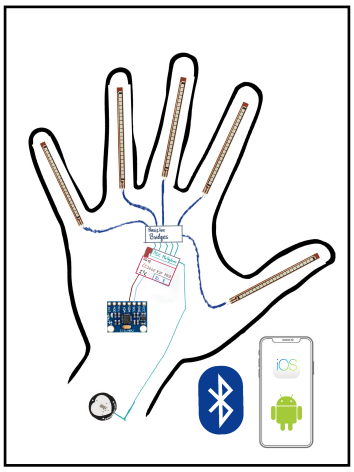
Block Diagrams

Circuit Connection

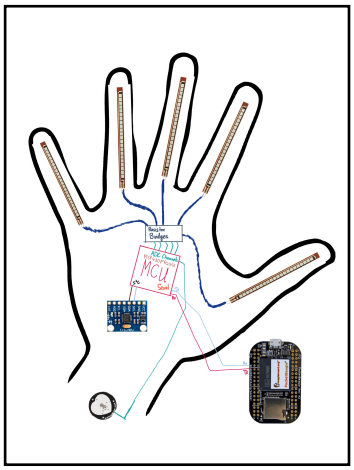
Here's a brief sense of connection layout on the glove, It also highlights the communication protocols used and connections. Note that it is subjected to change based on physical design parameters and availability.



WiFi



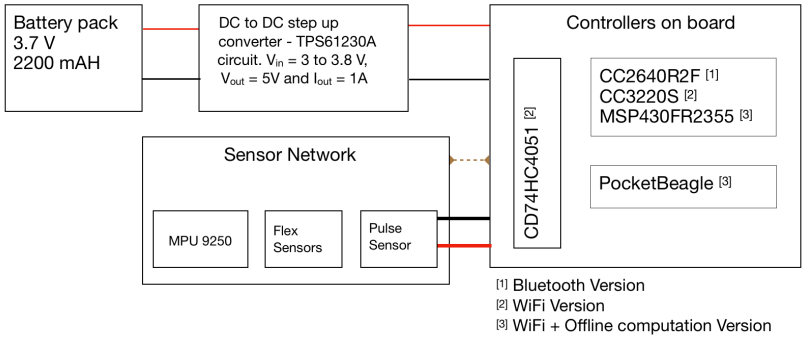
Bluetooth



WiFi + SoC

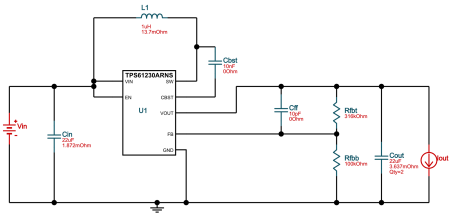
Power level circuit design

DC to DC Circuit

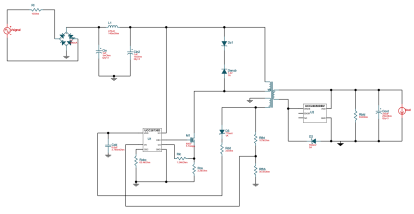


[1] Bluetooth Version
[2] WiFi Version
[3] WiFi + Offline computation Version

The step up converter is designed using Webench power solutions (DC/DC power system) and is shown below. There is also another design that employs AC to DC converter.



DC / DC solution



AC / DC solution

Bill of materials

TI Parts

Category (IC/EVM)	TI Part Number	Link to the Part Number (on TI website)	Quantity	Usage in our application	Available in TI E Store (Y/N)	Price (in USD)
EVM	SimpleLink CC2640R2F MCU LaunchPad	http://www.ti.com/tool/LAUNCHXL-CC2640R2?jktype=combinedrecs#technicaldocuments	1	Test the performance of Low energy Bluetooth for our application. It will be sending the data frames to a remote computer or cell phone[1].	Y	$29.00
EVM	MSP430FR2355 LaunchPad	http://www.ti.com/tool/msp-exp430fr2355	1	It is used to gather all the data and do all the interfacing work for the beagle bone on board[2].	Y	$13.00
EVM	SimpleLink CC3220S Wireless Microcontroller LaunchPad	http://www.ti.com/tool/cc3220s-launchxl#technicaldocuments	1	Test the performance of WiFi for our application. It will be sending data to a nearby mobile device[3].	Y	$40.00
IC	CD74HC4051 (PDIP: Plastic Dual In-line Package)	http://www.ti.com/product/cd74hc4051?keyMatch=CD74HC4051&tisearch=Search-EN-Everything	1	Analog multiplexer, in case we use the WiFi method (since the micro-controller in that case has only four channels and we need more)[3].	Y	$0.18
EVM	PocketBeagle (SoC: System on Chip)	https://beagleboard.org/pocket	1	It can interface with system if the micro controllers on board don't have that capability. It can also act as a powerful offline computation engine, so we can have some features of the device work even in offline mode[2].	N	$25.00
EVM	SimpleLink CC3200 SensorTag	http://www.ti.com/tool/CC3200STK-WIFIMK	1	For rapid prototyping, API development, and demonstration purposes[3].	Y	$40.00
IC	UCC28730 Zero Standby PSR Flyback Controller	http://www.ti.com/product/UCC28730/description	1	Testing circuitry for AC power supply. [Input: 220V to 240V, Output: Isolated 5V, 2A at 30°C][4].	Y	$0.52
IC	TPS61230A Step Up Converter	http://www.ti.com/product/TPS61230A	1	DC to DC power (takes power from battery on board and supplies to electronics on board)[Input: 3 to 3.8V, Output 5V, 1A at 30°C][5].	Y	$0.78
				Total		$148.48

[1] Bluetooth version
[2] WiFi + Offline version
[3] WiFi version
[4] AC to DC powering solution: Webench Design at https://webench.ti.com/appinfo/webench/scripts/SDP.cgi?ID=129FEF7183AEA9F3
[5] DC to DC powering solution: Webench Design at https://webench.ti.com/appinfo/webench/scripts/SDP.cgi?ID=E12AE57BE7E39E43

Non TI Parts

Non TI Part	Part Number (if applicable)	Role / functionality	Data Sheet / Link
Resistors		Generic components needed for circuit designing	
MOSFET	IPD80R1K0CEBTMA1		
Connection terminals			
Capacitors			
Inductor	2300HT-471-H-RC		
3.7V 2200mAH Lithium Polymer battery (rechargeable)	BAT-2547	Rechargeable battery for remote powering of electronics on board[1].	https://www.rhydolabz.com/hardwares-batteries-c-170_167/polymer-lithium-ion-battery-2200mah-37v-p-1803.html
IMU MPU-9250 Sensor module (breakout board)	MPU-9250	IMU (Inertial measurement unit) for measuring acceleration, rotation and palm temperature	https://www.electronicscomp.com/mpu9250-9-axis-gyro-accelerometer-module?ras=raslrelated&utm_source=retailreco&utm_medium=onsite&utm_campaign=raslrelated&fp=3
Pulse sensor	SKU: 18591	Pulse sensor for measuring heartbeat and performing data analysis on pulses for detecting abnormalities	https://robu.in/product/pulse-sensor-amped/?gclid=EAIaIQobChMI3pyi3Imh3gIVUh0rCh2Z_gnEAQYASABEgLyBPD_BwE

[1] Battery subjected to change if a batter replacement is found

Algorithms and technologies employed

The following algorithms and technologies are employed by the proposed project

- *Artificial Neural Networks* to estimate the joint angles of fingers for pose estimation based on flex sensor's response. The training data will be collected using computer vision methods combined with flex sensor readings. Once trained, we no longer will need computer vision.
- Direction cosine matrix *(DCM)* for IMU readings and position estimation of an IMU.
- *Abnormality detection algorithms* for checking irregular heartbeat pulsation.
- *Forward kinematics* for estimating the position of the fingertips in 3D space. These results are achieved by running forward kinematics on the above two results.
- *Application development* for *IoT solutions* and SDK development for different mobile platforms, namely, iOS and Android.
- *Wireless communication* through SoCs, micro controller based embedded system with maximum efficacy.

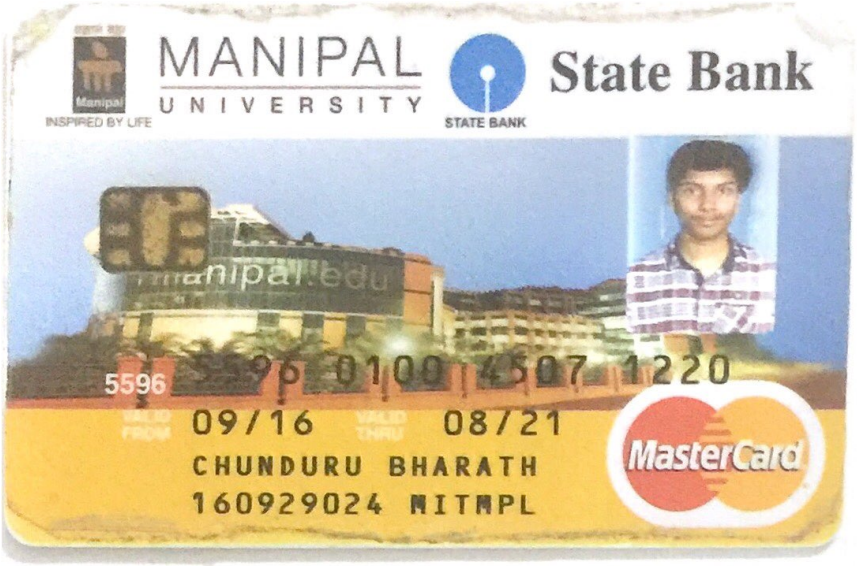
Impact of the Proposed Solution

This product has the potential to cause a revolution like the smartphone back in the early 2000s. The glove may prove to be competitive to the smartphone industry, in the long run.

The users will feel a natural connection with the device because the control is made possible through hand movements that come naturally to us (for example, raising the hand when controlling a music player means increasing the volume).

With a multitude of features S.I.G.H.T. will improve, provide the society with tools to rapidly move in the direction that they see fit:

1. The glove can double as an **easy to use** controller replacing many tedious to use controllers out there.
2. Women safety features will bring the **crimes against women down** as the glove will alert the closest police station and send a location ping with a timestamp helping the investigation and apprehension of the criminal.
3. Potential stroke patients will be able to detect a stroke and contact the closest hospitals at the very moment they feel discomfort(or the pulse pattern signals a stroke). This has the potential to **save lives**.
4. **Work Efficiency is expected to improve** drastically as presentation tools and write-in-air like features take the forefront of the product for everyday use. Therein expanding the market.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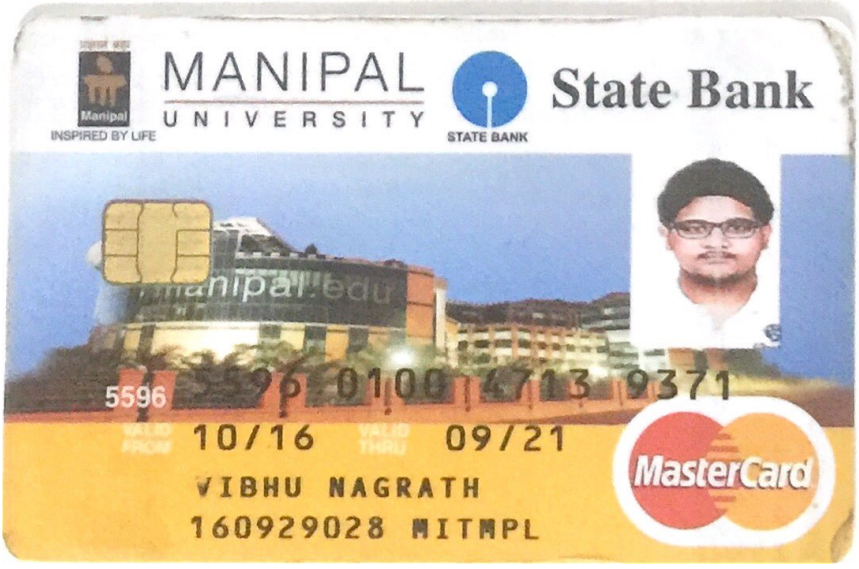
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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

Authorization Certificate

From :

Date : 22/08/2018

Yedukondala Rao
Manipal Institute of Technology
Karnataka-576104
9663565668

Dear Sir,

This is to certify that Yedukondala Rao will authorize to mentor the 372888 comprising of the

Bharath Chunduru, Avneesh Mishra, Vibhu Nagrath in the IICDC 2018 contest.

If the team is shortlisted for the Qualifying Round Phase -1, I agree to receive the TI tools worth 200 $ and drive the teams to submit the Prototypes.

With Regards,

Yedukondala Rao

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Assistant Professor
Mechatronics