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HYBRID PHONE

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ABSTRACT

The concept is to combine the abilities of the phone and that of a personal computer. The end-goal is to design a hardware device that is used only when needed, productive and ensures the essentials of both worlds. We aim to deliver the simplicity of, phone and PC with minimalistic design, so as to minimize addiction towards the unproductive aspects of the smartphone as well as the PC. Finally, we exploit the capabilities of the Raspberry Pi as a microcomputer.

Keyword : android, embedded systems, hybrid phone, linux, raspberry pi

I. INTRODUCTION

The hybrid phone can function as a stand-alone android smartphone but also support a Linux based computer. The phone will be built using Raspberry Pi which will be reconfigured as required. The ports and bus connections will be reconfigured since we will be docking the smartphone device onto a computer.

As such, we require the smartphone to be handy and as thin as possible, meaning that we will have to readdress the USB and serial ports as per the requirements.

The smartphone can be connected to the computer using a docking mechanism. When the phone is docked, it will be able to access all the essential firmware within the computer such as the BIOS. The computer being based on Linux software can have configured system software. This allows us to develop a compatible interface between the smartphone and the computer. The system software will be abstracted and encapsulated from the end user to prevent corruption of the system files.

It is important to note that when the phone is docked to the computer, all individual features of the smartphone will be hidden. It will act as a secondary support for the computer such as, providing wireless internet connection, providing NFC or Bluetooth support and even function as a touch-capable track-pad to control cursor actions for the computer.

II. LITERATURE SURVEY

Considering that our project is primarily based on hardware design with an end-product in mind, we look at

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the related work and developments, as a comparative study in this section. In the development of the Hybrid phone, we require several individual components and hardware resources. There are several institutions and research organizations that have worked on the individual aspects and intellectual properties regarding this concept. However, as a whole, the hybrid phone remains a prototype as yet. An important concept to be implemented into developing the smartphone is the use of multi-core architecture. This ensures maximum utility and efficiency in multitasking without any lag. This is important to deliver the best user experience. Extensive research has been carried out with respect to the limitations by Christian Martin in his paper. [1] The mobile battery requires heavy research considering various aspects of power consumption.

In the paper [2] we discuss the different components within the WANDA-CVD remote health monitoring system. This system utilizes an efficient system for effective smartphone battery optimization for the use in healthcare compliance systems. Despite the increase in research, it remains to be seen whether the technical feasibility and effectiveness of such systems will enhance patient care and other cases of remote applications. Most mobile-based interventions are limited to data transfers, unable to provide wireless coaching and feedback. Chowdhury *et al.* designed MediAlly, a prototype that would dynamically activate the collection of data from other external sensors based on a specified context. Misra *et al.* designed the ACQUA framework to optimize smartphone data transfer using a process of context determination. Many studies have performed detailed analysis of energy consumption in smartphones; Carroll [3] showed how usage patterns affect overall energy consumption and battery life. In this paper, we focus on battery longevity in real world scenarios under the continuous monitoring.

Kiran Jot Singh and Divneet Singh Kapoor performed a survey on IoT platforms for various applications. [5] They came to certain conclusions with respect to their findings. The selection of a board or platform for prototyping a DIY IoT application, project, or product is a critical step. In broad terms, three things must be taken into account in this regard: 1) specifications, 2) open API, and 3) open hardware. The project's specifications play a vital role in the selection of the hardware platform to be used for a particular IoT application. One must consider fundamental aspects such as the Processor or microcontroller, clock speed, GPIO, ADC/DAC, connectivity (Wi-Fi, Bluetooth, or Ethernet), communication (e.g., I2C, UART, and SPI), and, last but not least, the price of the hardware board to be selected.

A prior brainstorming session for the selection of a platform with a certain set of specifications for a particular application is always recommended. Afterward, the key aspect that comes into play is Open API. To avoid being locked, it is essential for a DIYer to select an IoT solution that comes with open standards, community support, and open libraries. The use of readily available open libraries and support enables a DIYer to develop applications in less time with better resource utilization and efficiency, which is reflected in the overall development life cycle of a particular application.

Finally, there is open hardware, which becomes considerably important when someone has accomplished the initial prototyping and is ready to transform the project into a product. For marketed applications, one needs to design a customized, cost-effective hardware solution. A platform with open schematics and hardware support is always handy in developing an application and deploying the product.

III. METHODOLOGY

The most important part of this project is the switching between the phone and the laptop as required; also, these switching needs to be seamless to ensure the best user-experience. So to ensure this, we have the necessary flow of control as follows –

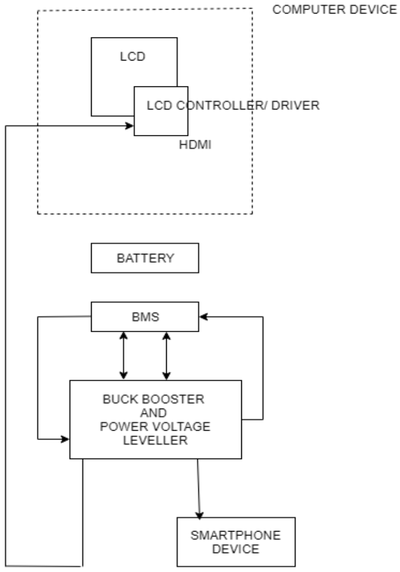

FIGURE 1: detailed block diagram for the interfaced components

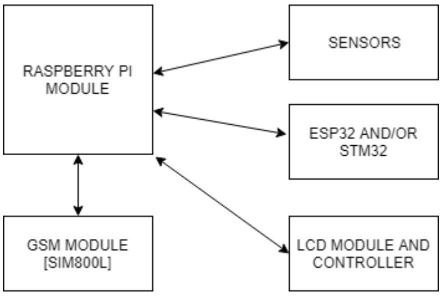

FIGURE 2: basic block diagram for component interfacing

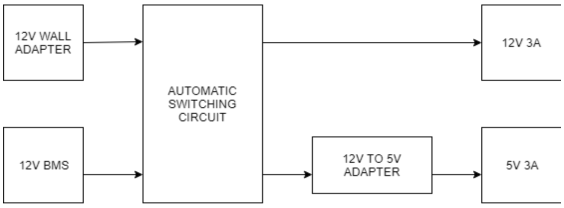

FIGURE 3: simplified block diagram of Battery Management System (BMS) which is also responsible for power-level shifting between 12V and 5V accordingly

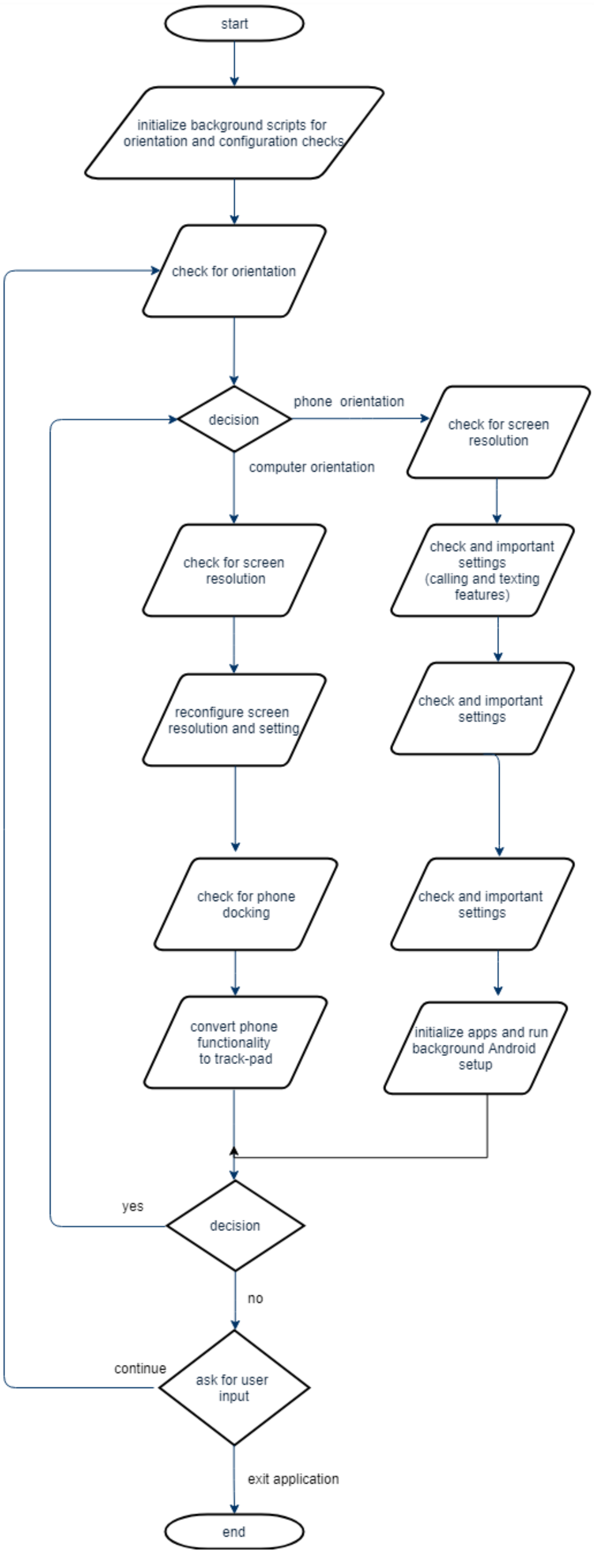

FIGURE 4: control flow of operations

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IV. LIMITATIONS

There are certain limitations and constraints that we have come across, in terms of hardware and software tools used with regards to developing and going forward with this project. We address those limitations in this section and also look towards improving our design in future developments and versions.

Snapdragon Development Board

This is a mobile hardware development kit that is designed and manufactured by Qualcomm Technologies Inc. This development kit has several versions with new versions releasing almost every other year. Each new version supports greater functionality and hardware capabilities.

This kit based on the Snapdragon processor, features a dynamic Android development platform providing an ideal starting point towards designing and developing mobile applications and high-performance devices. The current version of this kit supports the Snapdragon 835 platform that includes long battery life, improved augmented reality (AR) and virtual reality (VR) features for development, camera/ image processing enhancements and high-speed file transfer and downloading capabilities (in the order of gigabytes). The hardware development kit (HDK) also supports Qualcomm's optional wide quad high definition (WQHD) active matrix organic light emitting diode (AMOLED) LCD or 4K HDMI out, 4K Ultra encode and decode, 2 x 16MP or 1 x 32MP cameras, audio in-out, along with microphone inputs, and 3000mAh lithium-ion battery.

Advanced and next-gen functionalities such as artificial intelligence support for camera imaging, processing power efficiency and automatic many tasks thus making the system as a whole much more smarter and intuitive, guarantee a much better version for our own design under consideration in this project.

However, this development board is suited for developers working with original equipment manufacturers (OEMs) and manufacturers that require extremely precise evaluation of processor capabilities and corresponding processor peripherals. As such, this hardware development kit (HDK) is designed for immediate and quick mobile hardware or software developments at industrial levels to manufacture the versatile products we see around us.

From the perspective and scope of this project thus far, with limited financial support, this development board will be for further development and realization of an actual product from a working prototype stage.

HDMI splitter

We in our hardware design included the high definition multimedia interface (HDMI) splitter supporting single input and two outputs. This produces certain problems such as restricting the possible number of externally connected hardware devices (such as keyboard, mouse, USB drives or speakers etc.); also in this case, we are using the raspberry pi as the core computation unit. The input from the raspberry pi goes to the tow outputs via the HDMI splitter.

The HDMI splitter obviously deals with the HDMI cables which are thick and long. These cables inadvertently increase the size of the device since the cables are so long. Also, re-wiring the cables is tedious because we then have to configure each of the 20 underlying wires of the corresponding HDMI pins. This is extremely difficult keeping in mind the requirement of proficient soldering and maintaining insulation and

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possible shorting of the individual wires. As such we would be required to individually reconfigure all of the pins and wires manually.

Now considering the previously mentioned hardware development kit, we would have added, in-built HDMI functionality. The current Snapdragon 835 supports high quality resolution multimedia transfer and at high speeds. Also, this would provide a great alternative and considerably reduce the desired size of the final product. Also, the development kit under discussion here, supports huge memory compared to the raspberry pi. We would have quad-core support with 4GB PoP memory, GPU support, WiFi and BT5.0 capabilities.

Battery Management System

Lithium batteries are relatively difficult to handle because they display highly non-linear charge-discharge curve. With a lead-acid battery, it is relatively easy to tell how charged it is by measuring its voltage since there is a straightforward method of calculating state of charge from that information. However, with a lithium-ion battery, the state of charge relative to voltage is very flat through around 60% of the charge-discharge curve with sharp peaks at both ends.

Considering the lithium-ion battery, it is also easy to cause permanent damage by both overcharging and undercharging the cell. There are also safety considerations, as it is possible for damaged cells to overheat and get into a thermal runaway condition.

The battery management system (BMS) therefore, plays a very significant role. It makes sure we can accurately and precisely report the state of and it also monitors the cells to make sure there are no issues that might lead to a problem.

The battery management system typically consists of several separate circuit boards. First of all, there are the module control units (MCUs) which are sometimes also called “slave BMS modules”. These units will constantly monitor the voltage of each cell, or a small group of cells in the battery. The MCU will also typically include some temperature measurements of the inside of the battery pack and possibly of the cells themselves. The MCU will in-turn communicates up to a master BMS module. The master BMS will aggregate the data from all the slave MCUs and also measure bulk current flow in and out of the battery pack. From this, it can determine the state of charge of the battery. This data is then reported and communicated to the driver. The battery state-of-charge would also impact parameters such as how much “regenerative braking” one can use (particularly if the vehicle is not equipped with a proper braking-resistor system). If the pack is already near to the maximum safe level, then the battery management system will prevent the vehicle from dumping more power into the pack under the system of regenerative braking. This is the reason why there is generally a little bit of useful pack-overhead in order to try and maintain consistent braking feel for the driver. This feature can usually be turned off with an accompanying warning about braking feel.

The capacity of the pack is then limited by the ability to charge each cell up to its maximum safe voltage and then discharge it down to its minimum safe voltage. Due to tolerance and capacitive voltage-saturation, build-up in the manufacturing processes of the cells they typically have small variations in how quickly they charge and discharge. In order to make sure that the whole battery-pack is not constrained to the capacity of

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the cell that gets "full" or "empty" the quickest, the BMS also serves to balance the cells. It does this by using "balancing resistors" that switch on and off to discharge small amounts of power from individual cells or small groups of cells and thus make sure that the overall pack capacity can be maximized and consequently, not constrained to the capacity of the weakest cell.

Scientists and researchers have been investigating into the possible ways to move away from the balancing-resistor as they have an immediate impact on the charging-efficiency of the battery pack. However, the practical implementation is currently complex and costly. Also as manufacture and production methods are improving for lithium-ion cells the need for balancing-resistors is reducing to the point where its impact on overall battery management system efficiency is limited.

In some smaller battery packs with relatively lower number of cells, the MCU and master-battery-cell may be consolidated into a single device. This would be a typical configuration for a low capacity battery pack for automotive use and even for small batteries for applications such as robotics and other industrial equipment.

The BMS needs to be able to communicate with the other subsystems in order to relay corresponding state of charge levels and send any required messages if there is a problem with the battery pack. It will typically broadcast the status of the corresponding battery-pack via the CANbus, which is a serial communication protocol widely used in the industry. Depending on the architecture, the master BMS module may directly control operations such as main DC link pre-charge and power contactors directly or via the vehicle CANbus, with a separate dedicated vehicle-body control unit. The battery management system will also interface with both onboard AC/DC chargers and off-board direct DC fast chargers to tell the charger what mode to be charging the battery in. Because of its safety-critical nature both in maintaining the battery in a safe condition and also maintaining vehicle motion i.e. you do not want the BMS instructing the main DC link capacitors to open, considering there is an issue unless it is actually a very important issue when the vehicle or machine is in immediate operation.

V. CONCLUSION AND FUTURE WORK

In this project we have worked on embedded design and circuit design. This project as such includes a mix of knowledge regarding embedded and software design. The hardware required analog circuit design implementations while the interfacing with the end-user along with all the software applications, required interactive UI design tools.

The project requires us to design and develop a computer and a smartphone that will be integrated to form one single unit. The smartphone will be able to work individually however the computer will work only when the smartphone is docked to it. So in effect, we limit certain functionalities in the phone that can be otherwise accessed when connected to the computer. These restraints will be another step towards making a more productive product.

The current design of this device has limited capabilities according to the constraints of the components we have used. However, it is important to note that there is a lot of stability with regard to the functionality. The system easily and smoothly switches between the phone's and the computer's configurations as desired. The switching time is very low and seamless. We aim to include extended IoT capabilities and improve on the UI and overall design of the system. Thus we are looking forward to a more compact, more user-friendly yet flexible device as major improvements in the future.

VI. ACKNOWLEDGEMENT

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