As Above So Below: How NASA's Space Technology Saved Millions of Lives

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2024-12-16

1. Introduction

Ever since we have stood upright back in the primordial days, humans have always looked up to the stars with wonder and curiosity. For thousands of years we didn't understand what was going on up there, nor did we understand what was happening to us on Earth. What causes hurricanes? Why does the moon change shapes? Until the 20th century we didn't even know why the dinosaurs went extinct. All this changed when we started not only looking at the stars, but reaching for them. For centuries comets and asteroids were believed to be mythological creatures, such as dragons, spirits or Gods themselves. Through modern science we now know they are just space debris and also that our ancestors were not wrong to fear them. It was in the 1960s when Eugene Shoemaker recognised the tell tale signs of impact craters that we learnt how common impact craters are on Earth which finally led to the widely accepted theory of what eliminated the dinosaurs. He would then go on to train Apollo 11 astronauts to recognise the same on the moon which furthered our understanding of Near-Earth Objects (NEO) which are asteroids or space objects that can pose similar threats to us in the future. It was through this work that NASA successfully developed and launched their DART mission in 2022 which provided us with the capability to deflect the trajectory of small moon-like asteroids, granting us security for future asteroid impacts unlike the poor dinosaurs.

This is only one of the few ways NASA has connected its space science to be used on Earth in helpful and sometimes life saving ways. There is FINDER, a small handheld boxed device that can detect human heartbeat under metres of rubble. This technology saved many people during the Nepal 2015 and Turkey 2023 earthquakes amongst many. However, today's story is about the journey of a

big satellite's technology becoming a small handheld ddevice that saved millions of lives during the covid-19 pandemic. This report discusses the research question in section 2, the rationale behind this report in section 3, data cleaning and manipulation in section 4, section 5 will contain the main story, analysis and showcase and finally conclude in section 6, with references at the end.

2. Research Question

To explain the necessity for space research and understand its contributions beyond simply understanding the nature of our universe, the question this report asks is- how has studying space helped us here on Earth? The aim of this report is to demonstrate the necessity of studying outer space and how its benefits go beyond simply studying the universe.

3. Rationale

In recent years there has been a rise in the belief that space exploration is a waste of money and resources. In 2014 where 3 out of 10 Americans believed their tax payer money should have reduced contributions to NASA and 4 out of 10 are happy with the current 0.5% of the national budget given to NASA (Wormald, 2014). In 2023, a third of Americans said science's impact has been negligent and 8% believe science has had a negative impact.(Kennedy and Tyson, 2023)

In 2024 the budget for NASA decreased by 2% with only 1-7% increase in budget throughout the past decade (Dreier, 2024). Elon Musk himself has admitted that without NASA private space companies would not be able to operate as they do. Public funded space programs like ESA and NASA conduct space surveys and find information that private companies do not, instead they make use of this data as an outsource and perform other innovations relying on what publicly funded programmes do.

This is the story about how an invention in a medically-unrelated field I am passionate about i.e space science was used to save the life of not only my cousin but millions of others lives during the covid-19 pandemic, decades after its inception.

4. Data Manipulation

1. Cleaning of mortality rate data

```r
raw_data <- read_csv("data/mortality_by_temp.csv",
    locale = locale(encoding = "ISO-8859-1"))
```

```
## Rows: 17 Columns: 4
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (2): Chart, Body Temperature (BT) Range
## dbl (2): Mortality (%), Sample Size (N)
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this messag
```

```r
raw_data <- raw_data %>%
    mutate(`Body Temperature (BT) Range` = str_replace_all(`Body Temperature (BT)
        "\\?", " "))


combined_data <- raw_data %>%
    group_by(`Body Temperature (BT) Range`) %>%
    summarise(`Initial BT Mortality (%)` = sum(ifelse(Chart ==
        "Initial BT", `Mortality (%)`,
        NA), na.rm = TRUE), `Maximum BT Mortality (%)` = sum(ifelse(Chart ==
        "Maximum BT", `Mortality (%)`,
        NA), na.rm = TRUE)) %>%
    ungroup()


combined_data <- combined_data %>%
    mutate(`Initial BT Mortality (%)` = ifelse(`Initial BT Mortality (%)` ==
        0, NA, `Initial BT Mortality (%)`),
        `Maximum BT Mortality (%)` = ifelse(`Maximum BT Mortality (%)` ==
            0, NA, `Maximum BT Mortality (%)`))


cleaned_data <- combined_data %>%
    rename(`Body Temperature Range` = `Body Temperature (BT) Range`)

cleaned_data %>%
    kable(caption = "Mortality by Body Temperature Range",
```

```
        align = "c", format = "latex",
        booktabs = TRUE) %>%
    kable_styling(latex_options = c("striped",
        "hold_position"), font_size = 12)
```

Table 1: Mortality by Body Temperature Range

Body Temperature Range	Initial BT Mortality (%)	Maximum BT Mortality (%)
36.5 BT 37	17	NA
37 BT 37.5	17	17
37.5 BT 38	17	20
38 BT 38.5	17	24
38.5 BT 39	19	29
39 BT 39.5	21	31
39.5 BT 40	28	38
BT > 40°C	21	43
BT 36	28	NA
BT 37	NA	15

5. Data Presentation

NASA is popular worldwide for its space related achievements such as moon landings, mars rovers and sophisticated space telescopes. However, it seems obscure knowledge to a lot of people how many contributions (many life changing and life saving) NASA has made to the entire world beyond just space and aeronautics. Below is an illustration of the many patents NASA has released in varying fields throughout its tenure (NASA, n.d.)

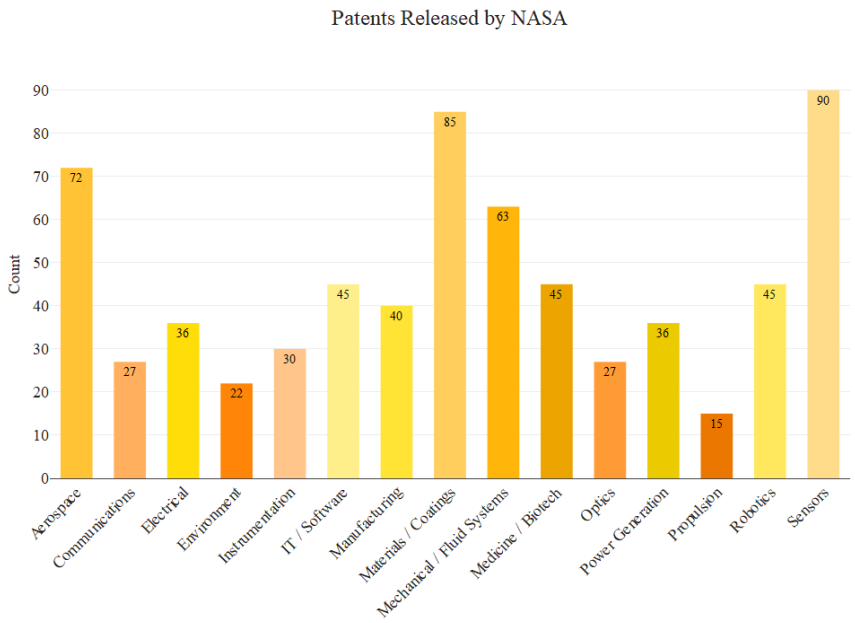

Figure 1: Patents released by NASA under multiple categories.

One of the 90 sensor patents NASA has released, is the infrared sensor which will the be main subejct of our discussion. Despite the knowledge and third-party infrared patents existing around 1901 it was never used for reading temperatures of objects, let alone people. That was, until NASA developed its own infrared technology back in the 1970s for a sky survey satellite called Infrared Astronomical Satellite (IRAS) (Center, 2024) to detect the thermal signatures from planets and stars in deep space which helped us learn about their nature. This technology would return precise temperature differences over vast distances through studying their radiation.

In 1983 IRAS by NASA was the first satellite to survey the sky in infrared. It was also around the 1980s when this technology was released as another one of NASA's patents and was subsequently developed into the first body temperature devices in 1991 (JPL ; Diatek, 1991). However, back then this technology was still expensive and not widely used since contact thermometers like those that used mercury were inexpensive and mass manufactured, plus the idea of a no-contact thermometer was still novel three decades ago.

In 2019 the Covid pandemic hit globally and early screening was a set-up everywhere during the pandemic, especially at public areas such as airports, public buildings and hospitals where through temperature checks it was determined

whether or not someone who suffering through covid. Since cross contamination and social distancing was a major priority, contact thermometers and proximity based tools could not be utilised. Therefore, the method used for temperature checks was a non-contact infrared thermometers (NCIT). Having my own family been affected by this, I learnt the importance of early screening which saved the lives of my two beloved cousins. Catching early signs of infection, wherein a high body temperature was one of the first symptoms and a rising temperature throughout the disease meant a higher mortality rate (Tharakan et al., 2020) was absolutely paramount throughout the pandemic.

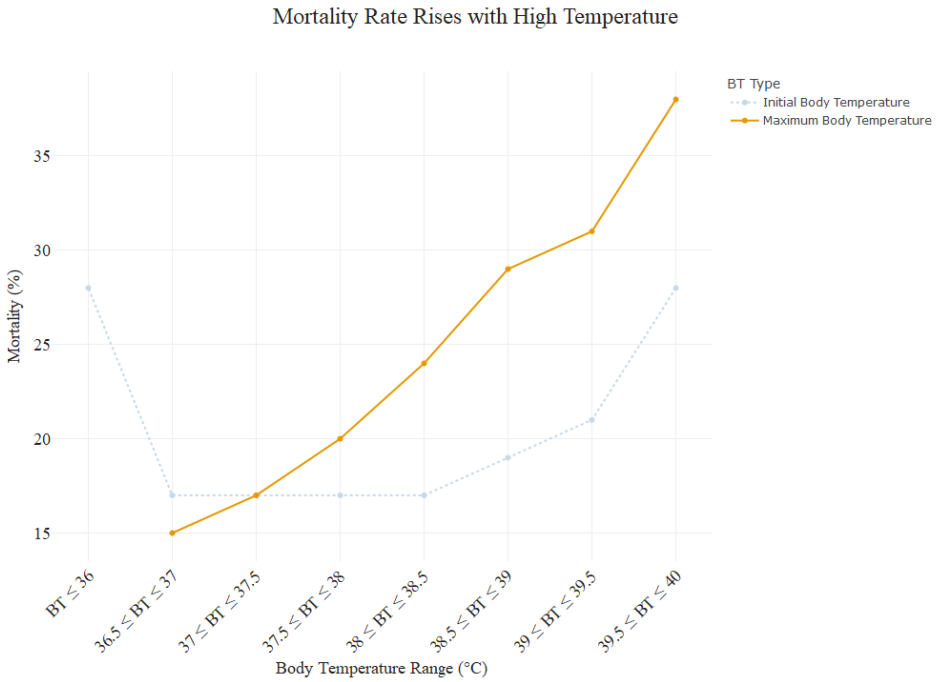

Figure 2: Constant temperature checks through NCIT were vital; as body temperature increases, a COVID-19 patient's mortality risk rises.

As illustrated above, a high body temperature increased a patient's risk to die where extremely low temperatures (below 36) resulted in 28% mortality rate and extremely high temperatures (above 39 or 40) led to a higher than 40% mortality rate.

On top of this another study (Chen et al., 2021) found that the chances to treat the disease successfully reduces as the disease progresses, citing very strongly of the importance of early detection.

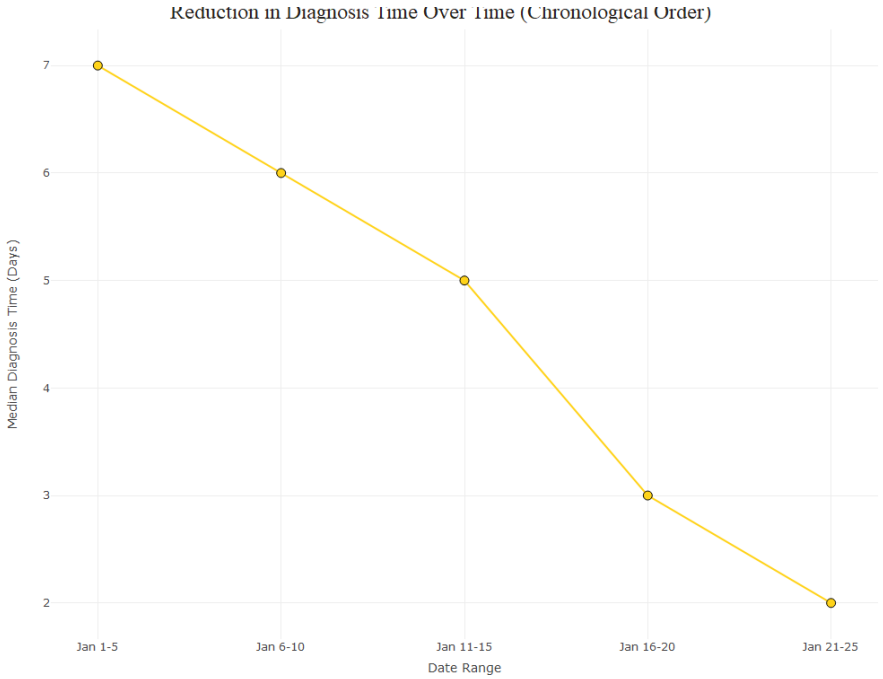

Figure 3: The later the patient is tested the lower the diagnoses efficiency is.

Due to the importance of the NCIT detecting early symptoms of the virus infection, their sales went from a niche market to skyrocketing by 2021 which is considered the peak of the pandemic around the world(Research, n.d.; ReportLinker, 2020).

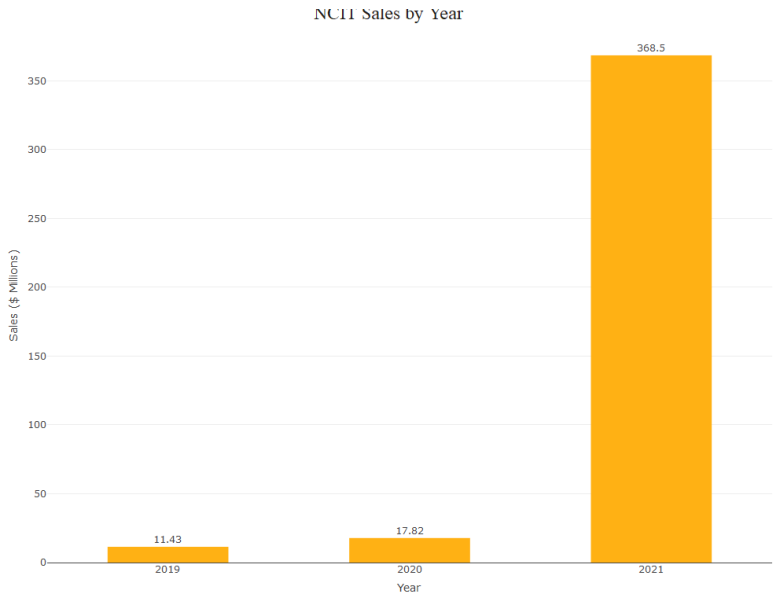

Figure 4: Stark rise in NCIT thermometers sales thanks to the NASA technology that helped covid early screening during the peak of pandemic (2021)

The popularity of this thermometer at the peak of the pandemic shows the importance it held during the covid pandemic and how this obscure technology developed to study temperatures of planets has transformed into becoming one of the biggest medical markets in the world in 2023 (Insights, 2020-2023) with Asia being the largest consumer of these thermometers.

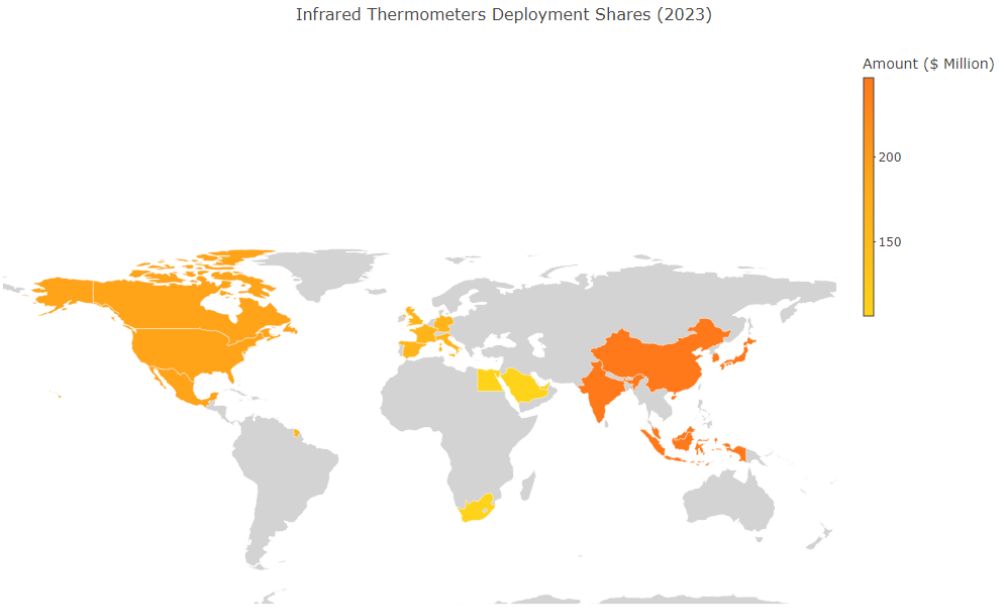

Figure 5: Asia has the largest share of NCITs in 2023, with the global market at $700 Million.

The number of lives early screening from these thermometers saved have made them replace traditional and digital thermometers today where most medical and domestic settings utilise the NCIT for a no-contact screening beyond just for covid. Today NCITs have become a big market where they have replaced mercuty thermometers and will soon replace deigital thermometers simply because of their speed, ease and no-contact methodology.

6. Conclusions:

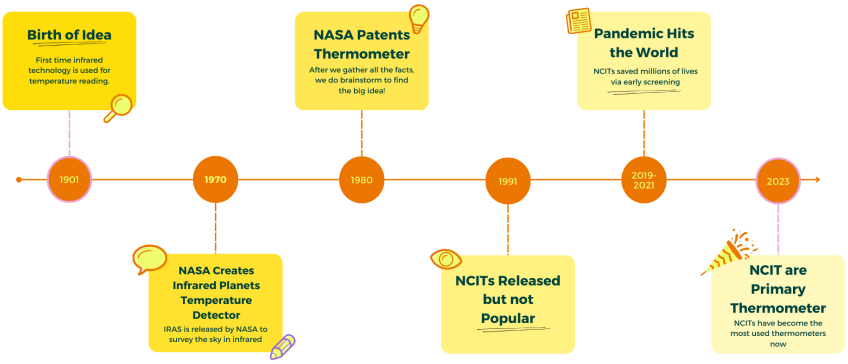

Figure 5: The journey of a space survey satellite to life-saving thermometers.

NASA is known for its many astronomical accomplishments, and while many people think that that is all NASA has to offer, with some also believing space exploration is a waste of tax payer money, we see here that NASA needs to operate as it always has because it changes our lives on earth as well as help us learn about the universe. What started as a NASA technology to detect temperatures of planets and stars through the sky survey called IRAS, turned into a life saving instrument we can carry around in our hands. We saw that the NCIT developed from this infrared technology aided in covid early screening was vital for patient mortality. NCITs helped reduce cross contamination and aided regular temperature checks which saved many peoples lives, as the longer the symtoms go unchecked the harder the diagnosis becomes which can lead to many deaths. Today NCITs have become one of the largest medical equipment markets, at $700 Million worldwide and have replaced the mercury thermometers and are going to replace the digital contact thermometers which is a stark contrast to people's reluctance to use it three decades ago. Without NASA there would have probably been a higher death toll during the pandemic. While surely such technology would have developed eventually, it was only due to NASA that this technology aleady existed when it was needed.

References

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